Land Inventory of East Gippsland - A Reconnaissance Survey

January 1996

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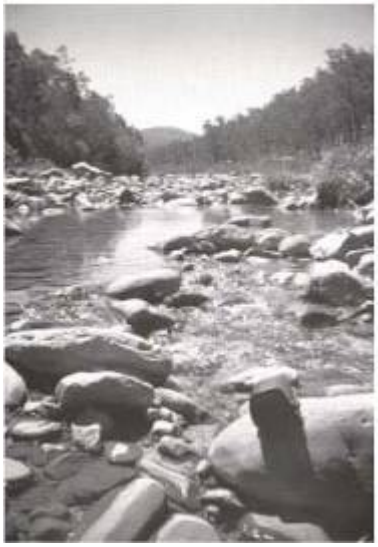
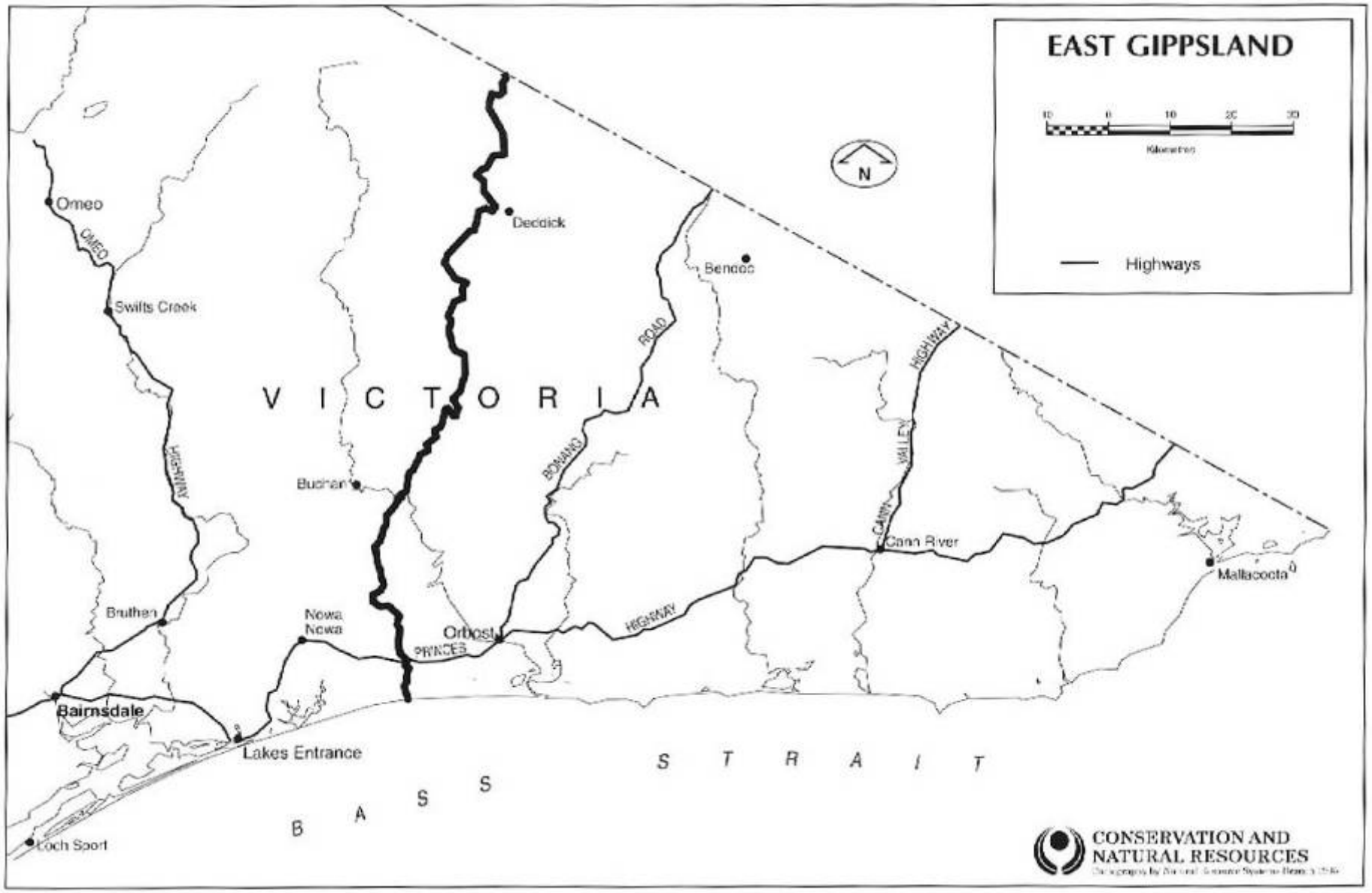
ABSTRACT
This study has developed out of a need for land inventory information for the East Gippsland region.

The approach used in this report mirrors that of Schocknecht (1988). It is a reconnaissance survey at a scale of 1:100 000, and also provides some laboratory data on soil characteristics which will facilitate a number of assessments. This data will be useful for a variety of planning activities. It also covers consistently the area east of the Snowy River in one study incorporating other data sets such as vegetation patterns. The map units are portrayed in a map atlas form, the study area being covered by 14 maps.

This study provides the basic structure of a Land Systems approach with mapping units based on a range of physiographic variables and climate. The report also provides some indication of divisions within each mapping unit and some of the relationships between mapping units. The information available here has a number of applications including forestry planning, landcare activities and planning on freehold land. The map units are already been used by local staff of the Department of Conservation and Natural Resources for a range of activities associated with the public and freehold land and are part of the information base for the Forest Management Area Plan (FMA). A number of landholder (landcare) groups have taken interest in this information and have held forums where this type of information has been presented. This information may also be a basis for further training and education on land characteristics and behaviour for a range of people including the Department.

ACKNOWLEDGMENTS
I would like to thank Mike Austin, David Howe, Heather Anderson and James Matters from the former Land Protection Division and Greg McCarthy, Peter Humphrey and other officers from the East Gippsland catchments of the Department of Conservation and Natural Resources. Special thanks to Pat Davies and Linda Hewlett for word processing and data base management. Thanks also to Peter Livitsanis, Les Russell, Nathalie Baxter, Heather Anderson, Kath Ferrari, Evan Jones and Grant Boyle.




EAST GIPPSLAND
Highways
N
Omeo
OMEO
Swifts Creek
HIGHWAY
Deddick
Bendoc
ROAD
BONANGO
HIGHWAY
CANN
VALLEY
Buchan
Cann River
Mallacoota
Bruthen
Nowa
Nowa
Orbost
PRINCES
HIGHWAY
Bairnsdale
Lakes Entrance
Loch Sport
V I C T O R I A
B A S S
S T R A I T
CONSERVATION AND
NATURAL RESOURCES

PART A FEATURES OF THE LAND

A.1 INTRODUCTION

This report is part of an approach by the Land Protection Branch, of the Department of Conservation and Natural Resources (CNR) to increase the coverage of Victoria with land inventory studies. The general outline of the survey was initially discussed and followed through with the co-operation of the East Gippsland catchments of CNR. It has also been the aim of the Branch to standardise the methodology and presentation of individual land inventories as much as possible. The methodology is based on categories and definitions that have been compiled for use Australia-wide, so that comparisons can be easily made between land inventories.

One of the most recent examples of a reconnaissance land inventory (1:100 000 scale) by the former Land Protection Division is by Schoknecht (1988) and this document has been used as a model for the East Gippsland study.

The report covers the former Orbost Region of the former Department for Conservation and Environment, now the East Gippsland catchments of the Department of Conservation and Natural Resources; east of the Snowy River and covers an area of approximately 9,300 square kilometres.

Ordovician sediment bedding, near Mallacoota

The aims of the report are:

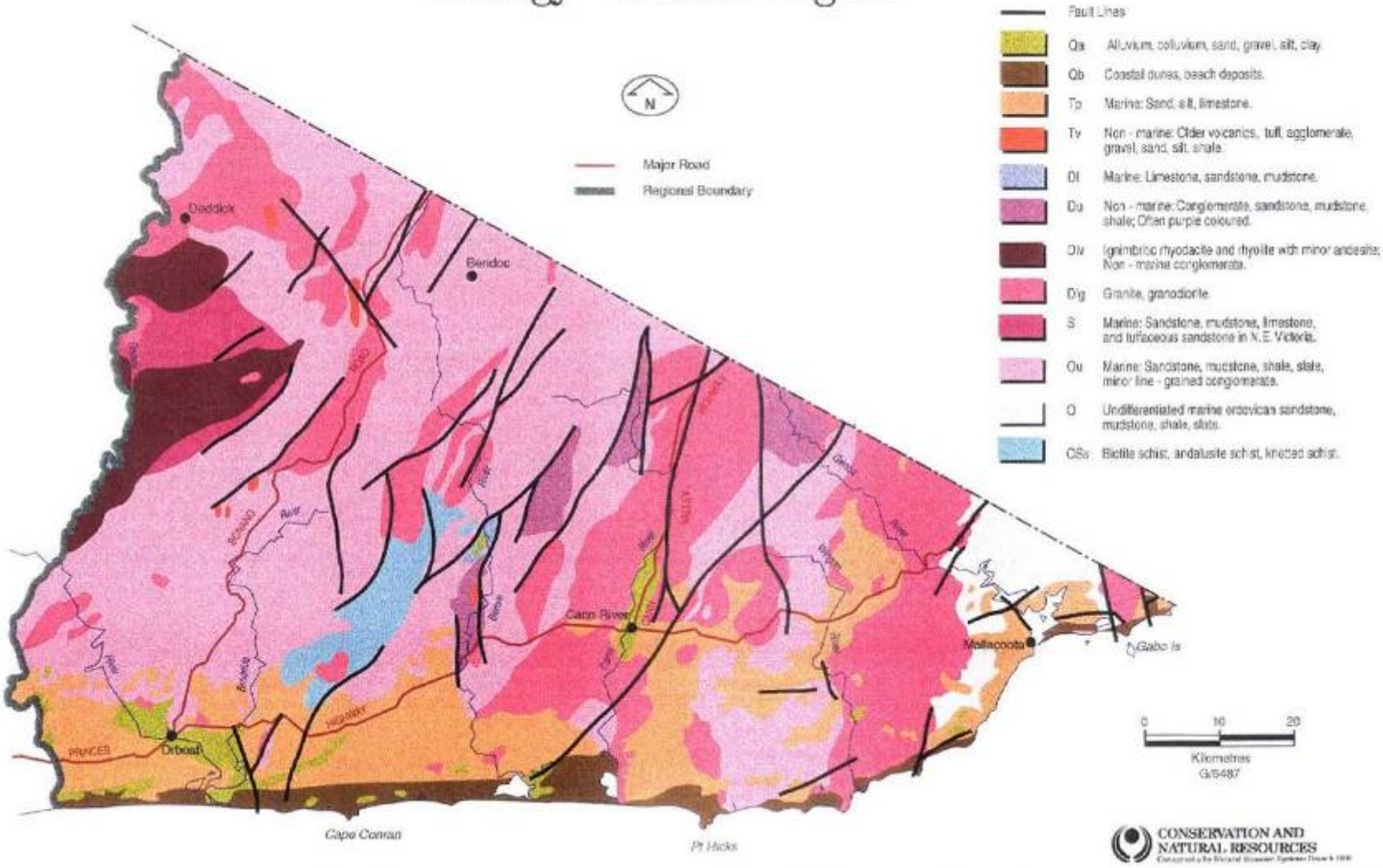
- to provide basic information, at a scale of 1:100 000, on the nature of the land in the former Orbost Region of the Department of Conservation & Natural Resources including;
  - a) natural characteristics (i.e. geology, landform, soils, climate and native vegetation)
  - b) land use
  - c) land deterioration
  - d) susceptibility to processes of land deterioration
- to provide a framework for further, more detailed, land inventory and assessment surveys; and
- to highlight complex areas and indicate where more detailed mapping would be beneficial.

The map units are broad `packages' of land - divided primarily on the basis of landform pattern and geology, but also after consideration of the other, and often dependent, land attributers of soil type, climate, native vegetation, land use and land deterioration.

The report consists of four parts: Part A describes the features of land in general terms, Part B describes the individual mapping units in detail, Part C gives a brief discussion of methods and land characteristic interactions and Part D is the appendices.

The maps and the information they contain should not be used beyond the scale intended - that is, a broad reconnaissance survey. In particular, the report should not be used to predict soil or land features at a specific site in other than the broadest sense. The mapping is at a broad scale, and is suitable for interpretation at a regional level. Subsequent more detailed inventory or assessment surveys, using this reconnaissance survey as a guide, should be carried out as the need arises.

Geology - Orbost Region



The Coastal plains and low hills are located inland of the Coastal Dune Systems and consist of plains and dissected areas, forming rises and low hills predominantly on Tertiary sediments.

The Tertiary sediments consist of sand, gravels, silt and clay, with consistent sandy surfaces but variable sub-surface layers. Quaternary (early-mid) sediments are also evident at the lower elevations including the Snowy River and Cann River valleys and occasional aeolian cappings. Dissection of Tertiary material has exposed Ordovician (older) sediments and metamorphics consisting of siltstones, schists and sandstones. The older sediments and metamorphics extend northward in low hills and hills. There are also a number of Devonian age granitic outcrops (granite or granodiorite) of varying extent i.e. Murrungowar pluton.

The dissected hills and mountains occupy the area south of the plateau, north of the Tertiary sediment outcrops and low hills and also to the east of the region. The geology of these areas include older (Ordovician and Silurian) sedimentary, Snowy River volcanics (Devonian rhyodacite), and granitic plutons which have been delineated on pluton location and mineralogy. There may also be minor alluvial (Quaternary) areas within this overall physiographic area. The Snowy River Volcanics also includes some coarse sandstone and conglomerate.

The plateau, high hills and mountains include the north and north-west area of the region and is characterised by the undulating plateau and low hills of the Errinundra Plateau area, the dissected and mountainous terrain including the Snowy and Rodger River basins within the region and the area north of the Deddick River valley including the Mt. Tingaringy area. The lower less dissected country is generally granitic (Devonian granodiorite, granite) and there are a few Tertiary basalt cappings.

The higher terrain is predominantly older sedimentary (Ordovician, Silurian) and also Snowy River Volcanics (Devonian rhyodacite) which may include some coarse sandstone and conglomerate. The latter underlies the Gelantipy Plateau. A number of upthrown blocks have exposed Devonian sediments which include a distinctive series of 'red-beds' such as those at Combienbar and Buldah.

A.2.1 Geological Mapping

The geology of the region is based on investigations by the Geological Survey group of the Department for Industry, Technology and Resources. Current available geology maps include the 1:250 000 scale Mallacoota and Bairnsdale sheet. There are a number of 1:50 000 scale sheets being compiled which have updated information such as the Bendoc and Murrindal sheets. There are no plans at present to have such maps produced further east at this stage.

Some work related to the geology of the region has been published (Hough and Beams (1979)).

Modification of the 1:250 000 scale sheet data by the information supplied for the 1:50 000 sheet suggests that the major modifications to the generalised map are the distribution of granitic areas around the Errinundra Plateau, and the extension of the Snowy River Volcanics north-east of Waratah Flat.

Access variability has meant that checking and designation of landform units varies over the region. Access is particularly difficult in the National Parks within the study area.

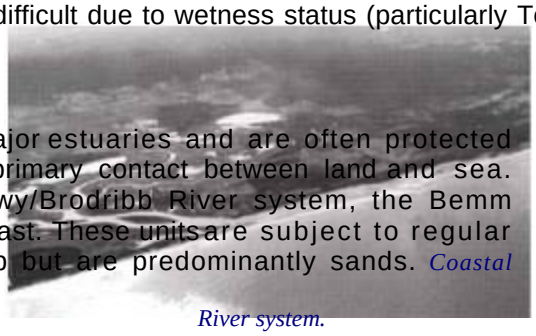
A.2.2 Landform

A.2.2.1 Swamps

These low-lying areas are characterised by constant high moisture status, flat terrain and well defined boundaries. The major examples are Tonghi Swamp, Wingan Swamp and also to the east of the Howe Range -- the far east of the study area. Access to these areas is difficult due to wetness status (particularly Tonghi) and remoteness.

A.2.2.2 Coastal flats

Coastal flats generally occupy areas in and around major estuaries and are often protected by primary dune and beach systems which are the primary contact between land and sea. Coastal flats are located at the mouth of the Snowy/Brodribb River system, the Bemm River and the Wallagaraugh River; Mallacoota Estuary east. These units are subject to regular inundation and have a varied sedimentary make-up but are predominantly sands.



Coastal flats at the mouth of the Snoxy/Brodribb River system.

A.2.2.3 Dunes

The Dune/foreshore systems are the primary contact between land and sea and form a variable degree of protection for the land from the sea. A major example of this landform is found at the Thurra River estuary.

Dunes are formed by wind and vary in size and steepness. Much of the region's coastline consists of dunes. There are a number of cases of dune systems overlying solid geology such as at Cape Conran where a dune system overlies a granitic outcrop.

A.2.2.4 Plains

These map units are generally flat or gently undulating alluvial areas. The various components of such plains (alluvial) are floodplain, back plain, levee, terrace, ox-bow lake (billabong) and other prior channels. There may be minor steeper areas such as the edge of terraces and incised streams.

Plains units are dominated by the extensive Snowy River flats and the Cann River Valley. However, there are also alluvial Plains units along most major drainage networks. These are not only located near the coast but are also found at a high elevation inland on the upper surface (plateau) associated with the Queensborough and Delegate Rivers.

Given the range of source material and topographic position these units are often distinctive in terms of soil properties although there may be some commonality. There is generally a high organic matter content, particularly for the surface horizons, and silt dominant uniform profiles are often found at active river banks and associated with levees. Due to the higher organic content and residual material these units are generally quite stable unless the hydrological regime has been altered. These units are often boundary units between different geologies.

A.2.2.5 Rises

These units generally have an undulating topography (3-10% slope) but due to the general physiography their distribution is limited in this region. More specific mapping at larger scale would allow greater differentiation between Rise and Low Hill categories which relates to relative relief. These units are predominantly associated with undulating Tertiary sediments, located around Orbost, Cabbage Tree to Bemm River, Thurra River and west of Mallacoota. Map units designated as Rises would not be out of place on the plateau on both granitic and older sedimentary terrain but are currently incorporated by Plateau and Low Hill categories, due to scale and dissection considerations.

A.2.2.6 Low hills

These map units occupy a sizeable proportion of the region but are mainly found in the coastal Plains/Low hills area based on Tertiary sediments or on the plateau to the north, on granitic and sedimentary terrain.

The low elevation Low hills units are characterised by broad crests and gain their Low hill category by virtue of the degree of drainage line dissection of the Tertiary sediments. This has been accentuated by a sandy surface which has prompted rapid infiltration. There are also Low hill units on granitic geologies, again with sandy surface soils. Low hill units on older sediments are located at lower elevations as lower gentle slopes and as minor hills and also associated with hill units at higher elevations (plateau; south and east of Bendoc).

While there are a range of Low hill units at variable elevation generally with a rolling topography (10-32%), topographic position is another determining factor in map units classification. There are the lower slope or isolated Low hill units which have their own connotations for land performance given any disturbance and the effect on the local hydrology. There are also the cappings or crests on Hill units which are significantly different from their surrounding ridge/ravine type topography. Characteristically, these elevated units have broad crests and may or may not alter the local hydrology. An example are the basalt cappings especially at Bonang and on Paradise Ridge road which have altered the local hydrology and geomorphology. This topographic position allows greater drainage whereas the lower elevation and low topographic position units are receiving moisture from higher up the slope.

A.2.2.7 Hills

These land units are extensive on all geologies, particularly at lower elevations and on the plateau associated with the granitic area of the Deddick/Amboyne area and the Errinundra Plateau (older sedimentary and granitic).

Hill units generally occupy the lower and mid elevations between the low hills and the mountains (north) and include such areas as the older sedimentary terrain north and west of Mallacoota, Club Terrace, Orbost and Buldah areas and the granitic areas north-east of Mallacoota (Howe Range), Genoa and the Cann River area. Hill units are generally rolling (10-32%) or steep (32-56%) and have variable topographic positions. Hill units also occur on metamorphosed sediments (schists) north of Murrungowar and at various contact zones as there are quite a number of separate plutons.

Some of the hill units (east of Cann River) on granitic terrain may have variable Quaternary/Tertiary sand sheet deposits on the crests and upper slope which varies the response to land disturbance. This also applies to some of the older sedimentary terrain, west of Mallacoota. There are also units associated with the Snowy River Volcanics.

A.2.2.8 Mountains

These map units have a large relative relief (>300 m) and form the main topographic units between the coastal/lowland area and the plateau to the north. They are generally steep (32-56%) to very steep (56-100%) and occasionally precipitous (>100%) or rolling (10-32%). The land unit type is found on older sedimentary, granitic and acid volcanic geologies.

Mountain units have the most dissected terrain of the region, in contrast to the low hills on Tertiary sediments. This dissection is especially marked on the older sedimentary terrain, especially in the Snowy River and Tingaringy National Parks. This has many implications for land performance after land disturbance. There are factors such as aspect, topographic position and stream density which tend to complicate the determination of soil and vegetation distribution patterns. There is also the monadnock of Mt. Delegate.

A.2.2.9 Scarps

These map units are often dramatic features but vary in scale within the region. These predominantly very steep map units are generally at the edge of plateau surfaces. They may be the result of rapid downcutting and dissection, faulting and folding and preferential erosion. There are the smaller scarps such as along the Queensborough River area (river cliff) and Mt. Merringuen. There are the larger scale scarps such as the Yalmy (Road) scarp which is along a geological boundary (fault) and scarps within the Snowy River National Park, where there has been deep downcutting.

A.2.2.10 Plateau

There are a number of Plateau surfaces, basically the edge or remnants of the NSW plateau surface. Within the region there are Plateau at Errinundra, Gelantipy, Mt. Canterbury and Mt. Tingaringy. In some cases, the scale of observation suggests Low hills or Rise topographic categories given the degree of dissection, however, the overall landform is that of a Plateau. Therefore there may be a number of components to the general Plateau category.

The Errinundra Plateau with its highly variable spatial distribution rainfall has a corresponding spatially variable distribution of vegetation and soil types, predominantly on older sedimentary and granitic terrain. The Gelantipy Plateau is dominated by Snowy River Volcanics (rhyodacite) and has a moister climate, vegetation and soil regime than the surrounding lower elevation areas, particularly to the north where the rainfall gradient drops markedly.

A.2.2.11 Entrenched Valleys

These features are a specialised landform where rapid down cutting or uplift have been major geomorphological agents. The main examples within the region include the Genoa Gorge which runs through sedimentary and granitic terrain. Cabbage Tree Creek valley has also been incised to form an entrenched valley.

A.2.3 Geomorphic processes influencing landform patterns

A.2.3.1 Differential erosion

Soil parent materials vary in their resistance to erosion, which together with the time they are subject to weathering influences landscape development.

There are differential erosion rates between the major geological types and there is also differential weathering within the major geological types. The older sedimentary terrain is the oldest in the region (Ordovician, Silurian and Devonian) and is generally the most dissected geological type in the region. These sediments have been subject to folding, faulting and the formation of metamorphic zones both local and extensive on contact with numerous granitic plutons (Devonian).

Within the broad old sedimentary category is a lithological variation of various siltstone, sandstones, shale and phyllite. At the specific scale there are variations in weathering and hence in soil development due to lithological variation. Thinly bedded silt/claystone is more easily weathered than thicker bedded sandstone. Contact metamorphism makes the sandstone much harder.

Schists and shales, are the predominant metamorphic materials. Granitic areas also have weathered differentially with some areas being prominent (Mt. Kaye area) and other areas weathered before the sedimentary terrain (Deddick Valley).

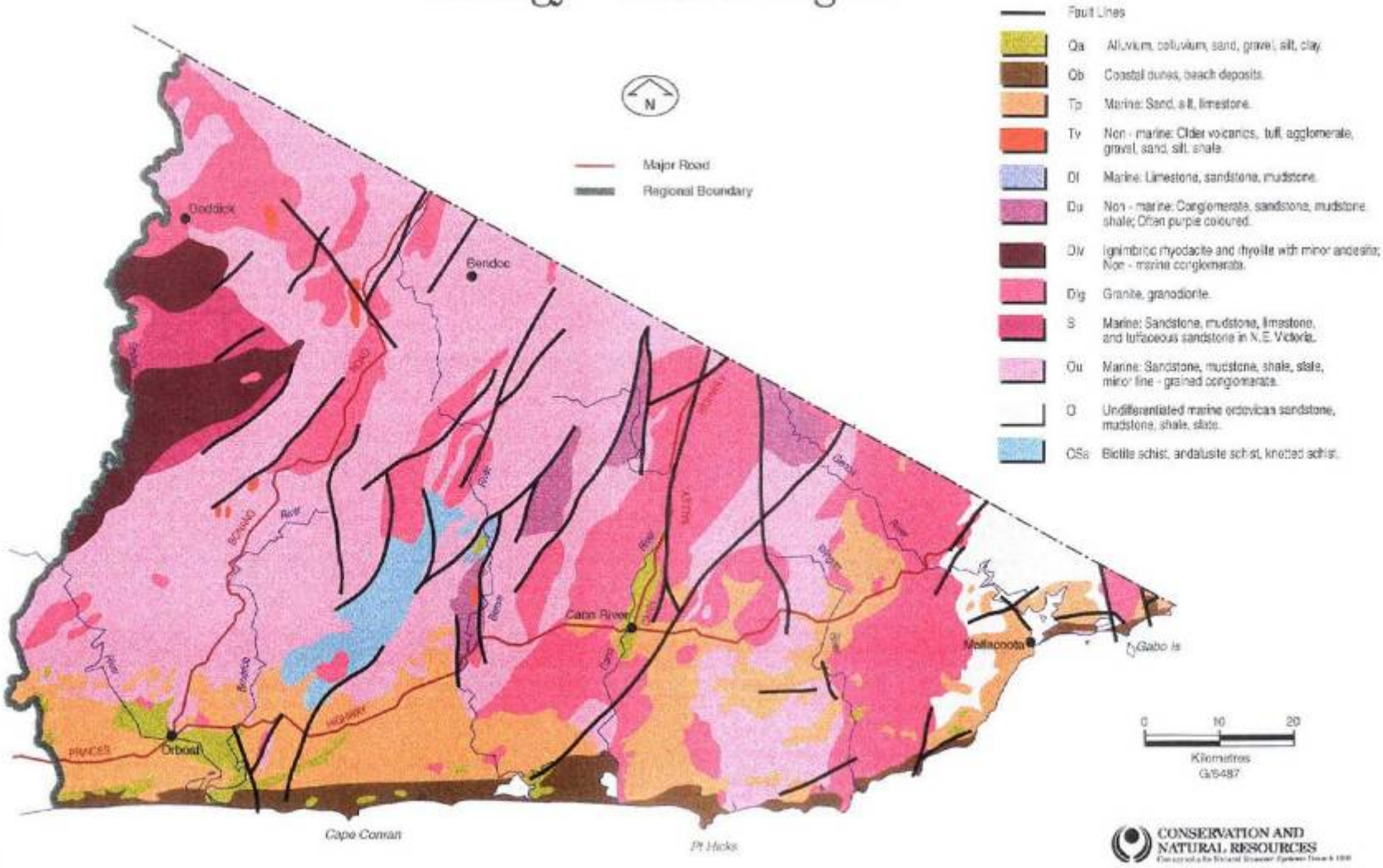
A.2 GEOLOGY AND LANDFORM

The region has a variety of geology and landform. The physiography of the region can be divided into four broad groupings:

- coastal dune systems;
- coastal plains and low hills;
- highly dissected hills and mountains; and
- plateau and high elevation hills and mountains.

The coastal dune systems occupy most of the Region's coastline and consist of a number of small and large dune systems with some associated swampy areas. The geology is Quaternary, mainly of Recent origin, and generally consisting of sands.

Geology - Orbost Region



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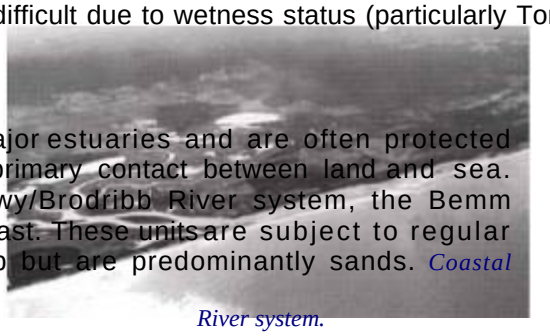

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A.2.3 Geomorphic processes influencing landform patterns

A.2.3.1 Differential erosion

Soil parent materials vary in their resistance to erosion, which together with the time they are subject to weathering influences landscape development.

There are differential erosion rates between the major geological types and there is also differential weathering within the major geological types. The older sedimentary terrain is the oldest in the region (Ordovician, Silurian and Devonian) and is generally the most dissected geological type in the region. These sediments have been subject to folding, faulting and the formation of metamorphic zones both local and extensive on contact with numerous granitic plutons (Devonian).

Within the broad old sedimentary category is a lithological variation of various siltstone, sandstones, shale and phyllite. At the specific scale there are variations in weathering and hence in soil development due to lithological variation. Thinly bedded silt/claystone is more easily weathered than thicker bedded sandstone. Contact metamorphism makes the sandstone much harder.

Schists and shales, are the predominant metamorphic materials. Granitic areas also have weathered differentially with some areas being prominent (Mt. Kaye area) and other areas weathered before the sedimentary terrain (Deddick Valley).

A.3 CLIMATE

A major characteristic of the climate of East Gippsland is the effect of both westerly and easterly weather systems. The latter is associated with depressions in the Tasman Sea, off Gabo Island which brings warm, moist air. This is a continuation south of the weather pattern that affects south-eastern New South Wales (NSW). This easterly climatic influence decreases westward, particularly west of Lakes Entrance but the interaction of climatic influences is more complicated inland where topography (including elevation) is elemental in influencing macro- and micro-climates, including rain-shadow areas. The distribution of climatic influences has important bearing on the distribution of vegetation and soil types.

There is a general lack of information on climate within East Gippsland catchments except for a small number of data collection points. These are the main population or nodal centres such as Orbost, Cann River, Mallacoota, Bendoc and Bombala (NSW) and specific use sites such as Point Hicks, Gabo Island and Errinundra Forestry Camp.

There is, therefore, a need to extrapolate and/or collect more data in the less accessible areas in order to improve the knowledge of the spatial (including elevation) distribution of climatic data. Rainfall is the most widely measured climatic variable but data are mostly only available for valley or lowland locations.

A.3.1 Temperature

Given the lack of spatial data, only general inferences can be made. The southern, coastal areas are generally mild with the moderating sea influence. Further inland maximum temperatures increase and minimum temperatures decrease. This trend develops further away from the sea, while with increasing altitude both maximum and minimum temperatures decrease.

January and February are the hottest months with average maximum mean daily temperatures being 25.2°C for Bombala (January) inland, 25.4°C for Orbost (February) and 21.4°C for Gabo Island (February). Temperatures are lower in July with average minimum mean daily temperatures being -1.2°C for Bombala, 4.1 °C for Orbost and 8.1°C for Gabo Island (Bureau of Meteorology, 1975). These values indicate the range of mean daily temperatures illustrating the large range of an inland (continental) climate 26.4°C (Bombala); with varying degrees of coastal (maritime) influence (Orbost: 21.3°C, Gabo Island; 13.3°C). Figure 2 indicate the average daily maximum and minimum temperatures throughout the year at selected stations.

A.3.2 Frost

The occurrence of frost depends on a number of factors, mainly the air temperature and humidity. Wind speed and cloudiness as well as site factors such as the type and density of vegetation cover and slope also affect the occurrence of frosts. Frosts are very site-specific, therefore, extrapolation of frost information is not reliable. In terms of temperature alone, light frosts are associated with temperatures of 0° - 2.2°C and severe frosts below 0°C.

Frosts are most common in the winter months but may occur over a much larger period (Autumn to Spring) especially in inland areas. For example, Bombala has frost occurrences from April to November with a peak in July (average 23) while there are only the occasional frost at Point Hicks (average 0) and none at Gabo Island. There is some evidence that Bendoc has lower temperatures than Bombala and has a greater frequency of frost spread over a greater part of the year. Frosts have major implications for agricultural and forestry activities.

A.3.3 Snow

Snow falls are restricted to the higher ground but have not been measured. Snow falls are influenced by a number of factors and may be subject to sizeable variations given topographic and micro-climatic variations.

A.3.4 Rainfall

Most precipitation occurs as rainfall apart from some snowfall on the plateau and other higher elevation areas. There is more data on rainfall. The average annual rainfall ranges from less than 700 mm in rain-shadow areas such as the Deddick River Valley to over 1700 mm on the Errinundra Plateau, though there are few sample sites for spatial distribution.

The special position of East Gippsland in relation to converging weather patterns means that there is a generally even distribution of rainfall throughout the year compared with other parts of the state. For most rainfall stations the peak average monthly rainfall is (predominantly) either May or June, with Spring and early Summer providing the major peak for some sites or secondary peaks for many sites.

For the coastal sites there is little or no secondary peak in November as with sites further west or inland, the distribution being relatively even apart from a peak around May and June.

The drier areas (<700 mm) tend to have the most even yearly distribution of average monthly rainfall. These patterns indicate a change of climate from east to west and also with distance inland and are illustrated by the diagrams indicating the variations in average monthly rainfall and average maximum and minimum daily temperatures. (Figures 3 to 7)

There is a generally very moist area which extends south from the Errinundra Plateau almost to the coast (Featherstone *et al,* 1987.) There is also a marked rainfall gradient to the west, north-west and north where rainfall amounts decrease rapidly as in the Bendoc Area.

There are a number of smaller high rainfall areas such as the Gelantipy Plateau within the Snowy River National Park and also in the Mt. Drummer area, east of Cann River township.

The driest areas are associated with the elevated surfaces of the Deddick Valley and north of Bendoc which are rain-shadow areas. This fact is amply illustrated by the type, growth and distribution of the vegetation cover.

The frequency of high 24-hour falls (over 75 mm) is greater for East Gippsland than any other part of Victoria.

A.3.5 Effect of climate on plant growth

Temperature significantly affects plant growth. At average daily temperatures less than 10°C plant growth is reduced and virtually ceases below 6°C. This has implications for a number of areas particularly the areas to the north at higher elevations. The months with less than 10°C average daily temperature are shown in Table 1 for a number of locations.

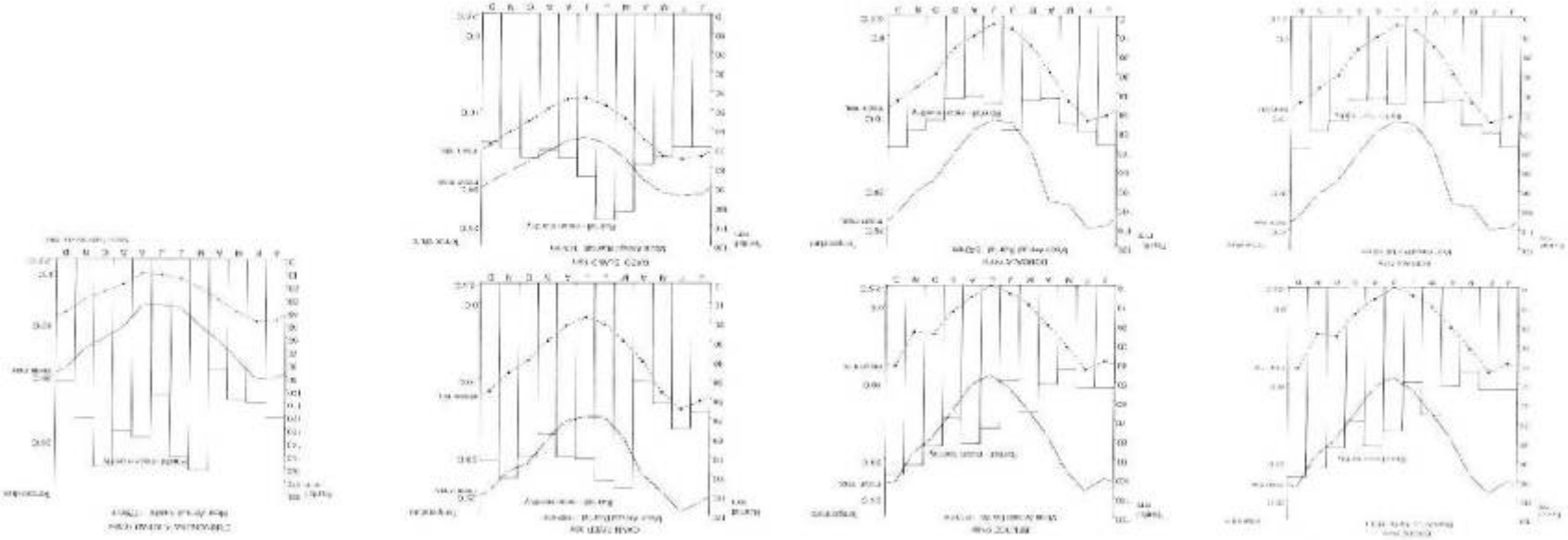
Table 1. Months where average daily temperature less than 10°C

Location	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov
Gabo 1									
Orbost		---	---	---	---	---	---	---	
Nowa Nowa				---	---	---	---	---	---
Cann River	---	---	---	---	---	---	---	---	
Bendoc	---	---	---	---	---	---	---	---	---

Source: Commonwealth Bureau of Meteorology (1975, 1988)

A.3.6 Effective rainfall

This concept is useful as it is a guide to the amount of moisture in the soil that is available to plants. Effective rainfall takes into account the evaporation from an area in relation to the rainfall so that rainfall exceeds potential evapotranspiration. Therefore while effective rainfall will be lower for the drier areas, those areas with lower temperature regimes will be subject to further stress which will in total give an indication of growth periods. Other factors to be taken into account at a site level include; drought tolerance of species, elevation and aspect and soil type and depth which may be very important for water storage. For a guide for selected sites see Land Conservation Council (1974).



A.4 SOILS

Soils are the product of complex interactions between factors such as climate, parent material, biological activity, topographic position and time. The role of time on soil formation is especially important, firstly because many soil-forming processes are slow, and secondly because environmental conditions may change over time and hence a soil may be the product of a number of soil forming conditions.

Soils of apparently different ages were observed in the study area, and their characteristics are discussed further in Part C.

A.4.1 Classification of the soils

The soils are classified according to the Factual Key (Northcote 1979), and written descriptions are also givento accompany the classifications. They are initially separated into four principal profile forms:

Uniform soils - soil profiles dominated by the mineral fraction with small, if any, textural change with depth

Gradational soils - soil profiles dominated by the mineral fraction and gradually becoming increasingly finer-textured (more clayey) with depth; and

Duplex soils - soil profiles dominated by the mineral fraction and having a pronounced and clearly defined texture contrast between the A and B horizons, which usually coincides with a marked increase in clay content.

Organic soils, in which the profile is dominated by the organic fraction, were not observed in the study area.

Each primary profile form has been subdivided according to colour, structure, soil reaction (pH trend throughout the profile), mottling, soil depth, characteristics of an A2 horizon if present, and surface condition.

Limited chemical or physical analyses were performed. Where possible, relatively undisturbed sites were selected and the soils were described and classified from exposures in gullies and roadside cuttings, or from samples obtained from hand augering.
For some sites the Australian Soil Classification (Isbell, 1995) has been used and will be used more in the future.

A.4.2 Description of the major soil groups

Gradational and duplex soils are the common basic soil types within the study area. They are predominantly brown, red and yellow with the red and brown gradational variants being associated with the higher rainfall areas. Duplex profiles are associated with drier areas and generally lower topographical position while shallow uniform and gradational profiles are found on steeper slopes (upper) and on crests such as granite.

Deeper uniform profiles (generally coarse) are associated with some lower rolling Hill/Plain units and with some alluvial deposition, where there may also be multi-layered profiles. There are some organic dominant A horizons associated with some upland moist areas, and a few organic peaty profiles are limited to a few alluvial and other minor areas.

A.4.2.1 Uniform soils

Soils with uniform texture profiles ranging from sands to clays occur on a variety of parent materials and landscape positions. The sandy soils are generally derived from coarser grained rocks and unconsolidated deposition (either by wind or water). The clayey soils are usually derived from fine grained rocks and unconsolidated deposition.

A.4.2.1.1 Coarse sands/gravel

Uc1.2, Uc1.42, Uc2.12, Uc2.21, Uc2.31, Uc2.33, Uc4,23, Uc5.11, Uc5.13, Uc5.21, Uc5.22, Uc5.31, Uc6.11, Uc6.14

Coarse sandy soils occur in a number of different situations. They occur close to granitic outcrops and are generally shallow, with limited to minor surface organic accumulation with a darker colour than the lighter coloured mineral horizon. Uniform coarse profiles also occur on Tertiary deposits which can be extensive, deep and have variable sand and gravel content depending on depositional history. There is often a grey sand (aeolian) with variable organic matter content overlying a yellow sand with some nodulisation or rounded gravels, or marl at depth. The dune sequences (Quaternary) are coarse sandy soils which often have a grey/pale sand overlying a humic pan of variable thickness which overlies a deep yellow sand (Podosol).

Coarse sandy soils generally have a high permeability, low nutrient status and low water holding capacity. They are susceptible to wind erosion and slow to regenerate when disturbed. They do not support high grade

pasture and are drought prone. Banksias are often dominant on these soil types. Coarse sands are dominant in map unit groupings DuK, DrK, DsK, LuT2, LrT2 and also occur in LuT1, LrT1, LuG, LrG, HrG, HsG, MsG and SsG unit groupings (particularly the drier units). These soils are generally classified as Rudosols and Tenosols in the Australian Soil Classification (Isbell, 1995).

A.4.2.1.2 Alluvial soils

Uc1.43, Uc2.21. Uc2.33, Uc4.23, Uc5.1/31,Uc5.13, Uc5.22, Uc6.14, Um4.24, Um5.42, Um6.1/31, Um6.21, Um6.22, Um7.11, Uf6.41, Gn2/4.52, Gn3.41/4.41, Dr4.11, Dy2.11, Dy3.11, Dy3.12, Dy3.41, Dy5.11, Dy5.41, Dd1/2.11, Dd2/4.11

Uniform (coarse) sandy or loamy (Uniform, medium) soils occur on recent alluvial deposits. These soils vary markedly in their pedological development ranging from only minor organic matter accumulation at the surface to soils with well developed horizons. There may also be buried soils beneath the newer alluvial accumulation. The depth of deep organic matter accumulation which will determine whether the profile is considered Uniform or Duplex.

Deep silty/fine sandy loams often occur on levee banks and close to major streams such as the Snowy and Cann Rivers, with little or no structure but some surface organic matter accumulation. These soils are often fertile and suitable for agriculture but may be limited by flood hazard.

There are minor occurrences of Uniform (fine, clay) profiles. Alluvial soils occur in most Plains units (PlA, PgA), developed from surrounding areas, and range from Uniform coarse to Duplex profile soils. These soils are generally classified as Tenosols, Rudosols and Chromosols in the new Australian classification (Isbell 1995).

A.4.2.1.3 Yellowish brown and brown stony loams

Um5.51, Um6.14, Um6.1/31, Um7.11

These soils occur on the steeper slopes and sharper crests of dissected sedimentary terrain. They are shallow and consist of a thin fine organic A horizon over a moderately structured stony B horizon, silty loam to clay loam which grades into fractured rock (generally thinly bedded siltstones, mudstones and sandstones). These soils are generally on drier terrain or northerly aspects. A combination of shallowness, low water holding capacity and low nutrient status in conjunction with well-drained terrain result in low productivity and restricted native vegetation growth.

There are also shallow friable loams in moister areas with variable stone content. Some Uniform (medium) textured profiles are also associated with granitic areas with high precipitation.

These soil types are generally associated with upper slopes and crests and occur in LrS, HrS, HsS, MsS, MrS, HrG7 and MsG7 groups of units. These soils are generally classified as Tenosols, Kurosols and Dermosols in the Australian Soil Classification (Isbell 1993).

A.4.2.2 Gradational soils

These are soils that have a gradual increase in texture with depth and are common on sedimentary, granitic and basaltic terrain particularly in moister areas and on upper and mid-slopes. Surface textures range from organic sandy loams to organic clay loams and subsoils from light sandy clay loams to clays.

The lighter sandier profiles are generally associated with granitic parent material. Soil depth varies markedly depending on weathering of parent material, lithology, topographic position, aspect and climate. Generally the shallower profiles occur higher up the slope and on crests and spurs.

A.4.2.2.1 Red brown gradational soils

Gn2.11 Gn3.11, Gn3.12/3, Gn3.14, Gn3.71, Gn4.14, Gn4.31

Red and brown moderately to strongly structured (fine) friable gradational profile soil types are dominant in the moister areas and in most topographic positions within these areas. There are some differences between profiles on different parent materials i.e. sedimentary (including limestone), granitic and basaltic. Soil depth is variable on all parent materials, correlating with topographic position, aspect and lithology, as is stone content.

On granitic terrain, the topsoils are organic sandy loams with sandy clay loam to sandy clay subsoils often with a coarse component throughout the profile. Topsoils for sedimentary and basaltic terrain are generally organic loams to clay loams and subsoils of clay loams to clay. The soils are well drained, friable and stony on upper and steep slopes. In the wettest areas the profiles tend to be brown throughout

Although all these profiles drain well and form an excellent medium for root growth there are marked differences in fertility depending on the parent material. These profiles are highly leached in most cases with pH <5 on sedimentary terrain with a low proportion of bases available for soils on sedimentary and granitic terrain apart from the weathering front (regolith) and therefore generally low to moderate fertility but with a high proportion of organic matter in the upper horizons.

However, there is a much higher proportion of bases available (greater fertility) on the limestone and basaltic terrain and generally smaller proportion of free hydrogen, aluminium and iron and therefore higher pH values than the sedimentary terrain. The basaltic terrain (minor occurrences) has higher fertility than other parent materials as is evident from the comparative vegetation on that terrain.

These soils are common in HrSv7, HrSh7, LrSh/v7, HsGh7, HsGv7, HrL, LrB, HrsSh8, HrsSv8, MsSh8 and MsSv8 units. These soils are generally classified as Dermosols, Kandosols and Ferrosols in the Australian Soil Classification (Isbell 1993).

A.4.2.3.1 Red, brown and yellow brown gradational soils

Gn2.52, Gn3.21, Gn3.22, Gn3.71, Gn3.84, Gn4.51/2.

These soils occur mainly on sedimentary terrain with some on granitic terrain, generally in less moist areas than the red and brown friable gradational profile soils. These soils tend to dry out for at least part of the year and generally have a hardsetting nature particularly in the A horizons (upper soil horizons). The subsoil (B horizon) may be hardsetting or may be friable and moist depending on topographic position and micro-hydrology (i.e. drainage heads).

These soils are shallow and stony on upper slopes but deeper on mid and lower slopes (particularly if developed on colluvium), with moderate to strong structure, though there is less structure in the lower A horizon. If this feature develops to a greater extent than with greater eluviation and illuviation the gradational profile becomes a duplex profile.

This range of soil type is common over much of the moderately humid climatic zone.

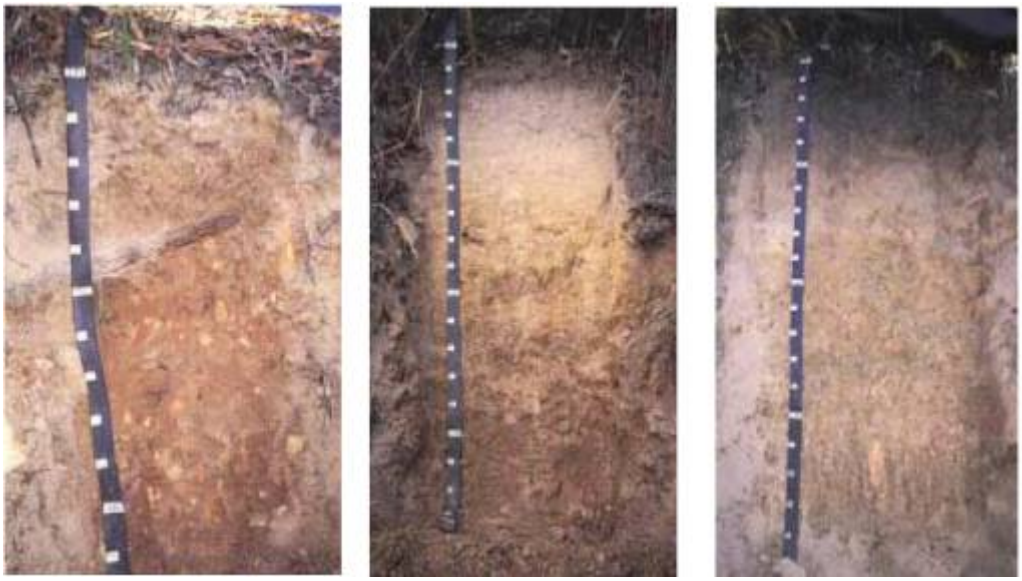
Textures of these soils range from organic sandy loams to loams and silty loams and subsoils of sandy, silty clays and other clays. Minor mottling may occur in the subsoil; generally greater on lower slopes, lower terrain and deeper and drier profiles. Fertility is generally low due to the lithology's (age, weathering) but is occasionally moderate. Surface organic matter content is of variable depth, generally according to topographic position and aspect.

These soil types occur in LuS, LrS, HrS, HsS, MsS, MvS, LrG, HrG, HsG, MsG, MrG, LrT and HsT groups of map units, particularly in the moderately humid climatic areas. These soils are generally classified as Dermosols and Kandosols in the Australian Soil Classification (Isbell, 1993).

Top row from left to right: Multiple profile near Orbost (Site 190) developed on rounded Quaternary gravel over mottled Tertiary clay. Db2.21 (Northcote), Brown Kurosol (Isbell).

Yellow Duplex profile near Orbost (Site 197) with a bleached A2 developed on Ordovician thinly bedded sediments. Dy3.41 (Northcote), Brown Chromosol (Isbell).

Deep red Gradational, strongly structured profile near Mt Buck, north of Orbost; developed on Ordovician sediments. Gn3.11 (Northcote), Red Dermosol (Isbell).



Bottom row from left to right: Stony brown Duplex profile near Mt Buck, north of Orbost developed on Ordovician sediments; spur site. Db2.41 (Northcote), Brown Kurosol (Isbell).

Deep yellow Duplex profile with bleached A2 at Cann River, developed on clayey Tertiary sediments. Gn? (Northcote), Brown Dermosol (Isbell).

Yellow Duplex profile with a bleached A2 horizon, Tonghii Road, developed on Devonian granitics. Dy3.41 (Northcote), Brown Chromosol (Isbell).

A.4.2.3 Duplex soils

Duplex soils are characterised by a rapid change in texture between the lighter topsoil (A horizon) and the heavier subsoil (B horizons). This soil type occurs over most of the study area particularly on the lower terrain and in the moderately humid and dry climatic areas, particularly common on the undulating dissected Tertiary sediments.

A.4.2.3.1 Yellow and brown duplex soils

Db1.11, Db1.21, Db1.41, Db2.11, Db2.21, Db2.41, Db4.11, Dy3.11, Dy3.12, Dy3.21, Dy3.41, Dy3.42, Dy4.11, Dy5.11, Dy5.21

Yellow and brown duplex soils occur on most parent materials within the study area, predominantly on sedimentary (Ordovician, Silurian and Tertiary), some metamorphic, granitic and basaltic terrain. The topsoils (A horizon) have variable organic matter content and may be bleached at depth (A2 horizon). Subsoils (B horizons) are often mottled (grey, orange) and generally acidic.

The less developed duplex profiles do not have an A2 horizon but still exhibit a clear substantial texture change between the topsoil (A horizons) and the subsoil (B horizons).

These profiles are generally hardsetting with a coarse component throughout the profile for granitic profiles with organic, sandy loam surface A horizons, sandy loam to loamy sand apedal (massive) hardsetting lower A horizons (A2) over a structured sandy clay loam to sandy clay B horizon (subsoil) which may be mottled.

On older sedimentary terrain (Ordovician age) the surface soil has an organic sandy loam to silt loam texture with a silty or fine sandy loam lower A horizon with little or no structure (massive) where it has developed into a bleached horizon. This clearly overlies a structured B horizon which is often mottled (grey, orange) which grades into shattered rock. Occasionally there may be some nodulisation at the junction of the A and B horizons. These profiles are particularly pronounced on drier, lower colluvial slopes. The brown duplex profiles often occur, in slightly moister conditions or are dependent on lithological differences (parent material).

Many of these soils are susceptible to various forms of land deterioration such as sheet, rill, gully and tunnel erosion particularly on the drier deeper colluvial sites including on the plateau north, east and west of Bendoc as well as on the foothills and dissected plains (LuT, LrT) nearer the coast.

These soil types generally occur in LrB, LuT, LrT, LuS, LrS, HrS, HsS, MsS, LuG, LrG, HrG, HsG and MsG groups of units, particularly in drier areas. These soils are generally classified as Chromosols, Kurosols and Sodosols in the Australian Soil Classification (Isbell 1993).

A.4.2.3.2 Red duplex soils

Dr2.11, Dr2.21, Dr2.41, Dr3.21, Dr3.41, Dr4.11, Dr5.21, Dr5.11.

These soil types occur mainly on sedimentary terrain that is moderately humid or humid, generally moister than areas of yellow and brown duplex soils apart from occurrences in the Deddick Valley on granitic colluvial and sedimentary outwash.

There are a number of different sedimentary lithologies on which red duplex soils have developed. These are Devonian "red bed" sediments, Tertiary clays and metamorphosed Ordovician sediments (schists). Soils developed on these lithologies (parent materials) are variable in their development with depth. The A2 horizon is bleached where present and the degree of structure, mottling and organic matter content vary.

The less developed red duplex profiles are often similar to red gradational profiles, apart from a greater texture change between topsoils (A horizons) and subsoils (B horizons) with variable organic matter content and variable depth and stone content. There are shallow stony friable and hardsetting profiles and deeper profiles on colluvial material.

More developed red duplex profiles have A2 (lower topsoil) horizons which may or may not be bleached. Deeper, developed profiles with or without bleached A2 horizons may or may not be mottled often grading into parent material or colluvial material. The B horizons are generally moderately or strongly structured, while the A2 horizons are either weakly structured or massive. The A horizons range in texture from loamy sand (granitic material) to silty loam (Devonian "red bed" sediments) and B horizons range from sandy clay loams to medium clay in texture.

The degree of profile development is influenced by topographic position and aspect, with deeper profiles on lower slopes and generally more developed duplex profiles (bleached A2 horizons) on the deeper, drier sites. The drier sites are susceptible to sheet, rill and some gully erosion. Erosion risk varies on different lithologies:

granodiorite, Tertiary (newer) sediments, Devonian "red bed" sediments, older metamorphic sediments and older sediments.

These soil types particularly occur in HrSm8, HrSh8, HsSm8, HsSh8, HrSm4, HrSh4, HsSm4, HsSh4, HrSm3, HrSh3, HsSm3, HsSh3, MsSm4, MsSh4, LuTm1, LuTh1, LrTm1, LrTh1 and also LrS groups of units, HrSm2, HrSm5, HrSm6, HrSm7, HrSh2, HrSh5, HrSh6, HrSh7, HsSm2, HsSm5, HsSm6, HsSm7, HsSh2, HsSh5, HsSh6, HsSh7, MsSm2, MsSm5, MsSm6, MsSh2, MsSh5, MsSh6 units. These soils are generally classified as Chromosols in the Australian Soil Classification (Isbell 1993).

A.4.2.3.3 Dark duplex soils

Dd1/11. Dd2.11/4/11

These soil types are generally associated with alluvial deposits such as those in the Bonang Valley and some of the Snowy River plain. There may also be some occasional occurrences associated with Tertiary basalt outcrops (which are often keyed out as brown Duplex profile soils).

These soils often have high organic matter contents particularly in the surface soil (A horizon) which have silty/fine sandy loam texture overlying a structured light medium to heavy clay subsoil (B horizon) which may be lightly mottled and may be gleyed in some locations. No A2 horizons have been identified. These soils being depositional are generally stable but are susceptible to deterioration changes in hydrology (increased flows) and changes in vegetative cover. The main deterioration susceptibility is likely to be stream bank erosion.

These soil types occur in a few Pl/gA units. These soils are generally classified as Chromosols in the Australian Soil Classification (Isbell 1993).

A.5 NATIVE VEGETATION

The vegetation of the region is diverse, influenced by physiography, climate and an isolated geography. The diversity of plants (and animals) is partly due to the degree of retention of native vegetation especially when compared with other regions of Victoria; less than 10% of the region has been cleared of vegetation. The diversity of physiography from coastal dune systems to alpine heathland and the variability of macro and microclimates provide a wide range of vegetative habitats.

There has been a keen interest in vegetation mapping in East Gippsland given the range and location of species which has resulted in a range of studies. A major overview which is used here as a basis for discussion is the study of floristic vegetation carried out by Parkes *et al.* (1984). This study groups the vegetation into a range of committees and associated communities, nineteen in all.

Previous overview studies have included other classifications based on structural variations such as forest woodland and shrub classes subdivided on height, and density and abundance. A detailed example of a structural classification for East Gippsland is given by the Land Conservation Council (1974). Specific vegetative studies are carried out by regional staff of the Department for Conservation and Natural Resources for a range of uses, from hardwood production to weed control and species conservation (Flora and Fauna Guarantee Scheme). A brief description of communities identified by Parkes *et al*. (1984) is set out below in approximate order of elevation occurrence.

Recently, there has been some revision work done on ecological vegetation classification with some inclusions or redefinitions as well as nomenclature changes (e.g. Damp Forest and omitting "sclerophyll" from the category headings); Woodgate *et al.* 1994.

A.5.1 Primary Dune Scrub

This is a coastal vegetative community of low shrubs, herbs and sand-tolerant grasses which are important for dune stabilisation which in turn is important for stabilising land and protecting communities further inland.

Breaching of the dune communities and movement of dunes can be seen near the mouth of the Thurra River. These dune communities extend along much of the coastline.

A.5.2 Saltmarsh

Saltmarsh communities, dominated by Sea Rush (*Juncus kranksii*) occupy estuarine areas protected by and adjacent to the primary, coastal dune systems. These communities occur at the Snowy/River/Brodribb and Wingan estuaries, Mallacoota Inlet, Barracoota Lake and other minor areas.

A.5.3 Coastal Sclerophyll Forest

This is a coastal riparian community found at scattered locations along the coast. Southern Mahogany (*Eucalyptus botryoides*) dominates open forest, often on Sandy alluvial soils in river gullies with an understorey of riparian, lowland forest and coastal species. Indicative species include Black Wattle (*Acacia mearnsii*) and Snow Daisy-bush (*Olearia lirata*).

A.5.4 Coastal Banksia Woodland

Salt-influenced shallow estuaries such as Mallacoota, Wingan, Tamboon and Sydenham Inlets and Snowy/Brodribb confluence have given rise to a Coast Banksia *(Banksia integrifolia*) and Southern Mahogany woodland with an understorey of Paper-barks (*Melaleuca ericifolia*, *M. squarrosa*).

A.5.5 Coastal Heathland

These occur on coastal lowland plains and depressions which are subject to seasonal waterlogging, supporting heath/woodlands. The majority are treeless however Silver-leaved (Mealy) Stringybark (*Eucalyptus cephalocarpa*) may occur at the margins or on the heathland. Four scrub communities have been identified: one confined to coastal cliff top plateau; another known as a grass-tree plain (dominated by Spear Grass-tree; *Xanthorrhea resinosa*); another damper version of the grass-tree plain and a wetter area of deep sandy soils more similar to Lowland Sclerophyll Forest with characteristic *Callistemon* and *Hakea* species. Regeneration from fire is quite quick in these areas. A number of heathlands especially with the Mealy Stringybark can be seen from the Princes Highway east of Cann River and west of Genoa.

A.5.6 Banksia Woodland

Banksia Woodland occurs on deep sands (Tertiary age fluviatile and aeolian deposits of sand and gravel) onthe coastal lowlands with Saw Banksia (*Banksia serrata*) the dominant tree in association with a range of eucalypts i.e. White Stringybark (*E. globoidea),* Silvertop *(E. sieberi),* Red Bloodwood *(E. gummifera),* Yellow Stringybark (*E. muellerana) or* Southern Mahogany). The understorey is similar to Lowland Sclerophyll Forest understorey, including Wedding Bush (*Riconocarpos pinifolius*), Paperbark Tea-tree (*Leptospermum attenuatum)* and Smooth Parrot-pea (*Dillwynia glaberrima)*. Examples can be seen from the Cape Conran Road, Genoa-Mallacoota Road and Murrungowar Road near Rocky River Road.

A.5.7 Lowland Sclerophyll Forest

This is the most abundant vegetation community in the study area (>30%) occurring near the coast to the foothills in a broad band from west to east particularly east of Club Terrace. The forest is dominated by Silvertop and White Stringybark with six sub-communities according to Parkes *et al*. 1984. These include an intermediate subgroup between the dominant sub-community and Banksia woodland, the dominant sub-community, between the Cann and Genoa Rivers.

A third sub-community with *E. muellerana* (Yellow Stringybark) north-east of Mallacoota and around Cabbage Tree Creek, also a species poor sub-community, a moist sub-community along drainage lines and moister areas and a sub-community west of Orbost (includes *E. cypellocarpa* and *E. sideroxylon*. The distribution of some species is related to climate (east/west gradient) rather than sub-communities; *E. gummifera*, (Red Bloodwood), *Angophora floribunda* (Rough-barked Angophora) and *Casuarina littoratis* (Black She-oak) occur in the far east.

A.5.8 Dry Sclerophyll Forest

This is a widespread community of diverse forests with Silvertop, White Stringybark often being dominant. Mountain Grey Gum and Red Stringybark (*E. macrorhyncha*) are also dominant in specific areas. A number of other species including Gums, Peppermints and Boxes also occur. The shrub layer is often sparse and often dominated by Shiny Cassinia (*Cassinia longifolia*) and a number of semi-shrubs and herbs. A local Peppermint (East Gippsland Peppermint; *E. croajingolensis) h*as been identified the region as well as the main species (Broad-leaved Peppermint; *E. dives* and Narrow-leaved Peppermint; *E. radiata*) and Brown Stringybark (*E. baxteri*) also occurs in this and Lowland Sclerophyll Forest communities. Terrain, micro-climate and aspect are important local species determinants and also affect growth.

A.5.9 Wet Sclerophyll Forest

This is a taller open community found at a higher elevation (200-1200 m) which contains well developed stands of a number of species: Shining Gum (*Eucalyptus nitens*), Messmate (*E. obliqua*), Brown Barrel (*E. fastigata*), Mountain Ash (*E. regnans*) and Mountain Grey Gum. These stands have great value for hardwood production, scenic and biological value.

Four sub-communities have been identified and wet sclerophyll is particularly well developed on the Errinundra Plateau where there is an ecotone forest between the Wet Sclerophyll Forest and the Cool Temperate Rainforest where Shining Gum dominates over a secondary tree storey of large Sassafras (*Atherosperma moschatum*) and Black Oliveberry (*Elæocarpus holopetalus*). Understorey shrubs layers are well developed with Blanket-leaf (*Bedfordia arborescens*), tree ferns (mainly *Cyathea australis*), ground ferns and also Silver Wattle (*Acacia dealbata*).

There is also a drier sub-community on more exposed stages and a riparian sub-community dominated by Manna Gum (*Eucalyptus viminalis)* and River Peppermint (*E. elata*). There are good examples of this community in the Roger River catchment as well as the Errinundra Plateau.

A.5.10 Cool Temperate Rainforest

This is a closed (dense) forest of wet montane gullies and sheltered slopes, predominantly on the Errinundra Plateau. There are few locations outside this region that are dominated by Sassafras and Black Oliveberry, with ferns (particularly *Dicksonia antarctica*) dominating the understorey. This community has developed in response to an absence of fire from surrounding forest and is also susceptible to exposure. Examples can be seen along Errinundra and Coast Range Roads.

A.5.11 Box-Ironbark Woodland

This community is restricted to dry slopes and rocky ridges on the lower hills around the lower Snowy and Brodribb Rivers with Red Box (*E. polyanthemos*), White Stringybark and Red Ironbark *(E. sideroxylon)*. An example can be seen along Rocky River Road and Coulsens Track.

A.5.12 Warm Temperate Rainforest

This is another closed forest which occurs in sheltered gullies and alluvial flats along major rivers scattered amongst the land hill country. Non-eucalypts dominate this community, including Lilly-pilly (*Eugenia smithii*) with lianes, tree and ground ferns) and epiphytes. There are also some Acacia species including Blackwood (*A. melanoxylon*) at some locations. This is near the southern limit of this community-type and includes the outlying Cabbage Fan-palm (*Livistona australis*) on Cabbage Tree Creek. The largest stand of warm Temperate Rain forest is on the upper reaches of Jones Creek near Genoa and also observable along the Prince's Highway.

A.5.13 Riparian Forest

This community is the open forest of wet slopes and river sides of nearly all the major lowland watercourses. There are three sub-communities, including an ecotone between Riparian Forest and Warm Temperate Rainforest and also a drier sub-community. Examples can be seen along the Bonang Highway, beside the Brodribb River. Indicator species at the secondary storey level include Blackwood and Hazel Pomaderris (*Pomaderris aspera*) as well as Blackberry (*Rubus fruticosus spp.*) which is a weed.

A.5.14 Montane Forest

The tall open forest of montane and sub-alpine moist sheltered valleys and protected slopes, is dominated by Alpine Ash (*Eucalyptus delegatensis*) with low understorey of various pea species. An example can be found at Mount Ellery.

A.5.15 Snow Gum Woodland

This is an open woodland or forest community dominant on sub-alpine areas which are well drained and generally above 1100 m elevation. Snow Gum (*E. pauciflora*) is found either as a low woodland on exposed ridges or as open forest (with Candlebark*; E. rubida*) on more protected slopes. The sparse low shrub is often dominated by members of the pea family.

A.5.16 Montane Sclerophyll Woodland

This community is a woodland or low forest with rocky, mountain soils, generally on northern slopes with low effective rainfall and occurs at Mt. Tingaringy and near Bendoc. Species include Candlebark, Broad-leaved Peppermint and Snow Gum and may merge with Snow Gum woodland at higher elevations and Dry Sclerophyll Woodland at lower elevations. The Understorey consists of pea species, similar to Snow Gum Woodland.

A.5.17 Rocky Outcrop Open-scrubland

This community occurs either as tall scrubland or closed scrub on rocky escarpments and exposed slopes of the upper Snowy River area and near Mountain Creek. Where eucalypts are present, they are in Mallee form and include Tingaringy Gum sp. (*E. saxatilis*), Gully Gum (*E. smithii*), Manna Gum and Tingaringy Gum (*E. glaucescens*).

A.5.18 Rain-shadow Woodland

This distinctive community is centred around the Deddick River Valley where rainfall is low (<700 mm per annum) The dominant species are White Box (*Eucalyptus albens*) and White Cypress Pine (*Callitris columellaris*) with the latter being more tolerant of harsh conditions. There is a riparian form of this community which includes woody species: a *Kunzea sp,* Common Fringe Myrtle (*Calytrix tetragona*) and Blakely's Red Gum (*Eucalyptus blakelyi*) which is often contorted by successive flooding.

Most of the larger White Cypress-Pine has been cut earlier this century and regeneration is threatened due to grazing by rabbits. Associated soils are stony and shallow and effective rainfall is low.

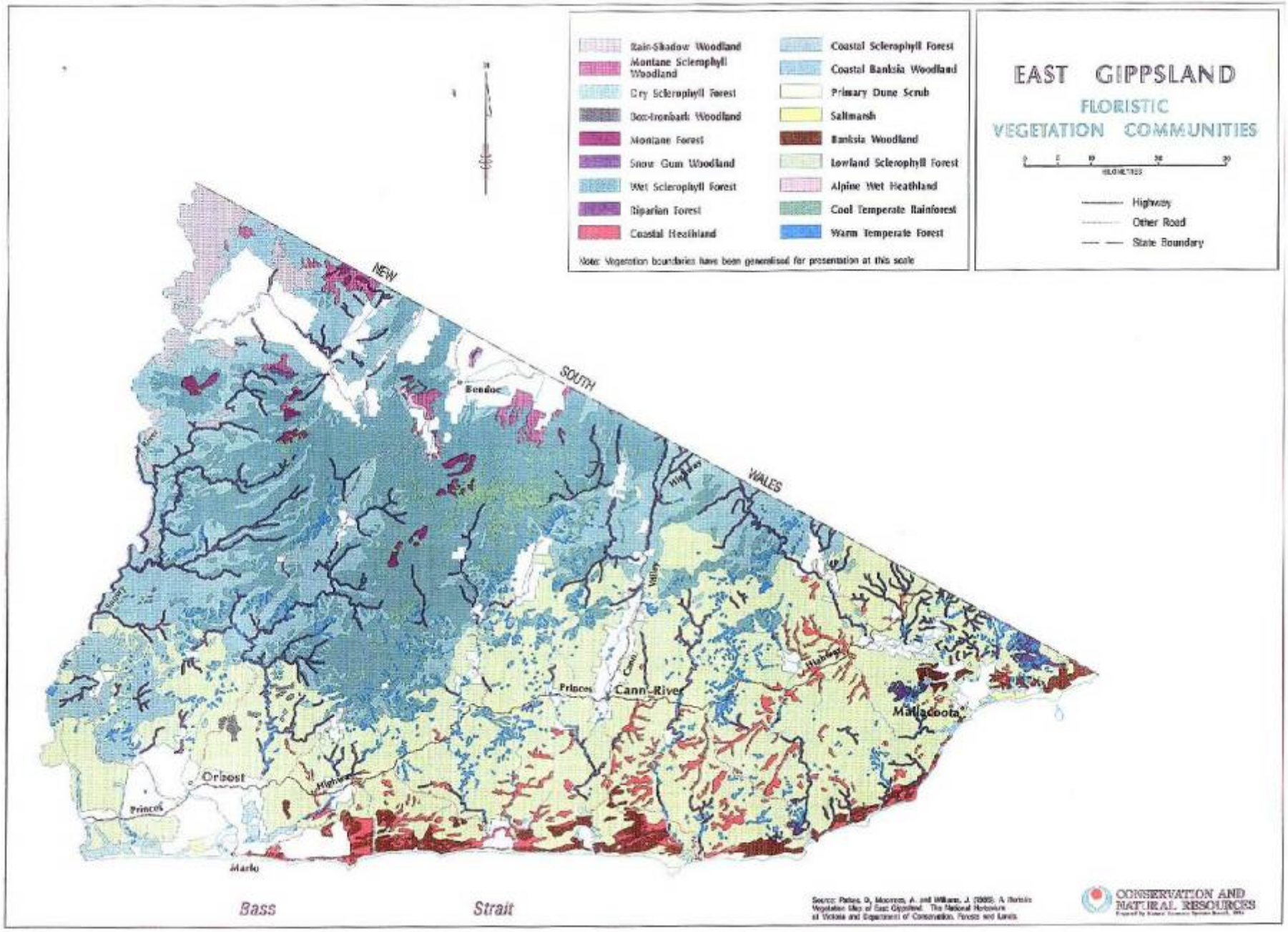
A.5.18 Alpine Wet Heathland

This community occurs on closed heathland to low woodlands of both sheltered and open sub-alpine plains, often on peaty, poorly drained soils and formed in the upper Delegate River catchment. Major species include Mountain Swamp Gum (*Eucalyptus camphora*) and Black Sallee (*E. stellulata*) and there are aquatic plants around free water. Two sub-communities have been defined; one is on the open plains, while the other is a heathland of gully heads and drainage lines and generally has a closed shrub layer, including Small fruit Hakea (*Hakea microcarpa*).

Plateau Track: Mustard road with Wet Sclerophyll forest

Brodribb River. Warm Temperate rainforest near Marins Ck (HrSm-5).

Deddick Valley looking west


EAST GIPPSLAND
FLORISTIC
VEGETATION COMMUNITIES
Rain-Shadow Woodland
Montane Sclerophyll Woodland
Dry Sclerophyll Forest
Box-Ironbark Woodland
Montane Forest
Snow Gum Woodland
Wet Sclerophyll Forest
Riparian Forest
Coastal Heathland
Coastal Sclerophyll Forest
Coastal Banksia Woodland
Primary Dune Scrub
Saltmarsh
Banksia Woodland
Lowland Sclerophyll Forest
Alpine Wet Heathland
Cool Temperate Rainforest
Warm Temperate Forest
Note: Vegetation boundaries have been generalised for presentation at this scale
Highway
Other Road
State Boundary
NEW
SOUTH
WALES
Bendoc
Princes
Cann River
Mallacoota
Orbost
Marlo
Bass
Strait
CONSERVATION AND
NATURAL RESOURCES

A.6 LAND USE

There seems little information on pre-European history of the region, with initial European settlement occurring from the north, spreading into the Bendoc area in the 1850s. This influx into the area was spurred on by gold exploration in the Bendoc/Clarkesville area. The terrain around Bendoc and to the north was easier to traverse, being on the southern boundaries to the Monaro Plateau together with the sparser vegetation compared with the rugged, moist, densely forested areas to the South.

It is not surprising therefore that, despite State boundaries the natural boundaries of the terrain are followed and activities (particularly grazing) on the plateau are serviced by towns to the north and that the telephone exchange network also follows the natural boundary of the plateau.

After mining exploration, some of the drier low undulating terrain was cleared for grazing on the plateau and some hardwood timber production was also carried out. Coastal development was also occurring with clearing for agriculture along the major river floodplains (Snowy and Cann Rivers) and a small part at Marlo and later at Mallacoota Inlet which afforded good shelter after the open ocean and rounding Cape Howe and Gabo Island.

After the major alluvial flats, coastal plains and the plateau were cleared, little further clearing followed. Hardwood production became a major activity, because a large proportion of the region retained its native vegetation.

A.6.1 Forestry

A.6.1.1 Native hardwoods

Timber harvesting has become the major industry of the region. Harvesting occurs at various locations and forest types (related to land type) and is of major importance to the State's total timber production. There are a number of saw-mills of different sizes and degrees of modernisation. These are located at population centres such as Orbost, Cann River, Newmerella, Club Terrace, Cabbage Tree and Bendoc.

Hardwood production varies according to location and forest type. Much of the tall sought-after timber is located in the Errinundra plateau area and includes Shining Gum (*Eucalyptus nitens)*, Brown Barrel (*E. fastigata*), Alpine Ash (*E. delegatensis)*, Narrow-leaved Peppermint (*E. radiata)* and minor occurrences of Mountain Ash (*E. regnans*). These stands are located in the moister areas and have the highest quality and productivity in the region. Fire plays an important part in regeneration and controlled burning is conducted as part of the management of the forests to ensure an appropriate re-generative environment. An ash bed with little or no shade is the best environment for seedling emergence.

Another grouping of timber species that grow on less moist and generally steep and less productive areas includes Messmate, Stringybarks (*E. globoidea*, *E. baxteri, E. muellerana),* Mountain Grey Gum (*E. cypellocarpa*) and Peppermint (*E. radiata* and *E. croajingolensis*). The so-called "mixed species" grouping is dominated by Silvertop (*E. sieberi*) which grows well on well drained sites in drier terrain and regenerates rapidly. Silvertop Ash is found extensively on the lower hills and dissected plains. As well as Silvertop, there are Mountain Grey Gum and Stringybarks including Messmate. This is a major resource though less productive than the plateau forests. When cleared, however, this terrain is more susceptible to deterioration than the gentler plateau and requires greater management input, particularly on granitic terrain.

Reductions of area available in the plateau and surrounding country due to changes in land use policy such as National Park extension, declaration of National Estate and clearing of private forested land for pasture mean that there will be greater emphasis on the mixed species forest for hardwood production in the future.

There is also another grouping of timber species which includes Red Box (*E. polyanthemos*), Peppermints and Red Stringybark (*E. macrorhyncha*) but these have a much lower productivity. There are also minor amounts of other species cut for local consumption such as fence posts; for example, White Box in the Deddick Valley. The White Cypress Pine (*Callitris columellaris*), a native softwood which occurs in the Deddick Valley was a timber much sort after due to its rot resistant capabilities but there are few sizeable native trees remaining.

Woodchips are produced from mill-waste from saw-log manufacture and trucked to Eden in New South Wales for shipment abroad (principally Japan). Some of the residual timber from clearing of freehold land also follows this process.

There are study programs currently underway by the Department of Conservation and Natural Resources (Squire, 1992) which are designed to assess methods of timber production and sustainability, the viability of processing more of the fallen tree and the environmental and economic consequences.

It must also be noted that when native forests are used for hardwood production, issues such as flora, fauna and water production must be taken into account as part of the overall forestry planning process.

A.6.1.2 Exotic softwood

There are no exotic softwood plantations in this region, although the area to the north of the Errinundra plateau and some areas further east which have drier conditions and less steep terrain may be suitable. The Victorian policy on forest management contrasts with that of New South Wales such as along the border north of Mount Canterbury. The Victorian side of the border consists of native forest (some recently burnt) and the New South Wales side consists of planted softwood (Radiata Pine). The New South Wales plantings are part of a large planting within the Bondi State Forest.

A.6.2 Agriculture

Due to the large proportion of land under native forests, agriculture is largely confined to the major valleys of the region and the coastal area with the more intensive agriculture located in the larger valleys, closer to population centres and transport. There is some grazing in forested areas and grazing is more extensive in remote areas.

A.6.2.1 Sheep

Sheep farming is generally confined to the northern part of the region such as the granitic and sedimentary undulating rolling terrain of the plateau which is drier than further south, the Dellicknora area and the rain-shadow area of the Deddick Valley. The plateau area is used for fattening and wool production with mainly wool production from Merinos in the Deddick Valley. However, beef cattle are becoming increasingly important.

A.6.2.2 Beef cattle

Beef cattle production is widespread on freehold land with some grazing in forested areas. Beef cattle are found in the main valleys including Combienbar, Club Terrace, Mallacoota, Genoa (including Wangarabell) as well as the Snowy and Cann River valleys and the Marlo Plains. The milder areas near the coast and on lusher pastures are used for fattening and turning out beef cattle.

A.6.2.3 Dairy cattle

Dairy cattle are concentrated in a number of areas predominantly the Snowy River floodplain and also the Cann River floodplain. Irrigated pasture is used to sustain this land use. There are also a few dairy farms in the Combienbar Valley. Good infrastructure is required for this type of enterprise. The nearest dairy factories are located in southern NSW or Lakes Entrance/Bairnsdale.

A.6.2.4 Cropping

Cropping is restricted to intensive horticulture on river flats; predominantly along the Snowy River near Orbost and some minimal cropping for animal feed.

A.6.2.5 Irrigated agriculture

This is generally restricted to the river flats of the Snowy, Cann and Combienbar Valleys where irrigation is used for pasture but in the case of the Snowy River there is also market gardening. The market gardening takes the form of vegetable production on the river alluvium and is helped by the mild climate of the area. Previously grown crops include beans, sweet corn, potatoes and capsicum but winter vegetables may also be grown and crop type varies from year to year. Hybrid sweet corn seed is another related enterprise in the general area.

A.6.3 Apiculture

The forested lands are most important for honey production with some eucalypt species being particularly favoured. Fire and clearing are the major concerns of apiarists but the large areas of forest and increased access make the area a productive proposition.

As well as eucalypt species, some acacia, tea-tree, banksia and hop bush also provide some seasoned pollen for the bees. The major eucalypt species include Blue Box (*Eucalyptus bauerana*), Red Box (*E. polyanthemos*), Southern Mahogany (*E. botryoides*), Mountain Grey Gum (*E. cypellocarpa*), White Stringybark (*E. globoidea*), Red Stringybark (*E. macrrhyncha*), White Box (*E. albens*), Red Bloodwood (*E. gummifera*) and Brown Barrel (*E. fastigata*). Some of these are restricted in area and location but very much favoured such as White Box, Red Bloodwood and Blue Box.

A.6.4 Mining

Mining goes back to gold prospecting in the Bonang/Bendoc/Cabanandra area in the 1850s with a relief mine (Victoria Star mine), south of Bendoc. There has also been some prospecting around Club Terrace, Paddys Creek nearby, Mallacoota and Combienbar. There is a mineralised deposit near Deddick of silver-lead, zinc and copper nearby at Accommodation Creek but only prospecting and investigation has been carried out to date.

There are minor occurrences of other minerals such as Molybdenum (Wangarabell) Platinum-Osmiridium and Barite (Boulder Flat), Soda-feldspar (Mt. Raymond), Graphite (near Bellbird Creek), Bismuth, Wolfram and Scheclite (Bendoc) and some mineral sands (near Point Hicks).

Sand and gravel extraction is restricted to the Quaternary and Tertiary deposits in the south of the region. There are sand and gravel extraction pits off the Murrungowar/Rocky River Road and just north of the Prince's Highway at Cabbage Tree Creek.

Sand and gravel deposits can be quite variable in the degree of sorting and are often inter-mixed with Tertiary silt and clay deposits. Mixtures such as marl deposits have been extracted east of Marlo (north of Cape Conran). There is a shortage of suitable road surfacing material in the region, especially given the cost of cartage over long distances. This also applies to road metal which often consists of weathered siltstones and sandstones and is extracted from roadside quarries generally on the end of spurs (closer to surface).

There are also metamorphosed sediments (Ordovician) but cartage and extraction costs have limited operations. These metamorphosed sediments generally occur north of Murrungowar with examples around Barrs Road and Bola mine of harder material (hornfels, etc).

A.6.5 Nature conservation

Besides forestry, this region has become well known for its native conservation areas such as the Tingaringy-Cobberas, Snowy River, Croajingalong, Coopracambra, Errinundra, Alfred and Lind National Parks. Some of these have only been declared in the last couple of years; the Alfred and Lind National Parks being the oldest. There are also reference areas relating to general protection of habitat and specific protection of species and areas of National Estate designated by the Commonwealth government.

The recent designation of the Errinundra National Park and National Estate has given protection to some of the area previously considered for hardwood production in order to preserve certain types of the forested environment. Consequently, hardwood production may increase elsewhere in the region.

Most of the National Parks are in mountainous rugged terrain, however the Croajingalong National Park covers a large area along the coast and is popular for recreation. The Tingaringy National Park includes Mt. Tingaringy and covers a range of climatic and vegetation zones from Rain-shadow woodland to Snow Gum woodland, while the Snowy River National Park includes the moist Roger River catchment, the Gelantipy Plateau, Snowy River Gorge and the drier Mt. Bowen area. Coopracambra National Park includes the Genoa Gorge, Mt. Coopracambra and a range of vegetation, geological and soil types. The Alfred and Lind National Parks include examples of Warm Temperate Rainforest.

There are areas set aside to protect and preserve a range of habitats for both flora and fauna with special consideration given elsewhere for such species as the Long-footed Potoroo and Leadbeaters Possums. Attention is also given to preserving the Cabbage Tree palms in Cabbage Tree Creek.

A.6.6 Recreation

The State Forests, National Parks and other reserves provide a range of opportunities for recreational activities which include sight-seeing, bush walking, camping, picnicking, four-wheel driving, fishing, rafting and other activities which have unique aspects in this region. The river mouths and coastline provide focal points for recreation: sailing and fishing at Marlo, and swimming and other camping activities at Cape Conran. Mallacoota is a major focus for recreation especially over the school holidays with fishing and sailing in the sheltered inlet.

The ocean at the mouth of the Wallagaraugh River near Gypsy Point is a major attraction for keen fishermen.

There is an educational centre at Cape Conran and various walking trails and camping at Wingan Inlet, Tamboon Inlet, Thurra River and Point Hicks. A sight-seeing/camping trail, the Baldwin Spencer Trail, was developed in honour of the early explorer Walter Baldwin Spencer. Attractions include walking up to the granite tors of Mount Ellery and the granitic Goonmirk Rocks near the edge of the plateau, with a number of camping areas such as the one at Goongerah.

A.6.7 Residential use

Orbost is the major town of the area, servicing the agricultural, forestry and some recreational and tourist activities. Forestry provides many service jobs in the town with direct services such as government activities, contracting services and spin-off servicing activities.

Cann River township is much smaller and is almost totally reliant on forestry activities with some servicing for the passing tourist trade. Mallacoota is a larger town which expands greatly over the summer period and school holiday time with tourists for camping, fishing and sailing.

Genoa is small town on the Prince's Highway where the road to Mallacoota branches off. Marlo, on the coast, south of Orbost is also a major tourist destination with some retirement residents. This also applies to Bemm River township.

Careful planning is required in the expansion of these towns to minimise the health risks associated with septic tank failures. particularly where there are periods of high usage Marlo has already had a number of septic tank failures.

Club Terrace is a hamlet which is centred around a saw-mill while Bendoc has two saw-mills, a police station, hotel, government office (Department of Conservation and Natural Resources) and a primary school. There is also a small scattered settlement at Goongerah as well as a few scattered rural communities such as Combienbar, Buldah and Wangarabell.

A.6.S Water supply

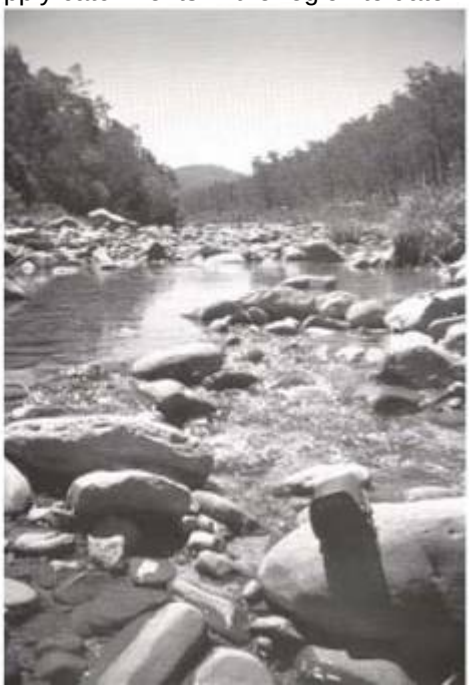
Water supply for the region is via river and stream diversions. The water has little treatment (filtering only) before being used. There are a number of water diversions servicing a range of clients.

Orbost obtains water from the Brodribb River and the Rocky River. The former has been "proclaimed" as a water supply and the latter has been "proclaimed" and a "determination of land use" by the Department of Conservation and Natural Resources carried out as measures to protect the quality of the water supply.

A proclaimed catchment is one that is recognised by government, and the community or its authorities are aware of its importance and can act to protect water quality and quantity by restricting land use within the catchment.

The Cann River catchment is proclaimed to Noorinbee and the Betka River provides water for Mallacoota but may need supplementation in drought periods. The Betka River is proclaimed to a water take-off point west of Mallacoota. There are no other proclaimed water supply catchments in the region to date

Camping area on granitic terrain at Tambool (HrGm-4).



Genoa Gorge, near Yambulla Peak Tk

A.7 LAND DETERIORATION

There are several forms of land deterioration evident in the region. Others are present but not as obvious. Often it is difficult to ascertain degradation levels because it may be difficult to identify control sites and comparable degradable sites for example, virgin forest compared with re-generating forest environments.

As with other studies, a distinction is made between observed land deterioration (during the study) and susceptibility to land deterioration which is an indication of the maximum degree of deterioration likely to occur under unsuitable management conditions. It should be noted that the environment is a dynamic system with changes (sometimes catastrophic such as volcanic and earthquake activity) occurring throughout time. However, the rates of change may be accelerated or slowed by human activity. It is the changes due to human activity that are referred to in this section.

Land deterioration is usually the result of inappropriate land management and the ability to restrict deterioration to within tolerable limits is fundamental to the aim of sustainable land use.

A.7.1 Sheet erosion

Sheet erosion takes place when the forces due to rainfall, flowing water and gravity overcome the cohesion and weight of the soil particles or aggregates. The result is that soil is washed away from the surface of the land.

Susceptibility

The potential for sheet erosion exists on any sloping land. Potentially erosive overland flow results when rainfall or runoff exceeds the infiltration capacity of the soil. Erosion susceptibility is generally greatest where soils have low infiltration capacities and the terrain is steep.

Areas of duplex soils or soils with sealing or hard-setting surfaces are most likely to cause overland flow and have the potential to be sheet or rill eroded. This is more likely on the drier areas where duplex soils have hard-setting A2 horizons with little or no structure (massive).

The degree of vegetative cover, climate and time of year are other important factors. Soils with less cohesion such as granitic profiles are susceptible to sheet and rill erosion because particles are easily detached and transported by flowing water. High-intensity rainfall events can detach particles if there is insufficient protection (vegetation). The timing of storms is important because vegetation cover may vary during the year. The type of vegetation cover may also be important. Even forested terrain, if sparse and particularly with sparse ground cover, may be susceptible to sheet and rill erosion due to the impact of coalesced water droplets falling from the trees.

Incidence

While not always obvious, sheet and rill erosion can lead to insidious deterioration of an area, the consequences of which are not felt until the process is well developed. The off-site consequences of sheet and rill erosion are the main indication that these processes are active. Examples of the effect of these processes include the siltation of streams and rivers, which is particularly evident in the Cann River. Another example is the recent deposition on minor and major floodplains. In some cases areas that have been cleared have a marked surface silt (and sand) layer which overlies the original developed profile. The original profile, while accumulating some silt and sand has generally developed an organic rich surface horizon but this has been buried by recent (100-150 years) rapid accumulation.

Movement of surface soil material from crests and upper slopes is often evident with some movement in disturbed forest situations but generally greater on cleared land such as the Deddick Valley, Cabanandra/Dellicknora and other upland areas as well as the Genoa (including Wangarabell), Buldah and Cann River Valleys.

There are often other forms of deterioration where sheet and rill erosion exist. Some lower colluvial slopes also have evident sheet erosion. Roading has produced a large network of exposed soil which has the potential to degrade and has been identified as a major source of sediment.

Effects and management
Sheet erosion reduces on-site productivity generally through the loss of topsoil and nutrients and the exposure of hard-setting or inhospitable subsoil horizons.

In areas prone to sheet erosion, grazing by native or introduced animals needs to be controlled to ensure that sufficient vegetation remains to protect the surface soil.

Timing of operations, minimal traffic and rapid re-vegetation are important to reduce the risk of erosion in areas disturbed during timber harvesting.

A.7.2 Gully erosion

Gully erosion is initiated when forces due to rainfall, flowing water or gravity overcome the cohesion and weight of the soil particles/aggregates, which are detached and then transported. This may develop into rills and thence to a gully should there be sufficient concentration of water and sufficient depth of regolith.

Susceptibility
Gullies develop where runoff and seepage waters accumulate, most commonly in valley alluvium where the depth to greater resistance (generally bedrock) is greatest. The areas at greatest risk are the lower slopes and valleys on or adjacent to the steeper hills and ridges. The retention of native vegetation usually prevents erosion, with the roots of plants providing mechanical resistance to soil detachment as well as keeping the soils relatively dry. It is predominantly in the cleared areas that gullies have been initiated and particularly on colluvial and alluvial deposits.

Gully erosion may also be aggravated and develop in areas where the soil is sodic on colluvial and alluvial deposits as well as areas with weak (strength) lithology or structural weakness such as faults and folds of underlying material.

Incidence
Changes in the local hydrology and concentration of water by management practices may initiate gullying. For example gullying on colluvial slopes in the Buldah Valley has developed because vegetation was cleared and runoff was diverted away from a road.

Gullying on streamlines has also occurred and may be classed as streambank erosion, for example at Wangarabell, Tonghi and the major rivers (Cann and Snowy). Some gullying also occurs in the Deddick Valley and to the east (Cabanandra/Dellicknora).

Effects and management
Gullying, while small in area provides many difficulties to management in addition to the generation of sediment. Off-site effects also include a greater frequency of flooding with the concentration of waters. To reduce erosion risk, overland flow to the gullies must be reduced. Greater water use by vegetation particularly at depth as well as diversion of waters will also reduce the risk of erosion.

For advanced gully erosion, common control measures include fencing out the area to control stock and protect any structures that may be constructed. Other measures include gully infilling, planting trees, shrubs and dense deep rooted grasses, eradicating rabbits and excluding cultivation (if appropriate) from the management program.

A.7.3 Streambank erosion

Streambank erosion results when forces due to water movement along a stream channel are sufficient to detach and remove soil material from the banks. Gully erosion may occur in conjunction with stream bank erosion.

Susceptibility
The potential for this form of erosion exists along most streams in the region. Streamside vegetation is important in stabilising the banks of streams. The stability of the material of the bank is important to bank resistance. The disturbance caused by vehicular stream crossings often affects bank stability up and down stream, particularly the latter.

Incidence
An example of severe stream bank erosion is the Cann River at the crossing of the West Cann River/Aerodrome Road which is a major route to the Combienbar Valley. The incision of the river (due in part to straightening work in the 1950s) has meant that water energy acts on the streambank rather than spilling and dispersing over a larger area. This type of channelised flow causes most problems on the outside of any river bank meander.

Effect and management
Streambank erosion can lead to sedimentation of stream channels and may damage structures such as roads and bridges. Management requirements may range from vegetation cover and exclusion of stock to the physical protection of the banks with materials such as timber, concrete and rock fencings; groynes or gabions.

A.7.4 Wind erosion

Wind erosion occurs when the forces due to wind are sufficient to overcome the cohesion and weight of the soil particles and allow their movement.

Susceptibility
The susceptibility of soils to wind erosion depends on a number of factors, including surface texture, position in landscape and the probability of strong winds when the soil is in a dry and exposed condition. Surface soils high in organic matter, or with sandy loam, silt or sandy textures are most susceptible. Areas susceptible to wind erosion include the coastal dune system, lowland plains, upland plains and hills (granitic), but predominantly the coastal dune system.

Incidence
The coastal dune systems are the most obvious landform features affected by wind. Active dunes move and may encroach on lowlands inland. There are examples at Thurra River and near Cape Conran.

Cleared lowland plains which have sandy surfaces may occasionally be subject to some wind erosion. This also applies to the plains and hills (Deddick Valley, Dellicknora, Cabanandra, Kirkenong and also Bendoc North) especially where granitic soils have loose surface horizons which may be easily disturbed by stock or increased grazing by native fauna.

Effects and management
The main effects of wind erosion are the loss of productivity due to the loss of surface nutrients and topsoil on-site and problems that may result off-site where the eroded soil is deposited.

To reduce the risk of erosion, the topsoil needs to be protected especially during dry and windy periods. In grazed areas a ground cover should be maintained. Fertiliser applications, re-sowing, rabbit control and conservative stocking rates may be necessary. Aggravated erosion around heavily used areas, especially on the coast may require planting of (indigenous and other) appropriate grasses and trees and some fencing to protect the re-growth area.

A.7.5 Soil compaction

Compaction is the increase in soil bulk density and related decrease in macro-porosity that develops when physical pressure on the soil exceeds its ability to withstand deformation and/or when organic matter is oxidised.

Susceptibility
Susceptibility to compaction depends largely on soil organic content, moisture content, texture and structure. Moist soils are most vulnerable due to reduced friction between soil aggregates that resist deformation and compaction.

Compaction occurs on most soils, but it is human activity that has increased compaction and altered the microhydrology of an area. Areas subject to intensive agricultural and grazing (e.g. freehold land) are susceptible to compaction which may lead to other forms of erosion. Forestry activities also have compaction effects on soils, not only from specific activities (e.g. log landing and snigging tracks) but also through changes in the microecosystem resulting from tree removal. Clearing of native forest for pasture generally leads to an increased oxidisation of organic matter and reduced macroporosity. The effect of regenerative forestry on the long-term compaction status of the soil is not fully known.

Effects and management
Soil compaction is another insidious form of land degradation as it restricts re-generation of vegetation and may increase runoff leading to sheet erosion and off-site sedimentation. Management practices should maintain or increase organic matter and minimise mechanical disturbance during agricultural and forestry operations. Severely compacted ground may need to be deep-ripped to improve drainage.

A.7.6 Mass movement

Mass movement occurs when shear force exceeds soil/regolith strength. This generally occurs when regolith strength is reduced by increased water content. Mass movement may range from soil creep or minor slumping to major landslide.

Susceptibility
Susceptibility to mass movement is generally greatest on steep slopes and longer slope lengths and depends on the regolith/lithology, as well as vegetation. Minor slumping often occurs on colluvial material that has been exposed, for example by roads. This is often aggravated by a change in permeability down the soil profile.

Vegetation, especially tree roots, anchor the soil, particularly on steeper slopes. Deep rooted vegetation also removes moisture from soil thus reducing the risk of mass movement.

The presence of springs is often associated with variable regolith depth and strength and such areas are susceptible to movement given moist conditions.

Variable geomorphology may lead to slope instability. For example, a high infiltration capping lithology over a poor infiltration lithology may lead to water springing from the contact area of the two lithologies and slumping may occur. This is often the case where basalt cappings cover less permeable material below.

Incidence
An example of springs and large slumping from a basalt capping over less permeable (or lower water holding capacity) material can be seen just west of Bonang. Minor and moderate slumping and undercutting can be seen along many of the roads in the forested areas. These are particularly evident on deeper, colluvial profiles.

Duplex soil profiles are often subject to differential weathering and collapse of massive A horizons, where roading has exposed profiles. Very steep areas may be subject to rockfall where disturbed. Soil creep which occurs naturally, may be accelerated by removal or reduction in vegetation either through natural occurrences or by human activity.

Mass movement may also be initiated by the undercutting of the toe of a steep slope by streams and rivers.

Effects and management
Mass movement accelerates down-slope movement of material and nutrients, exposes subsoils (which are often difficult to rehabilitate) and may cause damage to structures such as roads, fencing and buildings. It may also deposit large amounts of sediments to streams and may temporarily block the stream. Rehabilitation works may include planting of deep rooted plants, especially trees, which help to anchor soil and decrease the soil-regolith moisture content. Physical structures, particularly at the toe of a failed slope may be used, including concrete cribbing and gabion structures which allow water movement through the structure and diversion of local drainage away from the area.

A.7.7 Soil acidification
Soil acidification is associated with improved pastures in higher-rainfall and irrigation areas. The addition of nitrogen from either fertilisers or legumes results in acidification of the soil as the nitrogen is converted to nitrate, which in turn combines with base cations available from the soil storage or clay mineral exchange sites. When nitrates are taken up by plants or leached from the system soil acidity increases. The build up of organic matter associated with improved pasture results in increased cation exchange capacities and this seems to be an important factor in soil acidification.

Susceptibility
The susceptibility of land to soil acidification is influenced by climatic factors such as annual rainfall and soil factors such as organic matter content, clay content and mineralogy, texture, permeability and water holding capacity and vegetation type. Light textured soils of low initial organic matter content are more susceptible.

Incidence
Soil acidification is a potential problem in all cleared areas sown to improved pastures and therefore restricted to a relatively small area of the region, such as the Bendoc, Dellicknora and Deddick Valley areas and the coastal plain.

Effect and management
Soil acidification can result in aluminium and manganese toxicity, decreased availability of phosphorus, molybdenum, magnesium and calcium or decreased activity of soil microbes, including nodule bacteria. There is usually some soil structural decline associated with acidification, which increases the soils potential erodibility. Regular dressings of lime may be required if toxicity problems severely limit plant production.

A.7.8 Salting

Salting develops when stored salts derived from the atmosphere and from rock weathering become concentrated in the root zone or on the soil surface.

Susceptibility

Areas susceptible to salinity can be affected by local or regional groundwater systems. Recharge, (of the groundwater) typically occurs through sedimentary terrain on crests and slopes where permeable fractured rock strata lie near or at the surface (as well as weathered granitic parent material). Stored salts in the soil and weathered rock are mobilised by infiltrating water and salting usually occurs on lower slopes and in depressions where the salty water table nears or reaches the surface.

Clearing the native vegetation from recharge sites allows increased water infiltration to the groundwater systems and is largely responsible for the increase in salting since European settlement.

Incidence

There are some naturally saline coastal areas. However, salting is of minor significance in the region, largely due to forest cover retention. There are several susceptible areas such as coastal sites, coastal and some river plains and possibly on some of the drier cleared uplands.

Effects and management

High saline water tables inhibit plant growth. As groundwater comes closer to the surface salt tolerant plants will spread over an area and eventual lead to scalding if salt levels continue to rise and accumulate at the surface. Management techniques to reverse this trend include planting deep rooted species with a high uptake of water in order to lower the water table. The areas of cause and effect may not be geographically close with the cause being away from the affect, particularly for regional water tables.

A.8 LAND UNIT COMPLEXITY

There are some areas that are difficult to differentiate in relation to the key diagnostic factors. These are likely to be areas within specific map units that, due to the local conditions, may be similar to an adjacent area. For example, a moderately humid unit may have areas that are closer in character to an adjacent humid unit. This may be as a result of aspect and position which has produced a moister sub-unit area.

Areas of complex topography and geology also provide difficulties in differentiating appropriate units, such as the variable lithologies of the Tertiary sediments and the Snowy River Volcanics. At the scale of this study, it is difficult to distinguish and map such changes, although an effort has been made to reduce as much as possible the number of land-unit complexes.

A.9 FURTHER INFORMATION NEEDS

The choice of areas or sites for further more detailed research will depend on government and local priorities, determined by actual or perceived community needs; which can be complex and variable in East Gippsland. Potential topics for further investigation include:

- The effect of land management on the various processes of land deterioration, for example sheet erosion, sedimentation, nutrient and organic matter decline.
- Further mapping of complex areas, special area investigations and extending the mapping westward from the Snowy River to fit with other studies.
- Multi-disciplinary studies of new and existing studies via a geographic information system (GIS). Modelling environmental data for decision making using a range of data which can be manipulated by a specific database and GIS.
- Analyses of data, including training for a range of clients such as public land personnel of the Department and local landcare groups.

Top left: Buldah Gap Road; overlapping geologies of sedimentary colluvium over granitics

Top right: Plateau track and gums; Shining Gum

Right Victoria/NSW border; land use policy differences.

PART B

B.1 SUMMARY OF THE MAP UNITS

Landform	Geology	Physiography	Soils	Native Vegetation	Land Use	Notable soil deterioration processes
Swamp	Quaternary riverine alluvium	Level to gently undulating depression	Uniform fine, Uniform coarse, Duplex (dark, yellow)	Riparian	Conservation	Waterlogging, minor compaction
Coastal Flats	Quaternary coastal alluvium	level	Uniform coarse, Uniform fine	Saltmarsh, *Juncus feransii*, *Leptospernum laevigatum*, *Banksia integrifolia*	Conservation	Salting, bank erosion, minor compaction
Dunes	Quaternary aeolian deposits	undulating - steep	Uniform coarse	*Leptospernum laevigatum, B. integrifolia*	Conservation, recreation	Wind, sheet erosion and mass movement
Plains	Quaternary riverine and coastal alluvium	level-undulating	Uniform coarse, yellow & brown Duplex, Uniform medium, brown Gradational	*B. integrifolia, B. serrata, Eucalyptus consideniana, E. botryoides, Angophora floribunda, E. sieberi, E. gummifera*	Grazing, conservation, forestry, gravel & sand extraction	Wind, sheet & rill erosion, compaction
Rises	Quaternary riverine and coastal alluvium Tertiary sediments	undulating	Uniform coarse, yellow & brown Duplex, Yellow, brown & red Duplex, yellow/brown Gradational	*E. globoidea, E. botryoides, E. consideniana, E. sieberi, Angophora flroibunda, B. serrata* *E. globoidea, E. sieberi, E. consideniana, Angophora flroibunda, E. muellerana, E. baxteri*	Grazing, conservation, Forestry, gravel & sand extraction	Sheet, rill and wind erosion minor gully erosion and compaction Sheet, rill and wind erosion, minor gully erosion and compaction
Low hills	Tertiary sediments Palaeozoic sediments & metamorphics Devonian Granitic rocks Tertiary Basalts Limestone (Devonian)	undulating - rolling rolling	Yellow, brown & red Duplex, Uniform coarse Yellow, brown & red Duplex, red & brown Gradational Yellow & brown Duplex, red & brown Gradational Yellow and dark Duplex, brown Gradational Red & brown Gradational, brown Duplex	*E. sieberi, E. globoidea, E. consideniana, E. muellerana, E. baxteri* *E. sieberi, E. globoidea, E. sideroxylon, E. muellerana, E. obliqua, E. ovata, E. cypellocarpa, E. fastigata, E. nitens, E. dives, E. delgatensis* *E. sieberi, E. globoidea, E. sideroxylon, E. muellerana, E. obliqua, E. ovata, E. cypellocarpa, E. fastigata, E. nitens, E. dives, E. albens, E. polyanthemos* *E. ovata, E. globulus maidenii, E. rubida, E. pauciflora, E. baxteri* *E. globoidea, E. ovata, E. muellerana, E. consideniana*	Recreation, forestry, conservation, sand &gravel extraction, water supply Recreation, forestry, conservation, sand & gravel extraction, water supply Forestry, conservation, grazing, recreation, water supply, gravel extraction Grazing, forestry, conservation Forestry, grazing, conservation	Sheet, rill, gully erosion, some compaction. Sheet, rill, minor gully erosion and compaction. minor salting Sheet, rill, gully erosion (including tunnel erosion), some compaction, minor salting Sheet, rill erosion, mass movement, compaction, some gully erosion Sheet, rill and some gully erosion, minor mass movement, some compaction

Landform	Geology	Physiography	Soils	Native Vegetation	Land Use	Notable soil deterioration processes
Hills	Tertiary sediments	rolling - steep	Yellow, brown & red Duplex, Gradational	*E. sieberi, E. globoidea, E. consideniana, E. muellerana*	Conservation, forestry, recreation, water supply	Sheet, rill minor gully erosion, minor mass movement and minor compaction
	Palaeozoic sediments & metamorphics	rolling - very steep	Yellow, brown & red Duplex, red & brown Gradational	*E. albens, E. globoidea, E. muellerana, E. baxteri, E. macrorhyncha, E. ovata, E. dives, E. obliqua, E. cypellocarpa, E. viminialis, E. fastigata, E. delegatensis*	Forestry, conservation, recreation, water supply, gravel extraction	Sheet, rill minor gully erosion, minor mass movement and compaction, minor salting
	Devonian Granitic rocks	rolling - very steep	Yellow, brown & red Duplex, brown Gradational	*E. albens, E. globoidea, E. muellerana, E. baxteri, E. ovata, E. dives, E. macrorhyncha, E. obliqua, E. sieberi, E. cypellocarpa, E. viminialis, E. fastigata, E. nitens, E. delgatensis*	Forestry, grazing, conservation, recreation, water supply	Sheet, rill, gully erosion (including tunnelling), mass movement and some compaction
	Limestone (Devonian)	rolling	Red Gradational, red Duplex	*E. globoidea, E. sieberi, E. muellerana, E. baxteri, E. radiata, E. dives, E. cypellocarpa*	Forestry, grazing	Sheet, rill & minor gully erosion and compaction
	Devonian Acid Volcanics	undulating - very steep	Red & brown Gradational, Uniform medium, yellow & brown Duplex	*E. obliqua, E. cypellocarpa, E. fastigata, E. nitens, E. delegatensis, E. globoidea, E. baxteri, E. muellerana, E. macrorhyncha, E. radiata, E. dives, E. polyanthemos*	Conservation, recreation, forestry	Sheet, rill & gully erosion, some compaction

Landform	Geology	Physiography	Soils	Native Vegetation	Land Use	Notable soil deterioration processes
Scarps	Palaeozoic sediments & metamorphics	steep - precipitous	Red & brown Gradational, yellow, brown and red Duplex; often shallow, stony	*E. albens, E. polyanthemos, E. globoides, E. muellerana, E. baxteri, E. macrorhyncha, E. radiata, E. dives, E. cypellocarpa, E. obliqua, E. fastigata, E. nitens*	Conservation, recreation, water supply, forestry	Sheet, rill erosion, mass movement, gully erosion
	Devonian Granitic rocks		Red & brown Gradational, yellow & brown Duplex, Uniform coarse; often shallow, stony	*E. albens, E. polyanthemos, E. globoides, E. muellerana, E. baxteri, E. macrorhyncha, E. radiata, E. dives, E. cypellocarpa, E. obliqua, E. nitens,*	Conservation, recreation, water supply, forestry	Sheet, rill erosion, mass movement, gully erosion
	Devonian acid volcanics		Red & brown Gradational, yellow & brown Duplex, Uniform coarse; often shallow and very stony	*E. polyanthemos, E. sieberi, E. globoides, E. muellerana, E. macrorhyncha, E. baxteri, E. radiata, E. dives, E. obliqua, E. cypellocarpa, E. fastigata, E. nitens*	Conservation, recreation	Sheet, rill erosion, mass movement, gully erosion
Plateau	Palaeozoic sediments & metamorphics	undulating - rolling	Red & brown Gradational, yellow, brown and red Duplex	*E. nitens, E. fastigata, E. obliqua, E. cypellacarpa, E. radiata, E. dives, E. elata, E. delegatensis, E. pauciflora, E. camphora, E. regnans*	Conservation, recreation, grazing, forestry, water supply	Sheet, rill erosion, some gully erosion, compaction and minor salting
	Devonian Granitic rocks		Red & brown Gradational, yellow and brown Duplex	*E. nitens, E. fastigata, E. obliqua, E. cypellacarpa, E. radiata, E. dives, E. elata, E. delegatensis, E. pauciflora, E. camphora, E. regnans*	Conservation, recreation, forestry, water supply	Sheet, rill erosion, gully erosion, compaction and minor salting

B.2 MAPPING METHODOLOGY

The map units described in this report are broad areas of land delineated primarily on the basis of perceived differences in landform pattern and geology. Some distinctions have also been made considering one or more of the following features - climate, soils, native vegetation, land use and land deterioration.

The techniques and aids employed to delineate map units were:

- stereo interpretation of 1:80,000 black and white aerial photographs covering the entire area;
- 1:250,000 geology maps
  1:100,000 topographic maps
- climatic data, mainly from the Bureau of Meteorology and the Department of Conservation and Natural Resources;
- published works covering various aspects relevant to the study area;
- personal communications within and outside the Department of Conservation and Natural Resources;
- field traverses on which information on a variety of land characteristics was collected;
- site information, recorded on a standardised site card and to be stored in a computer data-base system, used to sort, compare, retrieve and print the data as required.

This section presents a description of the characteristic features of each map unit beginning with a general description. The geological type, range in average annual rainfall (mm) and slope (%), and dominant and minor landform elements then follow. The soils are classified according to Northcote (1979), and a written description of the soils, with an indication of the relative soil abundance, accompanies the Factual Key. Reference is also made to the Australian Soil Classification (Isbell, 1995).

Soil features noted include colour, texture, structure, mottling pH, inclusions and soil drainage. Other aspects of the surrounding terrain described include site drainage, presence and nature of hardpans, depth to hardpan or bedrock, land deterioration, land use and native vegetation species and structure.

The map units are named using a system derived from McDonald *et al*, 1984. Each map unit has been given a symbol based on its predominant landform pattern, slope, geology, number (separated on features such as location, soil type, vegetation structure and composition, land use and land deterioration) and rainfall class . The derivation and range of the map unit symbols is explained in the following tables.

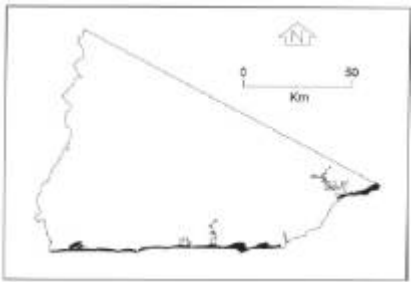
The study area has been divided up and has an accompanying key map and legend.

Examples: LuTm1 - **L**ow hills, **u**ndulating (3-10% slope), **T**ertiary geology, **m**oderately humid climate (700-1000 mm av. annual rainfall), Type **1** (soil types with predominantly duplex profiles; greater clay at depth).
RPguKml. **R**ise and **P**lain terrain complex, **g**entle to **u**ndulating slope (1-10%), coarse (**K**), unconsolidated sediments, **m**oderately humid climate, Type **1** (only one type differentiated).

Undulating Tertiary terrain, cleared, Sandy surface.

B.3 MAP UNIT DESCRIPTIONS

B.3.1 Dunes, Coarse Unconsolidated, Type 1



DuKm-1, DuKh-1, DurKm-1, DrKm-1, DrKh-1, DrsKm-1, DRuKm-1

These are coastal dune units with designated slope categories that have formed along a large proportion of the coast in the study area. There are occasional swales interposed between the dunes but the units are generally well to excessively drained because of the sandy parent material. The soils are typically uniform with greater organic matter content in the surface (A) horizon. Generally the soils have two distinct horizons - the upper being a pale to grey sand, depending on organic matter content while the lower horizon is a yellow sand occasionally with some nodule in the upper portion. These horizons are often separated by a dark brown humic pan, which has variable permeability. The vegetation is of the coastal type, with a greater number of Bloodwood trees in sheltered areas east of Wingan Inlet. Aspect and position (ie. exposure to prevailing winds) are important factors in coastal vegetation development.

Geology: Qrp; Quaternary windblown deposits. Dunes, beach deposits.

Rainfall: 700-1000 mm per annum.

Slope: Variable: Range 3-100%, generally 32-56%.

Dominant landform element: Slope.

Minor landform element: Closed depression (swale).

Soils: *Dominant:* Deep (1.0 $^{m+)}$ Uc, Uniform coarse sand soils with an organic surface horizon, unconsolidated grey sand over a humic layer (of variable thickness depending on topographic position) overlying a yellow sand deposit with some nodules (silcrete) in the upper portion. Tenosols

Minor: Dy Sandy duplex soils with organic dominant A horizons. Portasols

Native vegetation: The vegetation is dominated by climatic conditions. Low trees (often stunted) such as Silver-leafed Stringybark (*Eucalyptus cephalocarpa*) and Red Bloodwood (*E. gummifera*) with smaller shrubs and grasses particularly Marram Grass (*Ammophila arenaria*). Sedges and rushes are present in some depressions.

Stone/rock outcrop: Nil.

Pans: Weakly to strongly cemented humic sandy pan generally 0.5 - 1.2 m below the soil surface.

Land use: Predominantly native vegetation often within the Croajingalong National Park: conservation and recreation.

Observed land deterioration: Generally low, however there are active dunes along the coast particularly at Point Hicks and Cape Howe. Walking trails have been badly eroded in some places.

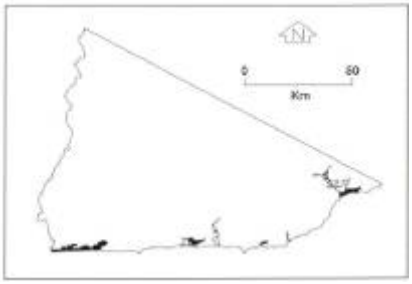
Susceptibility to land deterioration: Sheet erosion (low-high); Gully erosion (low); Waterlogging (low, to moderate in depressions); Wind erosion (high); Salting (low-high).

Sites with laboratory data: Nil

Thurra River estuary and active dune (DrKm-1)

B3.2 Coastal Flats Unconsolidated sediments, Type 1

ClKm-1, ClKFm-1, CgFm-1, CgFKm-1, CgKFm-1



Depositional low lying (occasionally inter-tidal) coarse sediments, occasionally with some fine sediments, located at estuaries and behind dune formations. The soils are generally poorly developed on unconsolidated sediments, with occasional deeper organic A horizons.

The coastal vegetation ranges from saline tolerant herbs to shrubs and small trees such as Bloodwood and Swamp Paperbark depending on topographic position.

The main occurrences of these units are at the estuaries of the major rivers.

Geology: Qra; Quaternary alluvium/swamp deposits, unconsolidated.

Rainfall: 700-1000 mm per annum.

Slope: Range 0-10%, generally 0-3%.

Dominant landform element: Flat.

Minor landform element: Slope concave/convex, streamlet.

Soils: *Dominant:* Uniform coarse (occasionally duplex). Apedal yellow/grey sandy profile, neutral to alkaline pH.

Minor: Duplex soils (Dy).

Native vegetation: Saline tolerant herbs, rushes and shrubs, some shrubs and trees: Swamp Paperbark (*Melaleuca ericifolia*), Southern Mahogany (*E. botryoides*), Coast Banksia (*Banksia* integrifolia) and Saw Banksia (*Banksia serrata*).

Stone/rock outcrop: Nil.

Pans: Generally no pans. Occasional weak pan or segregation horizon on higher ground.

Land use: Some grazing, occasionally improved on freehold. Conservation and recreation in Croajingalong National Park.

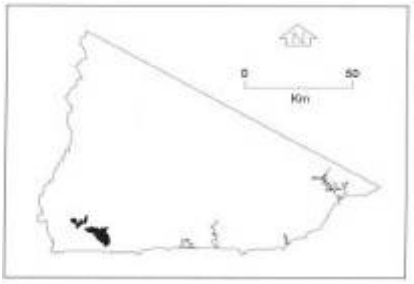
Observed land deterioration: Generally low, some sheet and bank erosion depending on topographic position, and wind erosion if exposed**.**

Susceptibility to land deterioration: Sheet and rill erosion (low to moderate); Gully (low to moderate); Compaction (low to moderately low); Mass movement (low); Wind erosion (low to high); Bank erosion (low to moderate).

Sites with laboratory data: Nil

B.3.3 Plains, Alluvial, Type 1

PlAm1, PlgAm1, PgAm1



These units account for the Snowy River floodplain near Orbost and are based on the recent alluvial material that makes up the floodplain area; floodplain, levees, terraces, ox-bow lakes (billabongs) and previous water course alignments. These sediments are of Recent (Quaternary) origin. The Plain units extend from west of Orbost to the base of Mt. Raymond to the east and southward merge into coastal flats at the base of the Marlo Tertiary outcrop. The Cabbage Tree floodplain joins this system. The range of soils in these units is variable due to varied rates and type of deposited material e.g. pebbles, gravel, sand, silt and clay.

The native vegetation has been almost totally cleared but Lowland Sclerophyll Forest, Coastal Sclerophyll Forest, Riparian Forest and Warm Temperate Forest were all probably present.

Geology: Qra, Qr1, Qp5; Recent and Pleistocene (Quaternary) alluvium. Sand, gravel, silt and minor clay.

Rainfall: 700-1000 mm per annum.

Slope: 0-10%, generally less than 3%.

Dominant landform element: Plain, open depressions, drainage depressions.

Minor landform element: Terrace.

Soils: *Dominant*: Dd, Dy, Um. Less well drained areas often have dark duplex or gradational profiles with loam to silty loam topsoils and silty clay or heavier subsoils (B horizons). They are often moderately well structured have a moderate to high shrink swell capacity, may have self-mulching characteristics in places and are susceptible to compaction. The pH trend is neutral and organic matter content is probably higher than the other soil types. The uniform (medium textured) profiles are dark to mid-brown fine sandy loams or silts (occasionally duplex) and have better drainage than the heavier duplex soils. These lighter soils occur on levee banks (Site 165).

Minor: Uc. Areas of uniform (coarse) profiles; sand and gravel lenses.

Native vegetation: Minor occurrences only. Previous cover: Lowland Sclerophyll Forest, Coastal Sclerophyll Forest, Coastal Banksia Woodland, Riparian and Warm Temperate Forest. There are occasional Southern Mahogany along the Snowy River.

Stone/rock outcrop: Nil.

Pans: Nil or not observed.

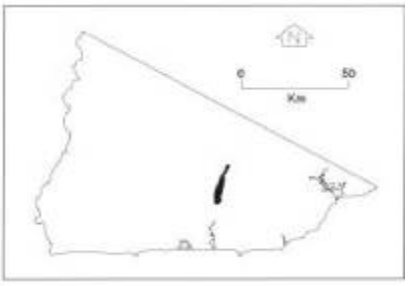
Land use: Virtually all of these units have freehold status and have been cleared and drained for agricultural purposes. Dairying, market gardening and general grazing are the main uses. This is the most intensively used land in the study area**.**

Observed land deterioration: Compaction, pugging, streambank erosion, reduction in organic matter**.**

Susceptibility to land deterioration: Sheet and rill erosion (very low to moderate); Gully erosion (very low to moderate); Compaction (low to high); Inundation/Waterlogging (moderate to very high); Mass movement (very low to moderately low)

Sites with laboratory data: 165

Snowy River floodplain, looking from Newmeralla(PlAm-1).



B.3.4 Plains, Alluvial, Type 2

PlgAm2, PlgAh2

Theses units occupy the Cann River Valley floodplain which extends from about 2.5 km south of Cann River township and northwards to Noorinbee North. This floodplain complex is made up of Recent (Quaternary) alluvium and includes levees, floodplains, terraces and previous water course alignments (meanders, ox-bow lakes). It should be noted that the Cann River has been diverted and straightened to reduce flooding for the local farmers. This has resulted in the objective being achieved but at a cost of an incised river, causing increased bank erosion and increased sediment loads.

The soils range from uniform silts along the river bank and previous courses to duplex profiles (yellow and brown). The native vegetation has been cleared but the surrounding vegetation is Lowland Sclerophyll Forest. Prior to clearing, Riparian Forest dominated by Gippsland Grey Box (*E. bosistana)* and Warm Temperate Forest generally occurred on these units.

Geology: Qra; Recent(Quaternary) alluvium. Sand, gravel, silt and clay.

Rainfall: 700-1200 mm per annum, generally 700-1000 mm per annum.

Slope: 0-3%.

Dominant landform element: Plain, open depression.

Minor landform element: Drainage depression.

Soils: *Dominant:* Dy3.11, Gn3.91. Strongly structured, friable, deep alluvial profile with distinctive horizon development but variable textural trends throughout the profile (gradational or duplex). Dark organic matter rich A horizons (silty loams) over a yellowish brown B horizon (silty clay loam to silty clay), with some yellow/orange mottling.

Minor: Um Silty profile, deep and uniform texture gradient often with a denser (clay) layer at depth; associated with stream banks, levees.

Native vegetation: Cleared with some remnants of native vegetation. Probable vegetation cover included Dry Sclerophyll Forest, Riparian Forest and Warm Temperate Rainforest: Gippsland Grey Box (*E. bosistana)* was a dominant species.

Stone/rock outcrop: Nil, apart from specific gravel lenses.

Pans: Nil or not observed.

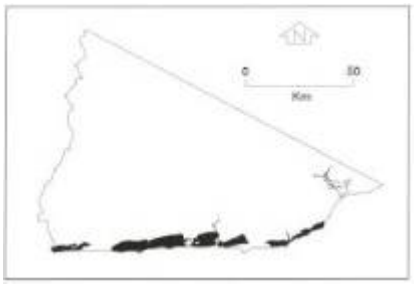
Land use: Cleared for pasture production, primarily for dairy and beef production. Some market gardening and other small holdings.

Observed land deterioration: Some bank erosion, severe in places.

Susceptibility to land deterioration: Sheet and rill erosion (very low to moderate); Gully erosion (very low to moderate); Compaction (very low to high); Inundation/Waterlogging (moderately low to very high); Mass movement (very low to moderately low).

Sites with laboratory data: 17, 143.

B.3.5 Plains and Rises, Recent sediments, Type 1



PgKm1, PCuKm1, PRguKFm1, PRuKm1, PRuKFm1, RuKFm1, RPguKm1, RPuKm1, RgKm1, RgKh1, RuKm1, RrKm1, RCgKFm1

These map units are associated with unconsolidated Quaternary sediments, predominantly sands but with numerous occurrences of silts, clays and marl. The topography consists of low dune and depression (swale) sequences, broad plain units and shallow drainage depressions. These units are associated with the coastal areas of the region, located behind the foreshore dunes and south of the Tertiary deposits. The soils tend to have uniform (coarse) and duplex profiles with sandy surfaces and often with a humic or siliceous pan at variable depth. The native vegetation consists of Lowland Sclerophyll Forest, Coastal Sclerophyll Forest, Coastal Banksia Woodland, Banksia Woodland and Coastal Heath.

Geology: Qra, Qrc, Qrp Recent (Quaternary) alluvium. Gravel, sand, silt, clay and marl.

Rainfall: 700-1000 mm per annum.

Slope: 0-10%, often less than 3%.

Dominant landform element: Plain, rise.

Minor landform element: Drainage depression, open depression.

Soils: Uc, Dy Multi-layered soil profiles often with a sandy component throughout the profile. The A horizons consist of sandy loam surface horizon with variable amounts of organic matter, decreasing down the profile (sandy texture). At variable depths the incoherent sand sharply overlies a dark sandy humic pan, usually massive and usually about 30 cm in depth. This may overly a sandy (yellow) horizon or a layer with a higher clay content (clayey sand, marl). Profiles where the lighter (i.e. sandy) upper horizons are greater than 1.0 m depth are generally denoted as Uniform. For soil properties such as drainage and permeability, a knowledge of the soil profile is essential.

Native Vegetation: The native vegetation consists of Lowland Sclerophyll Forest, Coastal Sclerophyll Forest, Coastal Banksia Woodland and Coastal Heath. The latter is particularly associated with areas of plant stressi.e. susceptible to waterlogging, wind erosion and moisture deficit stress. The species include White Stringybark (*E. globoidea*), Silvertop (*E. sieberi*), Yertchuk (*E. consideniana*), Southern Mahogany, Coast Banksia, Saw Banksia, Sunshine Wattle (*Acacia terminalis*), Sallow Wattle (*A. longifolia*), Prickly Tea-tree (*Leptospernum juniperinium*), Scented Paper-bark (*M. squarrosa*) and Spear Grass-tree (*Xanthorrhea resinosa*).

Stone/rock outcrop: Nil.

Pans: Nil or not observed.

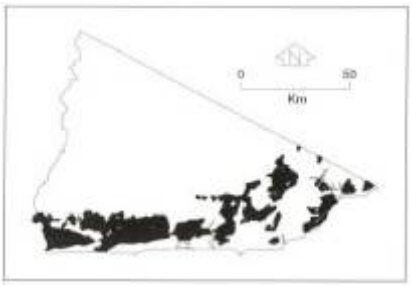
Land use: Some of these areas have been cleared generally for grazing or other uses including an aerodrome, tip, caravan park and a marl pit. Recreation is another major use of the area as well as conservation in the Croajingalong National Park (most of the area within these units) which includes an education area.

Observed land use deterioration: minor sheet and wind erosion.

Susceptibility to land deterioration: Sheet and rill erosion (very low to moderately high); Gully erosion (low to moderate); Compaction (low to moderate); Inundation/Waterlogging (low to moderately high); Mass movement (low); Wind erosion (low to moderately high).

Sites with laboratory data: 166.

B.3.6 Plains, Rises, Low hills, Hills and Entrenched valleys, Tertiary sediments Type 1



PuTh1, RgTm1, RluTm1, RluTh1, RuTm1, RuTh1, LRuTm1, LRurTm1, LguTh1, LuTm1, LuTh1, LuTv1, LurTm1, LurTh1, LrTm1, LrTh1, LrTv1, LsTm1, HrTm1, HrTh1, HrsTm1, HsTm-1, HsTh-1, HEsTm1, HEsTh1, HvTm1, PlAm0, PlAv0, PgAm0, PgAh0, PgAv0, PuAm0, PuAh0, WPlAh0, WlAm1, WlAh1

Tertiary sediments occur in a band juxtaposed between the coastal units and the dissected foothills to the north, occurring as broad undulating areas, rolling dissected terrain and as isolated capping on other geological material. The topographic designation of a unit is dependent on its relative relief, dissection and extent (size). The soils are typically Duplex while a Uniform profile soil type has been identified and specified in Type 2. The Duplex soils may range from a weakly structured mottled B horizon to a strongly structured whole coloured (red) B horizon. The A horizons are generally sandy. Generally, the more friable soils are located in moister climatic areas. There are a few swamp units associated with this grouping of units.

The vegetation is generally Coastal or Lowland Sclerophyll Forest with Silvertop dominant and White Stringybark. Climatic variations influence growth and species location within these units.

Geology: Tpb; Tertiary sediments. Sand, silt and clay, minor marl.

Rainfall: 700 - greater than 1200 mm per year.

Slope: Variable; 3-56%, generally 3-32%.

Dominant landform element: Crest, gentle slopes.

Minor landform element: Slopes, swampy drainage lines, open depressions.

Soils: *Dominant*: Dy, Db, and Dr; Duplex soils with mottled (red, yellow) clayey (sandy clay to medium/heavy clay and occasionally clayey sand) subsoil (B horizons). The whole coloured subsoils are strongly structured with finer structure while some of the mottled soils are less structured. The topsoils (A horizons) tend to be sandy (loamy sand, occasionally silty loam) with variable (generally low) organic matter content. There is often an A2 horizon which may be bleached (similar texture to A1 with less organic matter, but if not strictly an A2 horizon there is generally an $_{A12}$ horizon distinctly contrasting with the clayey B horizon below it (silty clay loam to medium clay).

Native vegetation: Coastal and Lowland Sclerophyll Forest, dominated by Silvertop and White Stringybark, Yellow Stringybark (*E. muellerana*) and Brown Stringybark (*E. baxteri*) in particular with generally with a shrub layer (*Acacia spp*.) bracken fern (*Pteridium esculentum)*, occasional *Banksia spp*. Minor occurrences of other species depending on topographic position and aspect.

Stone/rock outcrop: Nil/not observed.

Pans: Occasionally some minor nodulisation; silicate and ferric compounds being the main bonding agents.

Land use: Predominantly native forest with minor clearing for pasture near major roadways and major drainage lines.

Observed land deterioration: Generally low, occasionally moderate where road works or drainage lines have initiated bank erosion and where subsoil and substrate are unstructured and unconsolidated. An increase in slope accentuates these factors.

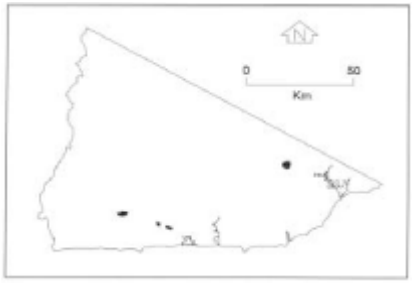
Undulating Tertiary terrain, cleared. Sandy surface

Susceptibility to land deterioration: Sheet and rill erosion (moderately low to very high); Gully erosion (low to high); Bank erosion (moderately low to high, including some susceptibility to tunnelling); Mass movement (moderately low to moderately high); Compaction (very low to high).

Sites with laboratory data: 10

B.3.7 Rises and Low hills, Tertiary sediments Type 2

LuTm2, LuTh2



These units are smaller in total area than Type 1 units on Tertiary sediments and are specifically related to more uniform (coarse) soil profiles. These units tend to be located on broad crests and therefore have gentle slopes but an undulating surface. Specific locations are often difficult to ascertain but the consistent presence of Banksia species is an indicator of this land unit type.

Known locations with specific roadside cuttings are (i) the junction Jones Creek/Drummer Roads (ii) Murrungowar and Big River Roads and (iii) Bemm River Road and Patrol Track. The vegetation is generally Lowland Sclerophyll forest with a heath type understorey and the consistent presence of Banksia species.

Geology: Tpd; Tertiary sediments Sand gravel, ferruginised sand and clay. **Rainfall**:

700-1200 mm per annum, predominantly less than 1000 mm per annum. **Slope**: 3-

10%.

Dominant landform element: Undulating rises on broad crest/dissected undulating plains.
Minor landform element: Closed depression.

Soils: *Dominant*: Uc6.14, Uc5.22. Uniform soil profile consisting of a thin organic surface horizon underlain by a grey sorted sand (often about 300 mm deep) which may overly a humic pan, but always clearly overlies a yellow sorted sand (overall depth > 1.0 m). Some nodulisation occurs in the upper reaches (silicate and ferruginous bonding) of the yellow sand. The profile is highly permeable, occasionally with restricted drainage due to pan development. In some cases the yellow sand will eventually (at depths of 2-3 m) grade into a marl or other unconsolidated parent material.

Native vegetation: Coastal Sclerophyll forest predominates with occasional lowland Sclerophyll Forest. Yellow, Brown and White Stringybarks are generally dominant with some Silvertop with *Banksia spp.* (Saw Banksia dominant) and heath understorey. The trees are separated and therefore the vegetation structures is termed a low woodland.

Stone/rock outcrop: Nil.

Pans: Humic; dark brown but weakly cemented. Silicified and ferruginised sandy pan which is nodularised and discontinuous.

Land use: Predominantly native forest, used for hardwood production. Occasional sand/gravel extraction**.**

Observed land deterioration: Generally low; some sheet erosion mainly on

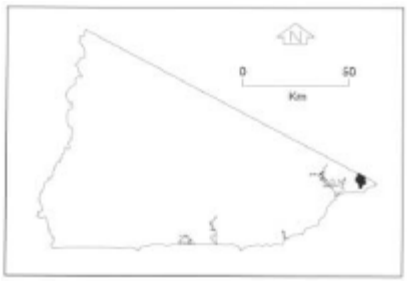
disturbed sites.

Susceptibility to land deterioration: Sheet and rill erosion (low to high); Gully erosion (low); Mass movement (very low to moderate); Inundation/Waterlogging (very low to moderately low); Wind erosion of sandy topsoils if exposed (moderately low-high).

Sites with laboratory data: Nil

Vetation on Tertiary sandy soils. Banksias are indicator species (LuTm-2)

B.3.8 Low hills and Hills, Granitic, Type 1 LuGh1, HsGm1, HsGh1



There are only two units in this category which relate to a specific pluton of granitic material that form the Howe Range east of Mallacoota. The separation of granitic parent materials is based on the differentiations used by the Geological Survey as published on the 1:250 000 Mallacoota geology sheet. The main map unit is the steep Hill unit which falls within the humid climatic category and as with many granitic map units there is some surface rock outcrop, particularly on the crests and upper slopes. Here there are friable, gritty gradational soil profiles and a variety of vegetation, generally lowland and Riparian Sclerophyll Forest. The Low hills undulating granitic unit has more developed soils with duplex profiles and variable vegetation coverage and size depending on topographic position and aspect.

Geology: Dgr; Devonian granite (Gabo Island Granite). Red biotite granite.

Rainfall: 1000-1200 mm per annum.

Slope: Variable; 3-56%, generally 32-56%.

Dominant landform element: Slope.

Minor landform element: Crest, depressions.

Soils: *Dominant*: Gn4.11, Gn4.31, Gn3.11. Red/brown gritty, friable gradational profiles, weakly to moderately well structured, shallow to deep on upper and mid slopes, particularly where moist. Duplex moderately to deep soil profiles occur on lower slopes. Moderately to strongly structured subsoils (sandy clay loam) occur particularly on lower (colluvial) topographic positions, with a sandy component including quartz, and may be mottled throughout. Weakly structured A horizons (sandy loam) with coarse fraction component throughout and on organic surface horizon.

Minor: Uc, Gn. Uniform and gradational profiles which have developed in close association with bedrock (granitic) and limited depth. These are generally coarse, with only partial breakdown of the granitic parent material.

Native vegetation: Predominantly Lowland Sclerophyll Forest and Riparian Forest with greater growth and species diversity on lower and sheltered slopes; aspect, slope and topographic position being important determining factors for variation in vegetation growth. White Ash (*E. fraxinoides*) is found on the Howe Range.

Stone/rock outcrop: Crest and upper slope of the steep hill unit (HsGh1).

Pans: No pans observed.

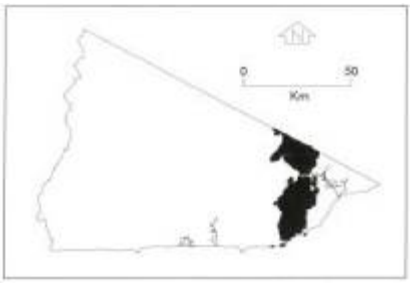
Land use: Conservation and recreation within the Croajingolong National Park and some hardwood production in State Forest. Some minor clearing on lower slope associated with sparse settlement.

Observed land deterioration: Sheet erosion and rock weathering where exposed and vegetation cover is thin.

Susceptibility to land deterioration: Sheet and rill erosion (moderately low to high); Gully erosion (moderately low to high depending on vegetation cover and topographic position); Compaction (moderately low to high); Mass movement (low to moderate); Inundation/Waterlogging (low to moderately high).

Sites with laboratory data: 202.

B.3.9 Low hills and Hills, Granitic, Type 2



RuGm2, LuGm2, LuGh2, LuGKm1, LuGKm2, LurGm2, LurGh2, LrGm2, LrGh2, LrGv2, HrGm2, HrGh2, HrGv2, HsGm2, HsGh2, EHvGm2, PlAm0, PlAh0, PgAm0, PgAh0, PuAh0

This group of units consists of undulating and rolling hills, and with one gorge unit (E/HvG) within granitic terrain north and south of Genoa. There are a number of units within this group but the variation is attributable to a climatic (rainfall) range within the area. Climate influences many soil properties and the range of vegetation in these units which ranges from drier Lowland Sclerophyll Forest to Wet Temperate Rainforest. There are some minor Plains units within this land system grouping.

A number of prominent hills (e.g. Maramingo Hill) have resistant granitic crests but generally most of the units consist of well weathered mantles all with a quartz component. There are some Tertiary/Quaternary cappings of aeolian sand on some ridges, particularly south of the Princes Highway. The more humid, sheltered areas have more friable subsoils but still have paler less structured or massive A2 horizons. The vegetation is dominated by mixed species of Stringybarks and Silvertop with other species in drainage lines and moister (southerly and easterly) aspects.

Geology: Dgl2; Devonian Granite (Maramingo Granite). Predominantly granite and granodiorite with some other granitic rocks.

Rainfall: 700 to greater than 1200 mm per annum, generally less than 1000 mm per annum.

Slope: 3-100%; generally 10-32%.

Dominant landform element: Slope.

Minor landform element: Drainage depressions open and closed.

Soils: *Dominant*: Dy3.11, Dy3.41, Db, Dr. Duplex soils with massive/weakly structured coarse A horizons (clayey loamy sand to silty loam) overlying moderately to strongly structured coarse sandy clay to medium clay B horizons which may vary in colour and mottling. The Dy and Db soils are associated with dry conditions and more likely to be mottled. The Dr profile tends to have less mottling in the B horizon and is often whole coloured (associated with a moister micro-climate). *Minor*: Gn4, Uc. These minor soil types are associated with crest or upper slope sites or around rock outcrop.

Native vegetation: Predominantly Coastal and Lowland Sclerophyll Forest with Silvertop, and White, Yellow and Brown Stringybark. Nearer the coast there are associations of Red Bloodwoods and Rough-barked Angophora (*Angophora floribunda*). Wingan Inlet is the general western limit of these species, associated with the vegetation of southern coastal New South Wales. The understorey may be Melaleuca heath type and/or Bracken Fern. Some of the plain units may be grassland (often swampy) with Silver-leafed Stringybark.

Stone/rock outcrop: Minor outcrops on crests of prominent hills such as Maramingo Hill.

Pans: Nil or not observed.

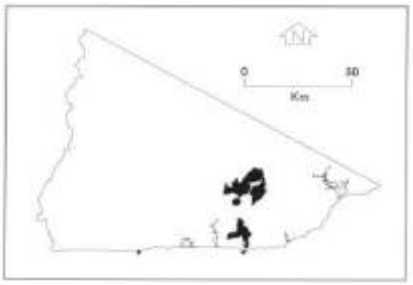
Land use: Generally these units are in State Forest north of the Princes Highway, while much of the native vegetation south of the Princes Highway is within the Croajingalong National Park. There is a communications tower on Maramingo Hill. The State Forest is subject to logging operations of its predominantly mixed species eucalypt vegetation.

Observed land deterioration: Sheet erosion, particularly where vegetation is disturbed and despite gentler slopes than adjacent sedimentary terrain. Road construction has led to some bank erosion (collapse, tunnelling, rilling) and gullying where water has concentrated into channelled run off. Moister areas are less susceptible to erosion.

Susceptibility to land deterioration: Sheet and rill erosion (mod. low to very high); Gully erosion (moderate to high); Compaction (low to high); Mass movement (low to moderate); Inundation/waterlogging (low to moderately high); Wind erosion (moderate to high if exposed).

Sites with laboratory data: 152, 153, 154.

B.3.10 Low hills and Hills, Granitic, Type 3



LuGm3, LuGh3, LrGm3, LrGh3, HrGm3, HrGh3, HrGv3, HsGh3, LrGKm1, PgAm0, PgAh0

These are undulating and rolling low hill and hill units associated with a granodiorite pluton featuring Mt. Drummer. While there may be some minor steep slopes associated with these units around Mt. Drummer there is insufficient relative relief (>300m) to technically describe an appropriate unit as a mountain. The area to the north of Mt. Drummer has lower slopes and there are some friable reddish soils (particularly the subsoil) associated with the middle, lower slopes and higher rainfall zones. The vegetation is predominantly Lowland Sclerophyll Forest, while in the broad drainage depressions and upper gullies there is Warm Temperature Rainforest, some of which is preserved within the Alfred National Park.

Geology: Dgl3; Devonian Granodiorite (Drummer Granodiorite).

Rainfall: 700 - greater than 1200 mm per annum, generally 1000-1200 mm per annum.

Slope: Variable, 3-32%, generally 10-32%.

Dominant landform element: Slope.

Minor landform element: Crest, drainage depression.

Soils: Dominant: Dr2, Db1, Gn4, Gn2. Red duplex soils with sandy A horizons (loamy coarse sand) and clayey, moderately structured subsoils (sandy clay loam) with coarse material throughout. The development of soil profiles on these units are dependent on topographic position and/or vicinity of hard rock outcrop (shallow profiles and less developed). Drier sites have more duplex characteristics such as a more marked change between A and B horizons and less friable subsoils and more yellow in colour. Gradational profiles are more likely in the moister areas and can be deep to very deep on weathered colluvial slopes, for example, around gully heads and drainage lines.

Native vegetation: Dry and Wet Sclerophyll Forest predominantly depending on aspect and topographic position, with Warm Temperate Rainforest in many of the drainage lines and drainage depressions. Mixed Species, predominantly White Stringybark and Silvertop associations dominate the drier aspects and topographic positions. Gums and other eucalypts are in more moist situations: Mountain Grey Gum (*E. cypellocarpa*) in drainage lines, and Manna Gum (*E. viminalis*), Lilly-pilly (*Eugenia smithii*) and Blackwood (*A. melanoxylon*) with typical rainforest.

Stone/rock outcrop: Minor; predominantly Mt. Drummer.

Pans: Generally nil; occasional pan in weathered parent material.

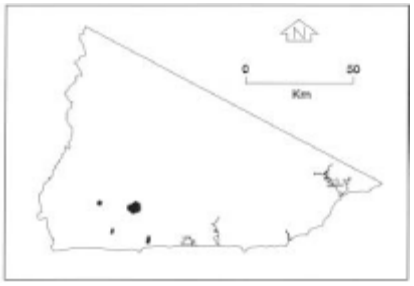
Land use: Most of these units are forested, predominantly State Forest and available for hardwood production, or they are within the Alfred National Park.

Observed land deterioration: Sheet and rill erosion, some batter slumping.

Susceptibility to land deterioration: Sheet and rill erosion (moderately low to very high); Gully erosion (low to high); Compaction (low to moderately high); Inundation/Waterlogging (low to high); Mass movement (low to high).

Sites with laboratory data: 178.

B.3.11 Low hills, Hills, Granitic Type 5



LuGKm5, LrGm5, HrsGh5, HsGm5, HsGh5

These units cover an outcrop of granitic material outcropping around Murrungowar, much smaller than most of the other granitic plutons in the study area. The soils vary from less developed profiles on the steeper terrain to deep yellow/brown duplex profiles on the gentler (particularly lower) slopes. The vegetation tends to be more open on the granitic terrain, generally Dry Sclerophyll Forest with some moister sites such as drainage lines having Riparian or Warm Temperate Rainforest.

Geology: Dgl5; Devonian Granodiorite (Murrungowar Granodiorite)

Rainfall: 700-1200 mm per annum, generally 1000 to 1200 mm per annum.

Slope: 10-56%, generally 32-56%.

Dominant landform element: Slope.

Minor landform element:

Soils: *Dominant*: Dy3.11, Dy3.21, Dy3.22, Dy3.41, Dy3.42. Duplex profiles (A/C horizons) occur on steeper slopes consisting of an organic structured A horizon (sandy loam) overlying weathered parent material overlying solid rock. Duplex profiles on gentler, lower slopes have sandy A horizons (sandy loam) which clearly overlie structured yellow mottled clay (sandy clay loams to medium clay with sand) B horizon. Soil profile depths ranged from moderately deep to deep.

Minor: Shallow Gradational (Gn4, Gn2) and Uniform profiles around crests and upper slopes: high coarse sand component.

Native vegetation: Dry Sclerophyll Forest type with some Riparian Rainforest in depressions and drainage lines. Forest structure is often more open than on other non-granitic parent materials with a low understorey. Gums may be more apparent again depending on topographic position.

Stone/rock outcrop: Confined to crest and upper slopes, particularly around Murrungowar.

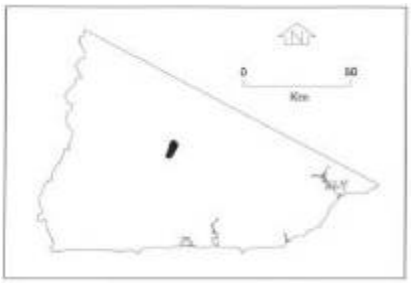
Land use: Although much of the Murrungowar area has been cleared for grazing, elsewhere these map units are forested and available for hardwood production.

Observed land deterioration: Sheet erosion, some undercutting and tunnelling where exposed particularly on lower slopes.

Susceptibility to land deterioration: Sheet and rill erosion (moderate to very high); Gully erosion (moderate to high); Compaction (low to moderately high); Mass movement (low to moderately high).

Sites with laboratory data: Nil.

B.3.12 Low hills, Hills, Granitic, Type 6



HrGv6

This unit primarily consists of the upper Errinundra Valley with a large area of low relief but the overall relief of the unit necessitates a Hill classification. This unit is at the foot of the Errinundra Plateau encompassing the lower Ada River area, Errinundra Freehold and north to Snake Creek. Geologically this area is part of the Ellery Granodiorite pluton. The soils range from shallow to deep gradational profiles on weathered parent material on lower slopes to deep uniform and multi-layered profiles on the valley floor. The vegetation is predominantly Wet Sclerophyll Forest with Messmate (*Eucalyptus obliqua*) and Mountain Grey Gum. About 20% of the units are cleared freehold at Errinundra.

Geology: Dgl6; Devonian Granodiorite (Ellery Granodiorite).

Rainfall: Greater than 1200 mm per annum.

Slope: 3-32%, predominantly 10-32%.

Dominant landform element: Slope (lower and middle).

Minor landform element: Terraces, flood plain.

Soils: *Dominant*: Gn3.11, Gn3.71. Um5.51, Um6.21 Gradational, profile predominantly an A/C profile depending on weathered nature of parent rock, and topographic position. Brown to dark friable organic sandy loam A horizon. Weakly structured, the A horizon clearly overlies weathered parent material (C horizon) at between 30 and 40 cm depth. A red friable gradational profile also appears on some lower, colluvial slope (southerly aspect) with a strongly structured clayey (sandy clay to gritty medium clay) B horizon (deep) which is overlain by a friable, earthy moderately structured organic A horizon (35 cm depth).

Native vegetation: The vegetation consists of Wet and Dry Sclerophyll Forest, generally Stringybark associations Yellow, Brown and White Stringybark with Messmate, Mountain Grey Gum, Manna Gum or River Peppermint (*E. elata*) in and around drainage lines with a sparse understorey on steeper, drier slopes and aspects.

Stone/rock outcrop: Minor, due to topographic position, mid-slope interfluves have occasional outcrops and stonier surfaces.

Pans: Nil.

Land use: Predominantly forested, some of the unit is within the Errinundra National Park the rest being State Forest and therefore available for timber harvesting. Approximately 20% of the unit is cleared and has been used for grazing; a land use that requires low management input.

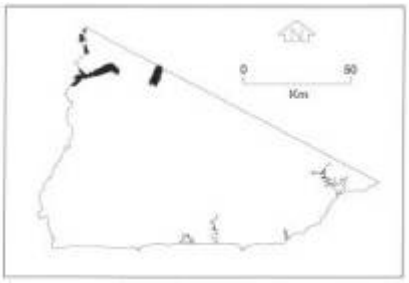
Observed land deterioration: Sheet and rill erosion. Some bank and minor gully erosion associated with drainage lines.

Susceptibility to land deterioration: Sheet and rill erosion (moderately low to high); Gully erosion (moderately low to high); Compaction (low to moderately high); Stream Bank erosion (moderate); Inundation (low); Mass movement (low to moderate).

Sites with laboratory data: Nil.

E rrinundra freehold land withthe escarpment in the background (hrGv6/MsGv7)

B.3.13 Low hills and Hills, Granitic Type 10



RLuGm10, LuGm10, LurGm10, LrGd10, LrGm10, HrGd10, HrGm10, HrsGm10, HsGd10, HsGm10, HvGm10

This group of units consists of a range of elevated (uplands), undulating, rolling and steep granodiorite/granite units around Bonang extending west to the Snowy River and at Campbells Knob. Some of these units lie in rain-shadow areas and are the driest part of the region. Much of this area within these units has been cleared for grazing. The soil types of these units range from shallow to moderately deep coarse brown and red gradational profiles to deep yellow, brown and occasionally red duplex profiles on lower and mid slopes. Drainage lines may have multi-layered (uniform or duplex) profiles. Vegetation consists of Dry Sclerophyll Forest, Rain Shadow Woodland with minor Wet Sclerophyll Forest and Riparian Forest. The Rain Shadow Woodland is west of Tubbut, centred around the Deddick River valley. There are also a number of minor outcrops such as that along the Bonang Highway/Coulsen Track and Yalmy Road near the Pinnak Road junction. These units range from undulating to steep terrain.

Geology: Dgl; Devonian Granodiorite/granite.

Rainfall: Less than 700 mm and 200 mm – 1000 mm per annum.

Slope: Variable; 3-56%.

Dominant landform element: Slope.

Minor landform element: Drainage depression, swamp.

Soils: Dominant: Dy3.41, Gn4. Yellow duplex profiles, generally moderately to strongly structured, mottled, gritty sandy clay loam to sandy medium clay B horizons overlain by sandy loam/loamy sand A horizons often with a bleached A2 horizon, either weakly structured or massive. These profiles are moderately deep to deep and grades into weathered parent material and solid rock and are generally hardsetting.

Minor: Dr3, Gn4, Gn2. Red duplex occasionally gradational where less developed (West Deddick Valley) and generally hardsetting. Shallow uniform coarse (Uc) profiles occur around some rock outcrops. Organic rich A horizons over alluvial mottled clay occurs on swampy riverine deposits.

Native vegetation: Much of the area has been cleared but native vegetation consists of Dry Sclerophyll Forest; Silvertop and White Stringybark in the slightly moister areas with occasional Riparian Forest.

To the west in the drier areas (especially <700 mm per annum) Rain Shadow Woodland is dominant with White Box (*E. albens*), White Cyprus Pine (*Callitris collumellaris*) and Blakely's Red Gum (*E. blakelyi*), with a heath and grass understorey and the occasional acacia species.

Stone/rock outcrop: Low to moderate. Occasional rock outcrop e.g. Kirkenong, Dellicknora areas.

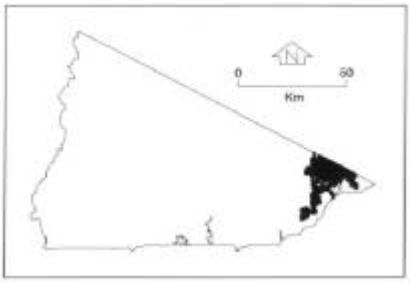
Pans: Nil or not observed.

Observed land deterioration: Sheet and rill erosion, some bank erosion.

Susceptibility to land deterioration: Sheet and rill erosion (moderately high to very high); Gully erosion (moderate to very high); Compaction (moderately low to high); Inundation/Waterlogging (low to high); Mass movement (low to high); Salting (low to moderate).

Sites with laboratory data: Nil.

B.3.14 Low hills and Hills, Sedimentary, Type 1



LuSm1, LuSh1, LuSTm1, LrSm1, LrSTm1, LrSTh1, HrSm1, HrSh1,HsSm1, HsSh1, HsSGm1, HsSGh1, PlAm0, PgAm0

These units of undulating, rolling and occasionally steep terrain occur in the far east of the region in the vicinity of the Howe Range, Genoa, Mallacoota and south to the Benedore River Reference Area. Also included in this group is a depositional area (alluvial plains) which is associated with the surrounding Low hills and Hills units. These units are associated with Ordovician sediments specific to this part of the region. The soils have duplex and brown gradational profiles depending on topographic position and micro-climate. Some profiles have been influenced by wash or windblown material (overlain) from adjoining Tertiary/Quaternary sediments and Devonian granodiorite. The vegetation is predominantly Lowland Sclerophyll Forest with some Warm Temperate Rainforest and Riparian Rainforest, mainly in the major drainage lines and drainage depressions.

Geology: Oal; Ordovician sediments (Mallacoota beds).

Rainfall: 700 to 1200 mm per annum.

Slope: Variable, 0-56%.

Dominant landform element: Slope, broad crest.

Minor landform element: Drainage depression.

Soils: *Dominant*: Dr5.11, Dy. Red Duplex shallow to deep profiles, generally friable moderately to strongly structured light to medium clay B horizons overlain by organic loam to fine sandy clay loam A horizons. Some of these profiles tend toward gradational profiles.

Minor: Gn, Um. Red/brown gradational profiles, occasionally mottled at depth (silty loam to silty clay loam). Also dark uniform medium profiles with clay at depth (>2 m).

Native vegetation: Predominantly Lowland Sclerophyll Forest; White Stringybark, Yellow Stringybark and Silvertop with some Warm Temperate Rainforest and Riparian Rainforest in drainage lines. Moister regime vegetation is more abundant north of Mallacoota Inlet.

Stone/rock outcrop: Minor, mainly crests and upper slopes.

Pans: Nil or not observed.

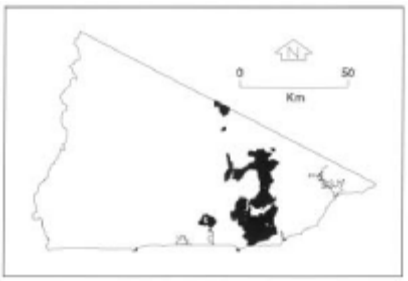
Land use: Predominantly forested with some flats which have been cleared for grazing with some uncleared freehold. The majority of these units (70%) is within the Croajingolong National Park with most of the remainder as State Forest.

Observed land deterioration: Some sheet and rill erosion. Minor bank erosion.

Susceptibility to land deterioration: Sheet and rill erosion (low to high); Gully erosion (low to moderately high); Compaction (low to high); Mass movement (very low to moderately high); Wind erosion (low to moderately low).

Sites with laboratory data: 164, 173.

B.3.15 Plateau, Rises, Low hills and Hills, Sedimentary, Type 2



UuSm2, UuSh2, UuSv2, RLrSm2, RLrSh2, LuSm2, LuSh2, LuSv2,LurSm2, LrSh2, LrSv2, LrSKm1, LrSTm2, LrSTh2, HrSm2, HrSh2,HrSv2, HsSm2, HsSh2, PlAm0, PlAh0, PlAv0, PgAm0, PgAh0, PgAv0,PuAh0

This large group of map units (including an associated alluvial Plains unit) occur east of Cann River, west of Wingan Swamp and from near the coast north to the WB line (Mealing Hill) and have been formed on older (Ordovician) sediments consisting of siltstones, slates and sandstones; the most extensive geological type in the region. These map units are surrounded by granitic plutons (Devonian) and other younger sediments (Tertiary) and therefore may influence soil and vegetation types around land unit boundaries (i.e. Tertiary/Quaternary influence near the coast). Soil type ranges from deep friable red gradational profiles, to shallow stony gradational and yellow duplex profiles depending on climate, topographic position and aspect. These factors also influence vegetation distribution; Lowland Sclerophyll, Dry and Wet Sclerophyll Forest, Warm Temperate Rainforest and Riparian Forest all occur in these map units.

Geology: Ou; Ordovician sediments. Phyllite, siltstone, slates, sandstone.

Rainfall: 700 to 1200 mm per annum.

Slope: Variable 0-56%; generally 10-56%.

Dominant landform element: Slope, broad crest.

Minor landform element: Drainage depression, flat.

Soils: *Dominant*: Gn4.11, Gn3.11, Dr2.11, Dy3.11, Dy3.21, Dy3.41. Deep red friable gradational profiles of loam to silty loam A horizons grading to silty clay B horizons strongly structured on mid to lower slopes (occasionally hardsetting A horizons) in moister areas (due to aspect and topographic position; elevation, drainage head). Yellow duplex and brown duplex profiles, loam A horizons and light clay B horizons, often mottled (but structured B horizon) and with A2 horizons occur on mid- to lower slopes in drier areas and on drier aspects and are hardsetting.

Minor: Gn4.51, Um6. Shallow, stony, hardsetting gradational and uniform medium profiles occur on crests and upper slopes particularly in drier areas. Multi-layered or uniform profiles occur in depositional areas.

Native vegetation: Lowland Sclerophyll Forest; Silvertop White Stringybark and other Stringybarks occur in drier areas particularly near the coast where Red Bloodwood and Rough-barked Angophora also occur. Dry Sclerophyll Forest of Stringybarks, Peppermints and Silvertop occur further north and there are some pockets of Wet Sclerophyll Forest and patches of Warm Temperate Rainforest and Riparian Forest in drainage depressions, gully heads and drainage lines. Occasional Banksia woodland and scrub occur on low areas.

Stone/rock outcrop: Stone outcrops are more likely on crests, upper slope and ridges and occasionally in drainage lines.

Pans: Occasional nodulisation in A2/A3 or B1 horizon: discontinuous.

Land use: Predominantly forested apart from some coastal and depositional areas with specific adapted vegetation and minor permanent clearing. State Forest is the predominant land use (just over half the area of these units) with hardwood production as a major activity. Some map units fall within the Alfred and Croajingalong National Parks.

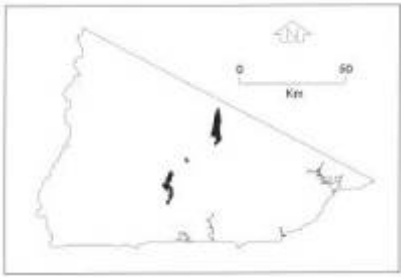
Observed land deterioration: Some sheet erosion.

Susceptibility to land deterioration: Sheet and rill erosion (very low to high); Gully erosion (low to moderately high); Compaction (low to high); Mass movement (very low to moderately high); Wind erosion (very low to moderately low).

Sites with laboratory data: 5, 181, 182, 195, 196.

B.3.16 Low hills and Hills, Sedimentary, Type 4

LurSm4, LurSh4, HrSh4, HrSv4, HsSm4, HsSh4, PuAv0



This small group of units consists of undulating, rolling and steep terrain on Devonian sediments, similar to Type 3 sediments. However the Type 4 sediments are generally finer than Type 3 units. The Type 4 units are located around the Buldah Valley (lower rainfall than surrounding area) and extend south; east of The Three Sisters. The soils range from shallow stony gradational profiles on upper and mid-slope, steep slopes to red duplex and gradational soils on lower slopes depending on moisture status and duplex, multi-layered and uniform profiles on terraces and valley floors. The vegetation is mainly Dry Sclerophyll forest with some Wet Sclerophyll Forest and Riparian forest in moister areas and aspects and in drainage lines. Some lower slopes, terraces and floodplain have been cleared.

Geology: Duc; Devonian sediments (Cann River Beds). Sandstone, siltstone, mudstone, shale, "red beds", conglomerate.

Rainfall: 700-1200 mm per annum, generally 700-1000 mm per annum.

Slope: Variable; 3-56%.

Dominant landform element: Slope, terrace, floodplain.

Minor landform element: Drainage depression.

Soils: *Dominant*: Gn3.11, Dr, Db1.11, Db1.21. Deep red/brown gradational profile (becoming duplex) with strongly structured stony B horizons (light to medium clay) grading into weathered parent material with occasional minor mottling. The A horizons can be hardsetting with massive or weakly structured A12/A2 horizons (sandy/silty loam to silty clay loam). Low to moderate organic matter content especially in drier areas. *Minor*: Um, Db, Dr profiles. Terrace and floodplain soils may have greater organic matter (surface horizons) and variable stone content with a high silt/fine sand component.

Native vegetation: Predominantly Dry Sclerophyll Forest with Silvertop, Narrow-leaved Peppermint (*E. radiata*), White Stringybark, Yellow Stringybark with other Stringybarks depending on moisture status, aspect and position. Some gums such as Mountain Grey Gum and Manna Gum occur in moister areas; Wet Sclerophyll Forest and Riparian Vegetation. Understorey consists of shrubs and herbs (e.g. Bitter-pea spp., low Acacia spp.) in Dry Sclerophyll Forest. Pasture has replaced the native vegetation on the valley floodplain, terraces and some lower slopes.

Stone/rock outcrop: Moderate (stone); mainly crest, upper and mid slopes.

Pans: Nil or not observed.

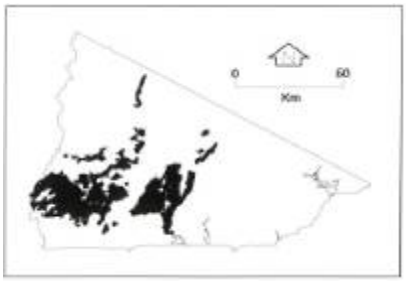
Land use: About 75% of these units are forested and designated State Forest and therefore available for hardwood timber production. There is a substantial area of freehold some of which is forested but much of it cleared for pasture, particularly around the major drainage line. **Observed land deterioration**: Sheet and rill erosion, gully and bank erosion associated with road construction.

Susceptibility to land deterioration: Sheet and rill erosion (low to high); Gully erosion (low to high); Compaction (moderate to high); Bank (including batter) erosion (moderate to high); Mass movement (very low to moderately high). A.5.7

Sites with laboratory data: 31, 38.

Buldah; colluvial erosion on "red beds", roadside (LurSm-4)

B.3.17 Low hills and Hills, Sedimentary Type 5



LuSh5, LurSm5, LurSh5, LrSm5, LrSh5, LrsSm5, LHurSm5, LHrSm5, LHrSh5, HrSm5, HrSh5, HrSv5, HrsSm5, HrsSh5, HrsSv5, HsSm5, HsSh5, HsSv5, HvSm5, PlAm0, PlAh0, PgAm0, PgAh0, PgAv0

This group of units is associated with the main sedimentary geology of the area. Type 5 units are located south of the Errinundra Plateau, west of Tonghi and east of the Snowy River. Some of these units are lower slope units at the foot of mountain units whilst others are previous erosional surface remnants or crest/upper slope units. This difference is most important for characteristics and performance for these units despite similar designations. Some minor alluvium (Plain units) are associated with this group of units. Soils range from brown/red friable gradational profiles (higher rainfall, higher elevations) to deep hardsetting gradational and duplex (yellow, brown) on lower slopes. Vegetation predominantly consists of Dry Sclerophyll Forest with Wet Sclerophyll Forest, Lowland Sclerophyll Forest. Warm Temperate Rainforest and Riparian Forest is found in drainage depressions.

Geology: Ou; Ordovician sediments Siltstone, minor schist, hornfels, contact rock, breccia, scree, quartzite. Black slate, phyllite, shale, sandstone - locally predominant.

Rainfall: 700-greater than 1200 mm, per annum. Generally 700-1000 mm per annum.

Slope: 3-56%, often 32-56%.

Dominant landform element: Slope, broad crest.

Minor landform element: Drainage depression, terrace.

Soils: *Dominant*: Gn3.11, Gn4.11, Gn3.91, Gn4.31, Gn4.51, Dy3.21, Dy3.41, Dy5. Red and brown gradational profiles (loam A horizons and light clay B horizons), shallow to moderately deep, stony and friable on upper and mid moister slopes; hardsetting and stony on drier slopes and crests. Deep gradational profiles on mid and lower slopes; moderately to strongly structured, more hardsetting and some mottling on drier slopes and aspects. Yellow duplex soils occur on drier lower depositional (colluvial) slopes and may have an A2 horizon. There is a strong textural contrast between the A (sandy loam/loam) and B horizons (light clay/medium clay), the former having little or no structure, the later being structured and generally with some mottling. *Minor*: Some duplex and uniform profiles associated with drainage depressions.

Native vegetation: Predominantly Dry Sclerophyll Forest; White Stringybark, Narrow-leaved Peppermint, Croajingolong Peppermint (*E. croajingolensis*), Broad-leaved Peppermint (*E. dives*), Yellow Stringybark, Cherry Ballart (*Exocarpus cupressiformis*), Silver Wattle. Lowland Sclerophyll Forest, Silvertop, Wet Sclerophyll Forest; Mountain Grey Gum with some Stringybarks and River Peppermint in Riparian Forest. Warm Temperate Rainforest includes Lilly-Pilly (*Eugenia smithii*), Blackwood (*A. melanoxylon*) as well as Mountain Grey Gum, Smooth Tree-Fern (*Dicksonia antarctica*) and Rough Tree-Fern (*Cyathea australis*).

Stone/rock outcrop: Minor rock outcrop. Moderate stone outcrops on crests and upper slopes, greater on steeper, dissected slopes.

Pans: Nil or not observed.

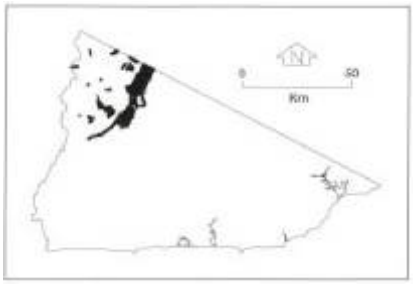
Land use: Forested, used for hardwood production within the State Forest. Water is diverted from the Brodribb River for water supply to Orbost; there is a proclaimed water supply catchment, which has been determined for land use (LUD).

Observed land deterioration: Sheet and rill erosion. Some minor gully/tunnel erosion of lower, flatter and dry (in climate category, dry aspect) cleared slopes.

Susceptibility to land deterioration: Sheet and rill erosion (very low to high), higher on steeper, drier and exposed slopes; Gully erosion (low to high), higher on drier lower slopes, deeper profiles; Compaction (moderate to high), higher where moister subsoil exposed and duplex profiles; Surface sealing (low to moderately high), moderately high on the drier slopes; Mass movement (very low to moderately high).

Sites with laboratory data: 40, 53, 65, 197.

B.3.18 Low hills and Hills, Sedimentary, Type 6



UuSm6, UdSm6, LuSh6, LuSv6, LurSm6, LrSm6, HrSm6, HrSh6, HsSm6, HsSh6, HvSm6

These units are associated with Silurian and Ordovician sediments, east of the Bonang Highway on the plateau surface or the dissected uplands of the Roger and Deddick River basins. Some of these units are well drained higher elevation cappings of dissected terrain (generally stony) while other units such as on the plateau have a range of topographic positions or follow valley floors. The soils tend to be shallow and stony on drier, dissected crests and slopes (gradational profiles) with deeper profiles (duplex and gradational profiles) on lower slopes and the more extensive map units. Vegetation type is predominantly Dry Sclerophyll Forest with some Wet Sclerophyll Forest and Riparian Forest, with less growth (density and height) on the more exposed and drier sites.

Geology: S; Silurian. Quartzitic sandstone, mudstone, shale. Ou; Ordovician. Black slate, phyllite, shale, sandstone, siltstone, minor schist, hornfels, contact rock, breccia, scree, quartzite.

Rainfall: 700-1200 mm, generally 700-1000 mm per annum.

Slope: Variable; 3-56%, generally 10-32%.

Dominant landform element: Slope.

Minor landform element: Crest, drainage depression.

Soils: *Dominant*: Gn4.31, Gn3.71, Db2, Dr3, Dr2. Shallow, stony brown gradational profiles, hardsetting on drier sites (aspect and topographic position) with loam A horizons and silty clay to light medium clay B horizons. Soils are deeper and friable on moister sites, where soils are moderately well to strongly structured, particularly the subsoil (B horizon). Moderately deep to deep duplex profiles often stony, brown or red (loam fine sandy A horizons and silty clay B horizons), occasionally with poorly or non-structured A2 horizon and strongly structured B horizons occur where profile development is greater (lower slopes). Drier aspects can be more erosion prone.

Minor: Dy3. Profiles on northerly aspect and drier position and dependent on parent material stability. Alluvial deposition forming minor multi-layered profiles; duplex or uniform (clay loam to silty clay loam).

Native vegetation: Predominantly Dry Sclerophyll Forest with Wet Sclerophyll Forest and Riparian Forest. Stringybark associations; White Stringybark, Red Stringybark (*Eucalyptus macrorhyncha*), Yellow Stringybark, Brown Stringybark with Narrow-leaved Peppermint, Croajingolong Peppermint, Broad-leaved Peppermint and Shining Gum, Messmate, Manna Gum and Mountain Grey Gum in moister areas particularly drainage lines. Understorey has a generally low moisture status; *Acacia spp*., *Cassinia spp*., Austral bracken and *Daviesia* spp. and other herbs.

Stone/rock outcrop: Some surface stone, particularly on crests and upper slopes.

Pans: Generally nil, occasionally some minor nodule development.

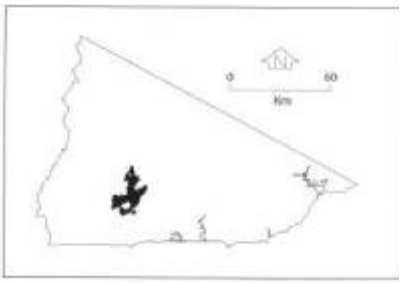
Land use: Predominantly forest with some freehold around Dellicknora and Bonang. Some of these units fall within the Snowy River National Park and the Concordia Gully Reference Area.

Observed land deterioration: Sheet erosion, particularly on steeper slopes. Some batter destabilisation on less stable parent material (deep clay B and C horizons) in drier areas.

Susceptibility to land deterioration: Sheet and rill erosion (very low to high); Gully erosion (low to moderately high); Compaction (low to high - deeper duplex profiles); Inundation (very low to high); Mass movement (very low to moderate).

Sites with laboratory data: Nil

B.3.19 Low hills and Hills, Sedimentary, Type 8 LurSh8, HrSh8, HrSv8, HsSm8, HsSh8, HsSv8



These map units are based on sedimentary terrain which has been metamorphosed, with schists the dominant parent material but have many similar characteristics to the surrounding sedimentary Type 5 map units. This unit lies within a very moist climatic area in the vicinity of Murrungowar, north west up to Greens Road and east partially along the Glen Arte River. The soils tend to have organic rich gradational profiles often lying abruptly on the parent material. A prime example can be found at Kuark Gap. The native vegetation is predominantly Wet Sclerophyll Forest with Warm Temperate Rainforest, Dry Sclerophyll Forest and minor Lowland Sclerophyll Forest.

Geology: Omm; Metamorphosed Ordovician sediments. Schist, hornfels, slate, schistose sandstone, chert.

Rainfall: 700 to greater than 1200 mm per annum, generally greater than 1200 mm per annum.

Slope: 10-56%.

Dominant landform element: Slope.

Minor landform element: Drainage depression.

Soils: *Dominant*: Gn4.31, Gn3.71. Friable gradational profiles with organic rich A horizons grading into slightly mottled B horizons with a relatively clear boundary to the parent material (schist/hornfels). The structure of the A horizons is weak to moderately well structured but porous with textures of organic fine sandy loam to light fine sandy clay loam. The B horizons are moderately well structured with a texture of fine sandy clay loam to sandy clay.

Minor: Shallow organic uniform profile (Um). Also shallow to deep hardsetting gradational profiles on drier sties and less metamorphosed parent material.

Native vegetation: Predominantly Wet Sclerophyll Forest with Warm Temperate Rainforest: Messmate, Mountain Grey Gum, Silver Wattle, Lilly-pilly, Blackwood, River Peppermint. Dry Sclerophyll Forest and minor Lowland Sclerophyll Forestalso occur; Silvertop, White Stringybark, Narrow-leafed Wattle (*A. mucronata*) and Long-leafed Dogwood (*Cassinia longifolia*).

Stone/rock outcrop: Minor occasional accumulation/exposure on peaks and some crests.

Pans: Nil or not observed.

Land use: Predominantly forested and designated State Forest and therefore available for hardwood production. A small area of freehold has been cleared and is used for grazing, east of Murrungowar Road.

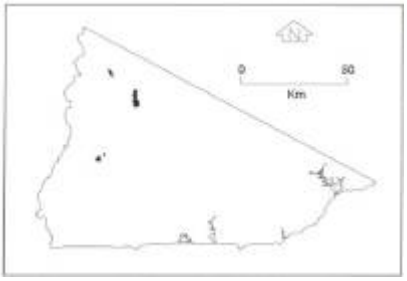
Observed land deterioration: Some sheet and rill erosion, scouring to bedrock where disturbed (roading).

Susceptibility to land deterioration: Sheet and rill erosion (low to moderately high on steep areas); Gully erosion (low to moderately high); Compaction (moderately low to high); Inundation (very low to moderate); Mass movement (very low to moderately high).

Sites with laboratory data: Nil

New road, Kuark Gap area on metamorphic terrain (HrSv-8/MsSv-8)

B.3.20 Low hills and Hills, Basaltic, Types 1, 2, 3 and 4LrBm1, LrBm2, LuBm3, LrBh4



These units occur as cappings in their respective terrain, some being more prominent than others (Type 1, Bonang; Type 2, Tubbut). The Type 1 and 2 units occur in a drier climate and exhibit a range of terrain soils and vegetation. There are flat to undulating crests often stony while side-slopes are generally rolling, occasionally steep. The soil variation follows this terrain pattern with shallow to moderately deep stony surface uniform/gradational profiles with deeper profiles lower in the landscape and duplex profiles in depressions. The vegetation is generally classed as Dry Sclerophyll Forest often different to surrounding map units. This also especially applies to the Type 3 basaltic site (Paradise Ridge Road). The Type 3 (made up of three outcrops) and the unmapped Type 4 (Club Terrace) map units are in moister areas and this is reflected in both soil and vegetation types.

Geology: Tvo; Tertiary volcanics. Olivine basalt, titanaugite basalt.

Rainfall: 700-1200 mm per annum.

Slope: 3-32%.

Dominant landform element: Broad crest, slope.

Minor landform element: Drainage depression.

Soils: *Dominant*: Dy2, Dd2. These soil profile types are dominant on the Type 1 and 2 units apart from the crests which are often very rocky. There is a dark finely structured surface A horizon which overlies a massive/weakly structured lighter coloured lower A horizon, both having a loam to clay loam texture. These horizons clearly overly a strongly structured B horizon, darker than the lower A horizon occasionally with some mottling or a gley appearance depending on location (e.g. near a drainage line) with a medium to heavy clay texture which is very sticky when moist.

Minor: Gn3.11(Type 3) Stony, moderately deep red, dark, brown gradational profile with a dark surface organic horizon with textures ranging from loam to light clay at depth and similarly for Type 4.

Native vegetation: Predominantly Dry Sclerophyll Forest and Rain-shadow Woodland (drier areas) have White Box, Red Stringybark and Broad-leafed Stringybark. There are also a number of gums such as Snow Gum (*E. pauciflora*), Mountain Grey Gum at the Type 2 site. At the Type 3 sites there are East Gippsland Blue Gum (*E. globulus sp. maidenii*) with Silvertop with a moist understorey of Blanket-leaf (*Bedfordia arborescens*). This is in marked contrast to the surrounding sedimentary terrain.

Stone/rock outcrop: Moderate to high stone content especially on crests with some minor outcrop.

Pans: Nil or not observed.

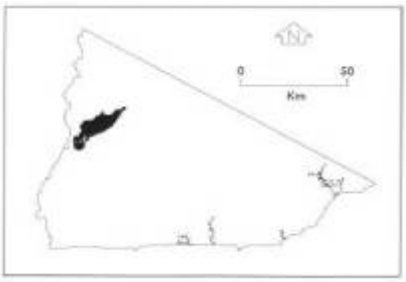
Land use: The majority of the Type 1 and 2 units have been cleared or partially cleared for grazing, while the Type 3 and Type 4 map units are forested, designated State Forest and available for hardwood production. However, the uniqueness of the Type 3 sites may lead to a recommendation for their reservation.

Observed land deterioration: Minor sheet erosion, minor mass movement (Type 1).

Susceptibility to land deterioration: Sheet and rill erosion (very low to moderate); Gully erosion (low to moderate); Compaction (moderately low to very high); Inundation/Waterlogging (low to high); Mass Movement (moderately low to high), high for steep edge/contact slopes (associated with springs).

Sites with laboratory data: 108, 192

B.3.21 Low hills and Hills, Volcanics, Type 1



LguVh1, LguVv1, LuVm1, LuVh1, LuVv1, LurVm1, LurVh1, LurVv1, LsVv1, HrVm1, HrVh1, HrVv1, HrsVm1, HrsVh1, HsVv1

These units are based on the Snowy River Volcanics geological formation which have a number of lithologies but are predominantly made up of acidic volcanics; mainly rhyodacite. This group of units comprises a large proportion of the Rodger River basin extending north of Yalmy Road from Sugarloaf Hill in the south to north of Monkey Top track. These units generally have a moist climate (> 1000 mm per annum). The soils are red and brown friable soils with gradational profiles and greater accumulation on some lower slopes. There are some multi-layered soils associated with major drainage lines (Waratah Flat). The native vegetation is predominantly Wet Sclerophyll Forest with Riparian Forest and some Dry Sclerophyll Forest and Cool Temperate Rainforest.

Geology: Dls; Devonian acid volcanics (Snowy River Volcanics). Rhyodacite, tuff, andesite, minor rhyolite and basalt. Also includes coarse sandstone, conglomerate and minor siltstone.

Rainfall: 700- greater than 1200 mm per annum, generally greater than 1000 mm per annum.

Slope: 1-56%, generally 3-32%

Dominant landform element: Broad slopes, crests

Minor landform element: Drainage depression

Soils: *Dominant*: Gn4.11, Gn3.11, Gn3.71, Gn4.31. Friable, often gritty throughout, red and brown gradational profiles with organic rich loam/clay A (surface) horizons over light clay B horizons. Moderately well to strongly fine structured profiles and less coarse structure compared with sedimentary gradational profiles.

Minor: Dy3.11 Lighter A horizon below some organic accumulation clearly overlying an occasionally mottled, strongly structured yellow clayey B horizon. This is associated with lower slopes associated with a major drainage line (alluvial/colluvial) and depositional Uniform coarse(Uc) loamy sand profiles i.e. Waratah Flat.

Native vegetation: Predominantly Wet Sclerophyll Forest with some Riparian Forest; Messmate, Mountain Grey Gum,

Blackwood and Blanket-leaf. Also Shining Gum, River Peppermint and White Stringybark, Silver Wattle, Southern Sassafras (*Atherosperma moschatum*), Soft Tree-Fern.

Stone/rock outcrop: Nil to minor. Some stone associated with steeper slopes, crests.

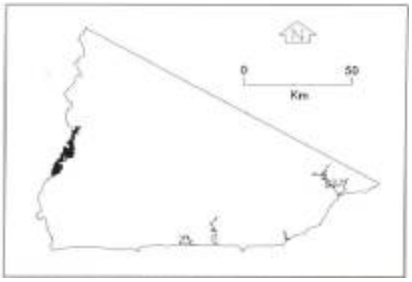
Pans: Nil or not observed

Observed land deterioration: Very minor sheet and rill erosion.

Susceptibility to land deterioration: Sheet and rill erosion (low to moderately high); Gully erosion (low to moderately high); Compaction (moderately low to very high); Mass movement (low to moderate); Inundation/Waterlogging (very low to high).

Sites with laboratory data: Nil

B.3.22 Low hills and Hills, Volcanic, Type 2 LurVm2, HrVm2, HsVm2, HMvVm2



These map units are based on the Snowy River Volcanics geological formation which have a number of lithologies; predominantly acid volcanics (rhyodacite). The Type 2 units consist of a greater proportion of red ignimbrite, some coarse sandstone and conglomerate compared with the Type 1 and Type 3 map units and also occupy the driest areas on the acid volcanics lithologies. There is also a limestone outcrop at Jackson's Crossing. A major geomorphological feature is the incision of the Snowy River and some of its tributaries into much of this geological formation. The soils tend to range from reddish friable gradational profiles to drier shallow, very stony uniform/gradational profiles. The vegetation is Dry Sclerophyll Forest, Rain-shadow Woodland, some Wet Sclerophyll Forest and Warm Temperate Rainforest.

Geology: Dls; Devonian acid volcanics (Snowy River Volcanics). Rhyodacite, tuff, andesite, minor rhyolite and basalt. Also includes coarse sandstone and conglomerate, minor siltstone. Minor limestone (Dla).

Rainfall: Less than 700-1000 mm per annum. **Slope**:

10-greater than 100%, generally 10-32% **Dominant**

landform element: Broad crest, slope **Minor**

landform element: Drainage depression

Soils: *Dominant*: Gn2, Gn4.31, Gn4.51 Stony, hardsetting, weakly to moderately structured gradational profiles, shallow to deep; depending on topographic position and aspect, often gritty and with coarse material throughout.

Minor: Shallow, stony uniform to gradational shallow profile. Occasional moderately deep to deep duplex profile on lower slopes.

Native vegetation: Predominantly Dry Sclerophyll Forest, Rain-shadow Woodland and some Wet Sclerophyll Forest and Warm Temperate Rainforest: White Stringybark, Narrow-leaf Wattle, Red Box (*E. polyanthmos*), Cherry Ballart, Messmate, Mountain Grey Gum, Blanket-leaf, Rough Tree-Fern, White Box, Kurrajong (*Brachychiton populneus*), and Peach Heath (*Lissanthe strigosa*).

Stone/rock outcrop: Moderate surface stone outcrop and moderate rock outcrop on crests and upper slopes especially major drainage line slopes (Snowy River).

Pans: Nil or not observed

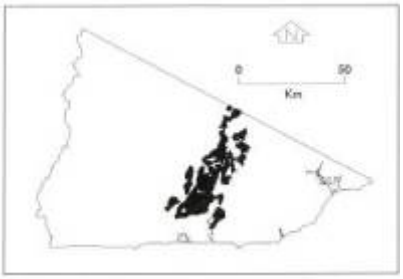
Land use: Generally forested though scattered and stinted on rocky areas especially drier upper slopes. These map units are within the Snowy River National Park with camping grounds at Raymond's Falls and at Jackson's Crossing. Some minor clearing at Jackson's Crossing.

Observed land deterioration: Low on gentle slopes, some minor sheet erosion and some embankment erosion where exposed on deeper, duplex soil profiles.

Susceptibility to land deterioration: Sheet erosion (moderately low to very high). Higher on steeper drier slopes; Gully erosion (low to high). Higher on steeper, drier slopes; Compaction (low to high); Inundation/Waterlogging (very low to moderate); Mass Movement (low to high). Higher on steeper slopes.

Sites with laboratory data: Nil

B.3.23 Low hills, Hills and Plains, Granitic, Type 4



LuGm4, LuGh4, LurGm4, LurGh4, LurGv4, LrGm4, LrGh4, LrGv4, LHrGm4, HrGm4, HrGh4, HrGv4, HrsGm4, HsGm4, HsGh4, PlAh0, PgAh0, PuAm0, WlAv0

These units are associated with the designated Noorinbee Granodiorite; north and south of Cann River township. These units occur north to the NSW border and flank the steeper, mountain units which include Mt. Denmarsh and Mt. Kaye, and Mt. Bemm to the south. The Plains units are depositional units which have their source material from the surrounding granitic material. The soil profiles on the undulating to steep units tend to be Duplex (yellow and red), occasionally Gradational while brown Duplex/Gradational and occasional multi-layered soils are found in the depositional plains units. The vegetation varies from Lowland Sclerophyll Forest in the south to Dry and Wet Sclerophyll Forest further north with drainage lines containing Riparian, Warm Temperate and Cool Temperate Rainforest. The Plains units have generally lower susceptibility to land deterioration than the hilly granitic units, except for waterlogging.

Geology: Dgl4; Devonian Granodiorite (Noorinbee Granodiorite).

Rainfall: 700-1200 mm per annum, generally less than 1000 mm per annum.

Slope: 0-56%, generally 10-32%.

Dominant landform element: Slope (lower and upper), plains (including terraces).

Minor landform element:

Soils: Dominant: Dy3.41, Dr2, Dr3.41, Dr5. Variations depend generally on topographic position, aspect and general climatic zone. The drier sites have hardsetting profiles with marked changes from sandy apedal A horizons (coarse sandy loam) which may include bleached A2 horizons to a structured clayey (sandy clay to clay with sand) B horizon which may be mottled and may have cutans present. Moister sites have less marked changes between A and B horizon with greater friability and generally more whole-coloured and redder than drier sites, for example site 199.

Minor: Multi-layered soil with recent deposits occur in some low lying areas (alluvium) with a higher organic matter content than other soils. Shallow to deep gradational profiles in some moister areas and higher topographic positions.

Native vegetation: Lowland Sclerophyll Forest occurs south of Princes Highway where there are Silvertop, White, Yellow and Brown Stringybark associations with a more coastal understorey (heath, bracken fern and occasional banksia). Dry Sclerophyll Forest occurs further north with occurrences of Wet Sclerophyll Forest with Warm Temperate and Riparian Rainforest in drainage lines and depressions.

Stone/rock outcrop: Low, outcropping on some crests and upper slopes.

Pans: Nil or not exposed.

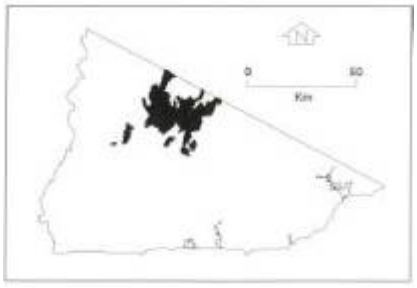
Land use: The Low hill and Hill units are forested and generally available for hardwood production (State forest), while some of the area concerned falls within the Croajingalong National Park to the south. The Plains units are generally cleared for pasture production.

Observed land deterioration: The sandy topsoils are prone to sheet and rill erosion, particularly where vegetation cover is poor and the granitic (particularly the yellow mottled) subsoils are also prone to erosion particularly if exposed: undercutting, gullying and tunnelling.

Susceptibility to land deterioration: Sheet erosion (moderately low to high); Gully erosion (low to high); Compaction (low to high); Waterlogging (low to very high); Mass movement (low to moderately high).

Sites with laboratory data: 35, 149, 193, 199

B.3.24 Plateau, Low hills and Hills, Sedimentary, Type 7



UurSv7, ULurSm7, ULurSh7, ULrSv7, LgSh7, LgSv7, LuSm7, LuSh7, LurSm7, LurSh7, LurSv7, LrSm7, LrSh7, LrSv7, LHrSm7, LHrSh7, LHrSv7, HrSm7, HrSh7, HrSv7, HrsSm7, HrsSh7, HrsSv7, HsSm7, HsSh7, HsSv7, HrSGv7, PgAm0, PuSAm0, PuSAh0

These units occupy the central area of the Errinundra Plateau, extending from Bonang in the west to Granite Mountain in the east and include some of the wettest areas of the region (1800 mm per annum). These units generally occupy the area immediately north of the Errinundra escarpment and consist of a series of low hills, minor ranges and undulating topography generally with rolling slopes and a Plain unit. and distinguished from the drier units on the general plateau surface to the north and west. The soils are predominantly friable, with gradational profiles but minor occurrences of harder-setting profiles in drier areas. Organic matter levels are generally high, particularly in moister areas and stone content varies. The vegetation is predominantly Wet Sclerophyll Forest with some Montane Sclerophyll Woodland, Cool Temperate Rainforest, Montane Forest, Snow Gum Woodland and Alpine Wet Heathland.

Geology: Ou; Ordovician. Black slate, phyllite, shale, sandstone, siltstone, minor schist, hornfels, contact rock, breccia, scree, quartzite.

Rainfall: 700 to greater than 1200 mm per annum. Generally greater than 1200 mm per annum.

Slope: Variable; 3-56%, generally 10-32%.

Dominant landform element: Slope.

Minor landform element: Drainage depression, open depression.

Soils: *Dominant*: Gn3.11, Gn4.11, Gn3.71, Gn4.31. These soils are friable, organic, moderately to strongly structured, moderately deep to deep, acidic, often stony red or brown gradational profiles (loam A horizons and (silty) clay loam /light clay loam B horizons). Stone content is often dependent on topographic position, aspect and lithology. These soils are leached and have high infiltration capacities despite heavier textures down the profile.

Minor: Gn4.31, Gn4.51 Drier sites, occasionally hardsetting e.g. on ridge tops etc. Minor occurrences of Duplex (yellow, brown) profiles and Uniform fluvial deposits (Um); organic loam.

Native vegetation: Very tall Wet Sclerophyll Forest is dominant with associated Cool Temperate Rainforest; Shining Gum, Mountain Grey Gum, Narrow-leaved Peppermint, Brown-barrel, Messmate Stringybark, Blackwood, Silver Wattle, Southern Sassafras, Blanket-leaf, Smooth Tree-Fern and Rough Tree-Fern. Montane Forest, Montane Sclerophyll Woodland, Snow Gum Woodland and Alpine Wet Heathland are also present Delegate River; Snow Gum, Alpine Ash, Broad-leaved Peppermint, Candlebark, Mountain Swamp Gum and Silver Wattle.

Stone/rock outcrop: Minor. Some stone particularly on upper slopes, crests.

Pans: Nil or not observed.

Land use: Predominantly forested, some natural heathland, minor clearing. A large proportion of these units lie within the Errinundra National Park. Hardwood production and grazing are other local land uses. There has been some gold mining in the past; Victoria Star mine and prospecting.

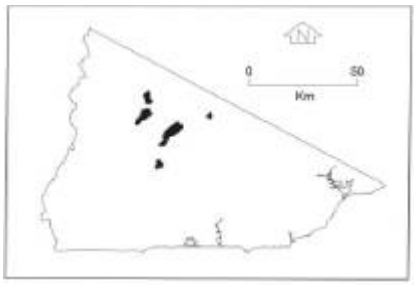
Observed land deterioration: minor sheet erosion.

Coast Range Road/Coban Road Sign, climatic effect, moss growth on southerly aspect (UurSv-7)

Susceptibility to land deterioration: Sheet and rill erosion (low to moderate); Gully erosion (very low to moderately high); Compaction (low to high); Inundation/Waterlogging (low to moderately high); Mass movement (very low to moderately high).

Sites with laboratory data: 25, 123.

B.3.25 Undulating Plateau, Low hills and Hills, Granitic Type 7



ULrGv7, LurGm7, LrGv7, HrGm7, HrGh7, HrGSv7, HrGv7, HsGm7, HsGh7

These units are found on the Ellery Granodiorite pluton and comprise the gentler topographic units found on this parent material either as a plateau, plateau remnant or the lower slope at the foot of the scarp face. As with the steeper map units these units have a very moist climatic regime which is reflected both in their soils and the vegetation types. The soils have gradational profiles (red and brown) which are gritty, friable, well drained and generally more stable than other granitic soils, particularly in lower rainfall areas. The vegetation is Wet Sclerophyll Forest with some drier aspect vegetation at lower elevations on drier aspects, with Cool Temperate Rainforest on lower slope drainage depressions. Bands of sedimentary and metamorphic rock occasionally intersperse the granodiorite e.g. Christians Road.

Geology: Dgl6; Devonian Granodiorite (Ellery Granodiorite).

Rainfall: Greater than 1200 mm per annum.

Slope: 3-56%, generally 10-32%.

Dominant landform element: Broad crest, slope.

Minor landform element: Drainage depression.

Soils: *Dominant*: Gn4.11, Gn3.11, Gn4.31, Gn2. Deep red and brown gradational profiles which are friable, whole coloured with organic rich A horizons (sandy loam) over friable moderately to strongly structured (fine - not much coarse structure) whole coloured B horizons; sandy clay loam/sandy clay. There is generally a coarse sandy component throughout the profile.

Minor: Shallow gradational profiles with less subsoil development. Deep gradational/duplex profiles occur on colluvial slopes. Uniform/gradational profiles with grey (gley) subsoil often occur in large drainage lines (Uf6, Gn3.9).

Native vegetation: Wet Sclerophyll Forest with Shining Gum, Brown Barrel (*E. fastigata*), Mountain Grey Gum, Narrow-leaved Peppermint, Messmate with other Stringybark and Gum associations. There is generally a rich diverse understorey including acacias; Blackwood particularly in drainage lines and regrowth of Silver Wattle on recently logged sites.

Stone/rock outcrop: Minor, generally only on steeper slopes on occasional shallow crests. Well weathered on upper rolling (Low) Hill units (HsGv7, U/LrGv7).

Pans: Nil.

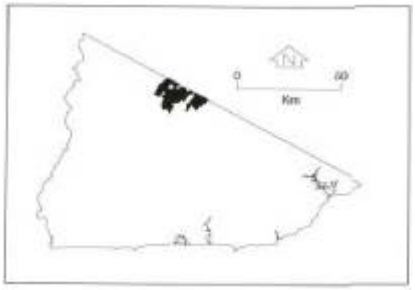
Land use: These units are forested and are either in State Forest (approximately 50%) and available for timber production (including re-generation) or within the Errinundra National Park.

Observed land deterioration: Very minor, some sheet and rill (land disturbance).

Susceptibility to land deterioration: Sheet and rill erosion (low to moderately high); Gully erosion (very low to moderately high); Compaction (low to moderately high); Inundation/Waterlogging (low-moderately high); Mass movement (very low to moderately high).

Sites with laboratory data: 136.

B.3.26 Undulating Plateau, Low hills and Hills, Sedimentary, Type 9



UgSm9, ULurSm9, LuSm9, LurSm9, LrSm9, LHrSCm9, HrSm9, HrsSm9, HsSm9

These units are on sedimentary terrain (including colluvial material) and generally have low relief with undulating to rolling topography often with short sharp steeper slopes and some drainage line flats. These units occupy the drier areas of the plateau north and east of Bendoc to the border with New South Wales and Coast Range Road to the east. These units are within the drier component of the climatic (rainfall) gradient, which is evident from the very high rainfall of the Errinundra plateau which generally decreases northward. The soils generally have yellow or brown duplex profiles often with a mottled B horizon. The vegetation where not cleared for pasture includes Montane Sclerophyll Forest, Dry Sclerophyll Forest, Wet Sclerophyll Forest and some Montane Forest and Snow Gum Woodland (Mt. Delegate).

Geology: Ou; Ordovician sediments. Black slate, phyllite, shale sandstone. Siltstone, minor schist, hornfels, contact rock, breccia, scree, quartzite.

Rainfall: 700-1000 mm per annum.

Slope: 1-56%, generally 10-32%.

Dominant landform element: Slope.

Minor landform element: Drainage depression, open depression.

Soils: *Dominant*: Dy3.41, Dy3.42. Yellow duplex profiles which are hardsetting when dry. The loam/(fine) sandy/silty loam A horizon overlies a sandy clay loam/sandy to medium clay B horizon, moderately deep to deep with a strongly structured but mottled B horizon and a massive A2 horizon often bleached. The surface organic rich layer varies in depth (5-25cm), due to aspect and topographic position. Stone content increases with depth.

Minor: Uc, Um, Dy. Multi-layered profiles; duplex and uniform; associated with drainage line deposition.

Native vegetation: Montane Sclerophyll Woodland and Dry Sclerophyll Forest are dominant; Broad-leaved Peppermint, Candlebark (*E. rubida*), Silver Wattle, Snow Gum, Gorse Bitter-pea (*Daviesia ulicifolia*), Red Stringybark and Long-leafed Dogwood. here is also some Wet Sclerophyll Forest and Montane Forest and Snow Gum Woodland; Messmate, Mountain Grey Gum and Snow Gum.

Stone/rock outcrop: Low to minor; some stone crests.

Pans: Minor occurrence; occasional variable inclusions content.

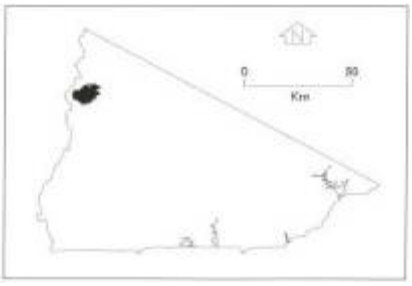
Land use: Much of the area has been cleared and used for grazing. The remaining area of these units is forest of variable quality, generally poorer than further south where there is more moisture. There has been some mining activity; general gold prospecting and also mining for wolfram at Mt. Bendoc (circa WWII).

Observed land deterioration:

Susceptibility to land deterioration: Sheet and rill erosion (low to high); Gully erosion (very low to high); Compaction (very low to very high); Inundation/Waterlogging (low to very high); Mass movement (very low to moderately high); Salinity (moderately low to moderately high)

Sites with laboratory data: 128, 133.

B.3.27 Undulating Plateau, Low hills and Hills, Volcanic, Type 3



UuVh3, UuVv3, UurVm3, UurVh3, UurVv3, LuVh3, LuVv3, LurVm3, LurVv3, LrVh3, LsVh3, LsVv3, LHrVm3, LHrVh3, LHrVv3, HurVm3, HrsVm3, HrsVh3, HrsVv3

These units are based on the Snowy River Volcanics geological formation and occur as an outcrop to the north of the Type 1 and Type 2 units. The Type 3 units are centred around the Gelantipy Plateau, from the Snowy River in the west to the Pinnacle in the east. The Deddick Trail passes through this group of units (north/south). The geological formation is dominated by acid volcanics (rhyodacite). These units are at a high elevation and generally in a high rainfall area which has influenced vegetation and soil types. The soil types have predominantly friable, often stony gradational profiles. The native vegetation consists of Montane Forest, Wet Sclerophyll Forest, Dry Sclerophyll Forest and Cool Temperate Rainforest.

Geology: Dls; Devonian acid volcanics (Snowy River Volcanics). Rhyodacite, tuff, andesite, minor rhyolite and basalt. Also includes coarse sandstone and conglomerate, minor siltstone.

Rainfall: 700- greater than 1200 mm per annum, generally greater than 1000 mm per annum.
Slope: Variable; 3-56%, generally 10-32%

Dominant landform element: Broad crest, plateau, slope

Minor landform element: Drainage depression, open depression

Soils: *Dominant*: Gn4.11, Gn4.31, Gn3.11, Gn2. Red/brown gradational profiles, friable, moderately deep to deep, moderately well to strongly structured (fine) but little or no coarse (large) structure, well drained and no mottling. Textures range from loam with sand and organic matter (A horizons) to sandy clay loam(occasionally sandy clay) at depth (B horizons). Often stony depending on topographic position; >30% gravel/stone in the B horizon.

Minor: Gn Drier area soil on general northern aspect and upper and middle topographic positions. Moderately structured but often weak to moderately structured in the B horizon. Not as friable as moister area soils but still with noticeable organic matter accumulation in the A horizons.

Generally stony; variable due to lithological variations (outcrops, jointing, tilting etc.).

Native vegetation: Montane Forest, Wet Sclerophyll Forest on the plateau surface. Also Dry Sclerophyll Forest and Cool Temperate Rainforest: Shining Gum, Silver Wattle, Southern Sassafras, Soft Tree-Fern, Mountain. Ash, White Stringybark, Red Box, occasional Yellow Box (*E. melliodora*), Yellow Stringybark.

Stone/rock outcrop: Surface stone may be about 30% on crests, less in depositional areas.

Pans: Nil or not observed

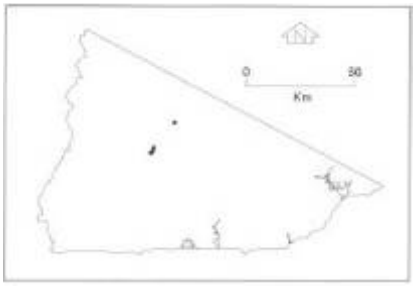
Land use: Access is restricted in this area of the Snowy River National Park with only a few tracks and subject to suitable weather conditions. The Deddick Trail passes through the Gelantipy Plateau Reference Area.

Observed land deterioration: Minor sheet erosion; drier areas

Susceptibility to land deterioration: Sheet and rill erosion (very low to high); Gully erosion (very low to moderately high). Greater for steeper and drier areas; Compaction (low to moderately high); Inundation/Waterlogging (very low to moderate); Mass movement (very low to moderately high).

Sites with laboratory data: Nil

B.3.28 Hills, Granitic, Type 8



HrGv8, HsGv8, HvGv8

This small group of units consists of two rocky outcrops which are part of the Ellery Granodiorite pluton. These two outcrops are Goonmirk Rocks and Mt. Ellery which are the highest points in the area and receive a high rainfall (often >1800 mm per annum). The soils are generally shallow, stony with organic brown and red gradational profiles where soil has developed interposed by stone and/or rock outcrops. The rock outcrops generally occur on the crest and upper slopes. The vegetation is sparse on the crest and upper slopes where Montane forest may occur with Wet Sclerophyll Forest on the lower slopes of this unit and some Cool Temperate Rainforest in depressions.

Geology: Dgl6; Devonian Granodiorite (Ellery Granodiorite).

Rainfall: Greater than 1200 mm per annum.

Slope: Variable; 10-100%.

Dominant landform element: Crests, slope

Minor landform element: Tors.

Soils: Dominant: Gn4.11, Gn4.31, Gn3.31. Brown and red gradational profiles which are generally shallow, but deeper on lower slopes, with organic friable sandy loam A horizons grading into moderately to strongly structured sandy clay loams to gritty sandy clay B horizons.

Native vegetation: Montane Forest with Snow Gum occasionally Candlebark and Silver Wattle occurs around Mt Ellery and in the vicinity of Goonmirk Rocks. Wet Sclerophyll Forest is also present particularly on the mid/lower slopes of these units and Cool Temperate Rainforest occupies drainage lines and drainage depressions.

Stone/rock outcrop: High. Mainly on upper slopes and crests; large outcrops (tors).

Pans: Nil.

Land use: Both these units fall within the Errinundra National Park, and both are sight-seeing landmarks within the Park: conservation and recreation.

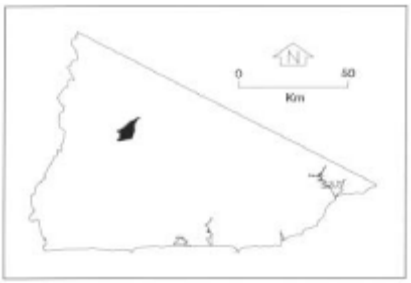
Observed land deterioration: Sheet erosion accentuated by trampling.

Susceptibility to land deterioration: Sheet and rill erosion (low to high); Gully erosion (moderately low to moderate); Compaction (low to moderately high); Mass movement (low to moderate).

Sites with laboratory data: Nil

View south from Coast Range Rd to Hensleighs Creek Rd

B.3.29 Hills, Granitic, Type 9



HsGm9, HsGh9, PgAm0, PgAh0

These units are either rolling or steep hills on Granodiorite in the Goongerah area extending from south of Goongerah north to Brown Mountain and the head of the Errinundra plateau. An alluvial Plains unit is also included in this group (floodplain and terraces), being surrounded by granitic Hill units. The soils are shallow to deep brown and red friable coarse gradational profiles in moister areas (higher elevations and topographic positions), while mid and lower slopes, particularly in drier areas have duplex profiles (generally yellow and brown) which are more erodible. Vegetation is predominantly Dry Sclerophyll Forest with some Wet Sclerophyll Forest and Riparian Forest in moister areas and major drainage lines.

Geology: Dgl; Devonian Granodiorite/Granite.

Rainfall: 700-1200 mm per annum.

Slope: 0-56%, generally 32-56%.

Dominant landform element: Slope.

Minor landform element: Drainage depression, terraces (flats).

Soils: Dominant: Dy3.21, Dy3.42, Db: Yellow and brown duplex soils in drier areas on lower and mid slopes. Sandy loam upper A horizons weakly structured, overlie a massive loamy sand A2 horizon (occasionally conspicuously bleached), sometimes overlie a clayey loamy sand A3. These A horizons clearly overlie a coarse gritty medium clay, moderately well structured B horizon which is moderately mottled. The B horizon generally grades into weathered parent material at depths of 2.0 m or more.

Minor: Shallow to deep brown and red gradational profiles occur in moister areas particularly the upper slopes, higher elevations. Multi-layered (uniform and duplex) profiles occur in drainage lines and flats.

Native Vegetation: The vegetation is predominantly Dry Sclerophyll Forest with Narrow-leaved Peppermint, some Stringybarks; White and Yellow Stringybarks and some gums, with a more open canopy and sparse understorey. The moister areas have denser vegetation growth including understorey and greater tree growth, with species such as Brown-barrel Ash and Mountain Grey Gum.

Stone/rock outcrop: Moderate on spurs, crests; low on lower slopes. **Pans**:

Occasional nodulisation and hardsetting (cemented) A2/A3 horizons.

Land use: Predominantly native forest classified as State Forest and therefore available to hardwood production. There are a number of freehold blocks around Goongerah, mainly in the valley on the Brodribb River flats. There is a camping site which is part of the Baldwin Spencer Trail tourist route.

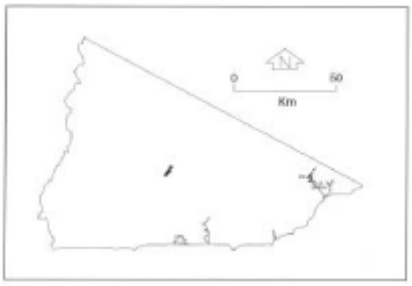
Observed land deterioration: Sheet and rill erosion, some gullying and tunnelling, particularly associated with clearing and bank erosion in drier areas.

Susceptibility to land deterioration: Sheet and rill erosion (low to very high); Gully erosion (moderately low to very high); Compaction (low to high); Inundation/Waterlogging (low to moderately high); Bank/Tunnel erosion (moderately low to very high).

Sites with laboratory data: Nil.

B.3.30 Hills, Limestone, Type 1

HrLh1, HrLv1, PgAh0



This group of units covers an outcrop of limestone and acid volcanic material at Boulder Flat, north of Club Terrace. There is a cleared Plains unit (Boulder Flat) which is also included and consists of a number of terraces. The main Hill unit is rolling with occasional steeper slopes in a generally moist climate. The soil types are gradational profiles, deep on mid to lower slopes with variable parent material in the profile. Some slates and purple sediments are associated with the limestone as well as rhyodacite/coarse sandstone, outcropping in the drainage line. The Plains unit has a duplex depositional profile. The vegetation is predominantly Wet Sclerophyll Forest with some Dry Sclerophyll Forest and Riparian Forest, depending on aspect and topographic position.

Geology: Dla; Buchan Caves limestone. Dls; Snowy River Volcanics. Qra; Floodplain deposits.

Rainfall: 1000 to greater than 1200 mm per annum.

Slope: Variable, 0-56%, generally 10-32%.

Dominant landform element: Slope, flat (terraces).

Minor landform element: Drainage depression.

Soils: Dominant: Gn3.12, Gn3.13, Gn4.21 Dr, Dy3.11, Dy5.11. On the Hill unit mid slope is a friable red/black (B horizon colour: 2.5YR 3/6); deep profile with limestone floaters in the profile and is strongly structured with a neutral to slightly alkaline pH. Texture ranges from organic loam/silty loam A horizons to light medium clay B horizons. The flat plain must have a duplex profile (occasional gradational) of loam A horizon and silty clay/light clay B horizon without an A2 horizon and is only weakly to moderately well structured and faintly mottled at depth (>1 m).

Minor: Shallow red/brown gradational profiles on upper, drier slopes and aspects.

Native vegetation: The Hills unit is generally covered with Wet Sclerophyll Forest Narrow-leaved Peppermint, White Stringybark, Silver Wattle with some Dry Sclerophyll Forest of White, Yellow and Brown Stringybark and Riparian Forest: Manna Gum, Mountain Grey Gum. The vegetation is generally closed tall forest with greater understorey growth in Wet Sclerophyll Forest.

Stone/rock outcrop: Minor; Rock bars in major streams, crests.

Pans: Nil or not observed.

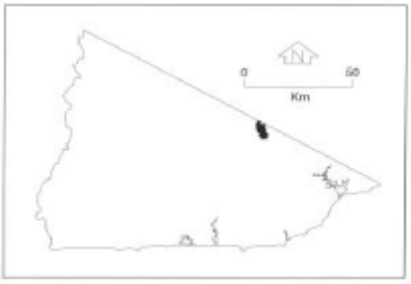
Land use: The Hill unit is predominantly native forest designated State Forest whilst the other units have been cleared (freehold). A small proportion of freehold land above Boulder Flat has been partially cleared and mining activity has been carried out excavating for calcrenetic material, but is currently abandoned. Boulder Flat itself (comprising of terraces) has been cleared and is used for grazing.

Observed land deterioration: Sheet erosion where land is disturbed. Some minor streambank erosion.

Susceptibility to land deterioration: Sheet and rill erosion (low to moderate); Gully erosion (low to moderate); Compaction (low to moderately high); Streambank erosion (low to moderate); Waterlogging/Inundation (low to high).

Sites with laboratory data: 21, 22, 23.

B.3.31 Hills, Sedimentary, Type 3



HrSm3, HrSh3, HsSm3

These Hills units are formed on Devonian sediments which have a distinct 'red bed' component and also include a coarse sand (fine gravel, sandstone/conglomerate which is highlighted in this grouping (Genoa Beds) located around the Genoa River near the New South Wales border. The major unit has rolling topography while the other units are steep or very steep but with only sufficient relative relief to be designated a Hill. The soil types range from skeletal profiles on upper slopes to deep gradational and duplex (yellow, brown and red) on the mid and lower slopes. The vegetation is Dry Sclerophyll Forest with some Riparian Forest in drainage depressions.

Geology: Duc; Devonian sediments (Genoa Beds). Sandstone, siltstone, mudstone, shale, "red beds", conglomerate.

Rainfall: 700-1000 mm per annum.

Slope: 10-100%, generally 10-32%.

Dominant landform element: Slope, broad crest, incised drainage line.

Minor landform element: Drainage depression.

Soils: *Dominant*: Gn, Dy3.11, Db3.11, Dr2.11. Moderately deep to deep gradational and duplex profiles depending on topographic position and aspect. Subsoil development is subject to parent material variations such that coarser conglomerate produces a coarser soil profile and a denser finer more structured B horizon (subsoil) is formed on siltstones, mudstones and fine sandstones. The A horizon textures are generally organic loam and light medium to medium clay in the B horizon. Apart from moister areas these soils tend to be hardsetting. Surface organic matter horizon tend to be loose and have variable depth, but are generally shallow.

Minor: Gn/Uc/Um; Shallow, stony profile with shallow loose organic horizon overlying the mineral horizon grading quickly into parent material.

Native vegetation: The vegetation is predominantly Dry Sclerophyll Forest with Stringybark associations principally White Stringybark, Yellow Stringybark, Narrow-leafed Peppermint and Silvertop with a dry climate understorey

(heath, wire grass (*Tetrarhena juncea*) and some shrubs). There is also some Wet Sclerophyll Forest and Riparian Forest associated with the drainage depressions. Species such as Red Stringybark, Blue-leafed Stringybark (*E. agglomerota)* and Blue Box (*E. bauerana*) occur on drier ridges.

Stone/rock outcrop: Moderate to high. Stony, particularly on ridges and where the drainage system has incised into the land; immediate tributaries to Genoa Gorge.

Pans: Nil or not observed.

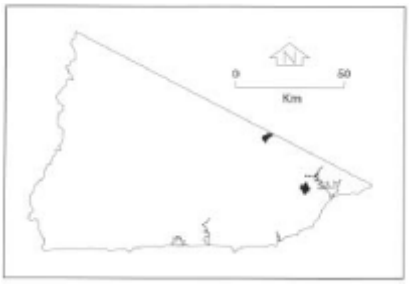
Land use: Forested apart from rocky areas. These units are within the Coopracambra National Park and have limited formed access.

Observed land deterioration: Sheet erosion, creep, minor rock movement.

Susceptibility to land deterioration: Sheet and rill erosion (moderate to very high); Gully erosion (moderate); Compaction (moderately low to moderately high); Water logging/Inundation (very low to moderate); Mass movement (low to very high); Bank erosion (low to moderate).

Sites with laboratory data: 201.

B.3.32 Mountains and Escarpments, Granitic Type 2



MsGm2, MsGh2, SsGm2, SvGm2

These units are steeper units associated with the previous low hills and hills units but having the distinction of greater relative relief as well as steeper slopes. Examples are the escarpment of Mt. Merragunegin and Genoa Peak which has its own distinctive pinkish granite. Aspect and topographic position are important factors in the distribution of soil and vegetation types in these units. For example upper slopes have a developing friable, structured gradational profile which shows much greater stability than the deeper, more duplex profiles on lower slopes which are generally drier, except in drainage lines.

Geology: Dgl2; Devonian granite (Maramingo Granite).

Rainfall: 700-1000 mm per annum, generally less than 1000 mm per annum.

Slope: 32-100%, generally <56%.

Dominant landform element: Slope.

Minor landform element: Rocky crest.

Soils: *Dominant*: Gn4, Gn2, Dy3, Db2. Shallow to moderately deep brown friable gradational profiles, strongly structured (fine) with coarse material throughout with loamy sand A horizons and sandy clay loam B horizons. Deeper gradational to duplex profiles on lower slopes, with $_{A12/A2}$ horizon development in drier areas on colluvial accumulated material and may be mottled (less stable than the gradational profiles in the moister areas).

Minor: Uc; Uniform coarse profile where parent rock outcrops.

Native vegetation: Lowland Sclerophyll Forest dominates these upmap units. Predominant species are Stringybarks with some Silvertop with some gums; Mountain Grey Gum and indicative moister climatic understorey in the moister areas and aspects.

Stone/rock outcrop: Crest; peak, at Genoa Peak and on main ridge crests.

Pans: Nil or not observed.

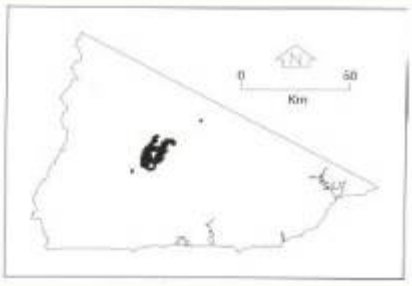
Land use: Native forest, designated State Forest used for hardwood production and some minor grazing on some reclaimed plain units.

Observed land deterioration: Some sheet erosion (minor) on the upper slopes, but greater erosion potential on drier and lower, (colluvial) slopes. Waterlogging on plains units. Some bank erosion.

Susceptibility to land deterioration: Sheet and rill erosion (moderate to very high); Gully erosion (moderately low to high); Compaction (moderately low to high); Waterlogging (low to very high in plains units); Mass movement (low to high).

Sites with laboratory data: Nil.

B.3.33 Mountains and Escarpments, Granitic, Type 7



MsGv7, MvGh7, MvGv7, SMvGv7, SvGv7

These units are found on the Ellery Granodiorite pluton on and around the edge of the Errinundra Plateau incorporating the Plateau surface, dissected (scarp) face and dissected remnants. These units incorporate some of the wettest areas of the study area. A local rainfall collection site has an average annual rainfall of nearly 1800 mm with frequent recordings of over 2000 mm.

The soils predominantly have gradational profiles; friable, well drained and generally much more stable (with vegetation cover) than other granitic soils in drier areas. Soil textures are generally sandy loams grading to sandy clay loams with a gritty component throughout. The vegetation is predominantly Wet Sclerophyll Forest with Cool Temperate Rainforest, Riparian Forest and Montane Sclerophyll Forest in drainage lines and some lower slopes. There may be minor occurrences of sedimentary and metamorphic rocks (narrow north/south bands) within these units, especially in the vicinity of Christians Road.

Geology: Dgl6; Devonian Granodiorite (Ellery Granodiorite).

Rainfall: 1000 to greater than 1200 mm per annum.

Slope: 32-100%.

Dominant landform element: Slope.

Minor landform element: Broad crest, drainage depression.

Soils: *Dominant*: Gn4.31, Gn4.11 Shallow, deep red and brown gradational profiles, well drained with weak coarse structure but a strong fine structure with a coarse sandy component throughout. Textural change from a sandy loam A horizon to a sandy clay loam/sandy clay B horizon depending on soil development: less development and stonier on steeper mid-slopes.

Minor: Red and brown friable Gradational profiles on metamorphic and sedimentary parent material, with finer textures than granitic counterparts.

Native vegetation: Wet Sclerophyll Forest predominates with some Shining Gum and Mountain Grey Gum with other gums e.g. River Peppermint. Cool Temperate Rainforest and Riparian Forest and Montane Sclerophyll Forest are also represented here along drainage lines, drainage depressions and some gentle slopes. The high rainfall is a dominant factor in species location and the lush growth, with an understorey including Hazel Pomaderris (*Pomaderris aspera*) and Blanket leaf.

Stone/rock outcrop: Minor/moderate. More pronounced on steeper upper and mid slopes within these units.

Pans: Nil.

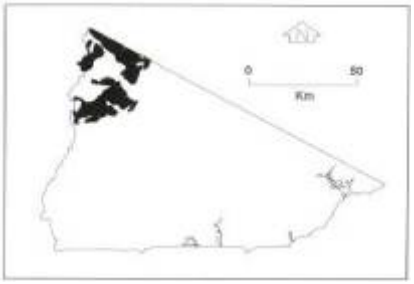
Land use: These units which are forested are either in the Errinundra National Park or in State Forest (available for timber harvesting given the appropriate guidelines and prescriptions).

Observed land deterioration: Minor to moderate. Sheet and rill erosion, occasional bank slumping on exposed, steep batter.

Susceptibility to land deterioration: Sheet and rill erosion (low to very high); Gully erosion (low to moderately high); Compaction (low to moderately high); Bank erosion (low); Inundation/Waterlogging (very low to moderately low); Mass movement (low to high).

Sites with laboratory data: Nil.

B.3.34 Mountains and Escarpments, Sedimentary, Type 6



MrSm6, MrSh6, MrsSm6, MsSd6, MsSm6, MsSh6, MvsSm6, MvSd6, MvSm6, MvSh6, SMvSm6, SsvSh6, SsvSv6, SvSd6, SvpSm6, SvSm6, SvSh6, SpSm6

These units are based on Silurian and Ordovician age sediments and consist of the Yalmy Scarp, the sedimentary terrain of the Rodger River Basin and the dissected sedimentary terrain north of the Deddick River including Mt. Tingaringy, peneplains of the NSW border area and east to Dellicknora. The Mt. Tingaringy Peneplain is regarded to have more in common with the steeper surrounding terrain than the lower elevation Low hill and Hill units. These Mountain units tend to have shallow stony profiles particularly on the crests, upper slopes and mid-slopes but many have greater soil development (deeper) elsewhere. The vegetation consists of Montane Sclerophyll Woodland, Snow Gum Woodland, Montane Forest (Snow gum) at higher elevations and Dry Sclerophyll Forest, Rainforest Woodland, Wet Sclerophyll Forest, some Riparian and Cool Temperate Rainforest.

Geology: S; Silurian. Quartzitic sandstone, mudstone, shale. Ou; Ordovician. Black slate, phyllite, shale, sandstone. Siltstone, minor schist, hornfels, contact rock, breccia, scree quartz.

Rainfall: 700-1200 mm per annum, generally 700-1000 mm per annum.

Slope: 32 - greater than 100%, generally 32-56%.

Dominant landform element: Slope.

Minor landform element: Peneplain, drainage depression.

Soils: *Dominant*: Gn3.11, Gn4.11, Gn3.71, Gn4.31, Um. Shallow to moderately deep, stony, friable gradational and uniform profiles of fine sandy loam A horizons to silt loam/ fine sandy clay loam B horizons (greater organic matter content at moister sites). Deep, friable strongly structured red and brown gradational profiles in moister areas (moister aspects and topographic positions) with loam/silt loam A horizons to clay loam/light clay B horizons. Soils are generally acidic.

Minor: Gn4.13; Gradational profile with alkaline soil reaction trend; may be Gc where localised limestone is the parent material. Duplex profiles (Dy3) on drier lower slopes which may have accumulated (colluvial) material. Multi-layered or uniform soil profiles on recently deposited material in drainage lines.

Native vegetation: Variable vegetation associations with subalpine grasslands/rocky areas and montane forest; Snow Gum, Tingaringy Gum (*E. glaucesens, E. saxitilis*) at higher elevations (Mt. Tingaringy). Wet Sclerophyll Forest, Dry Sclerophyll Forest and Riparian Forest; Shining Gum, Mountain Ash, Mountain Grey Gum, Messmate, Stringybark associations; Red Stringybark, Yellow Stringybark, Brown Stringybark and Silvertop. Rain-Shadow Woodland; White Box, White Cyprus Pine and Blakely's Red Gum. Associated understorey for forest canopies; *Acacia* spp., *Pomaderris* spp, *Cassinia* spp. Smooth Tree-Fern, *Pea* spp, *Geebung* spp. and other herbs.

Stone/rock outcrop: Moderate to high stone content on the steeper dissected country with exposed rock on crests and upper slope e.g. Mt. Tingaringy, western rock face.

Pans: Nil or not observed.

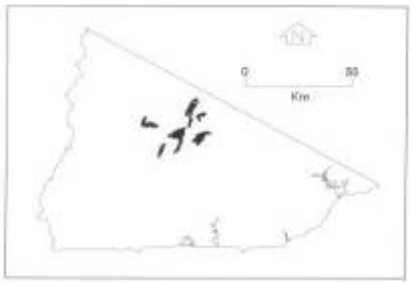
Land use: Predominantly forest with most of these map units within the Snowy River and Tingaringy National Parks.

Observed land deterioration: Some sheet and rill erosion.

Susceptibility to land deterioration: Sheet and rill erosion (low to very high); Gully erosion (low to high) Compaction (low to moderately high); Streambank (low to high); Mass movement (low to high).

Sites with laboratory data: Nil.

B.3.35 Mountains and Escarpments, Sedimentary, Type 7 MsSv7, MsvSv7, SsSh7, SsSv7, SMvSv7, SsSm7, SvSv7



These units form part of the scarp face of the Errinundra Plateau and some scarp faces along the ridges on the plateau, such as along the Queensborough River. These units comprise one of the moistest areas of the region. These units are based on sedimentary terrain but there are contact zones with granitic areas and minor metamorphic and sedimentary occurrences within the general granitic areas. The sedimentary units are generally on very steep terrain. The soil types tend to have friable gradational profiles, often stony with greater accumulation of material on lower slopes and around drainage lines. There may be some less friable profiles on the drier sites (topographical position, aspect). The vegetation type is predominantly Wet Sclerophyll Forest with Cool Temperate Rainforest found in the drainage depressions. There is also some Dry Sclerophyll Forest.

Geology: Ou; Ordovician sediments. Black slate, phyllite, shale, sandstone, siltstone, minor schist, hornfels, breccia, contact rock, scree, quartzite.

Rainfall: Greater than 1200 mm per annum.

Slope: 32-100%.

Dominant landform element: Slope.

Minor landform element: Drainage depression.

Soils: *Dominant*: Gn4.11, Gn3.11, Gn3.71, Gn4.31. Shallow to deep, friable, organic, stony, moderately well to strongly structured red and brown with gradational texture profiles (loam A horizons over silty clay loam/light clay B horizons). These profiles though leached and quite acidic (pH <5.5) generally have high infiltration capacities even with heavier textures down the profile, due to the friability and structure of the soil. Stoniness is generally greater on the steeper slopes and drier areas.

Minor: Gn3.91. There are harder setting gradational profiles, often stony and shallow on drier aspects, ridge tops and slopes.

Native vegetation: The predominant vegetation is Wet Sclerophyll forest with Cool Temperate Rainforest in drainage depressions: Shining Gum, Brown Barrel, Messmate Stringybark, Narrow-leaved Peppermint, Mountain Grey Gum, Silver Wattle and Shiny Cassinia.

Stone/rock outcrop: Low to moderate surface stone content with occasional minor rock outcrop.

Pans: Nil or not observed.

Land use: All these map units are forested and lie either in State Forest or the Errinundra National Park. Therefore both recreational, conservation and production values are represented within these map units.

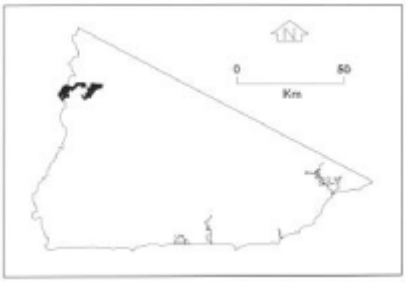
Observed land deterioration: Sheet erosion (minor), some minor batter destabilisation.

Susceptibility to land deterioration: Sheet and rill erosion (moderate to high); Gully erosion (moderately low to high); Compaction (moderately low to high); Inundation, waterlogging (low to moderate); Mass movement (moderately low to high).

Sites with laboratory data: Nil.

View east from Cottonwood Range over the plateau area, Bendoc (hrsSm-7).

B.3.36 Mountains and Escarpments, Volcanic, Type 3



MsVm3, MsVh3, MsVv3, MvVm3, SMvVd3, SMvVm3, SvVm3

These units are based on the Snowy River Volcanics geological formation and have a number of lithologies; rhyodacite being predominant. These units are to the north of the Type 1 and Type 2 Volcanic map units and occur to the north, west and south of the Gelantipy Plateau. These units have much greater relative relief than the Hill units which means often rapid movement of water and incision by drainage lines. The drier area to the west has been deeply dissected by the Snowy River.

The soil types range from shallow to deep friable gradational profiles in moister areas to shallow, stony uniform and gradational profiles in drier areas. The vegetation ranges from Cool Temperate Rainforest, Wet Sclerophyll Forest to Dry Sclerophyll Forest and some Riparian Forest.

Geology: Dls; Devonian acid volcanics. Snowy River Volcanics. Rhyodacite, tuff, andesite, minor rhyolite and basalt. Also includes coarse sandstone and conglomerate, minor siltstone.

Rainfall: Less than 700-1200 mm per annum, generally 700-1000 mm per annum.

Slope: Variable; 10- greater than 100%. Often greater than 56%.

Dominant landform element: Slope, scarp

Minor landform element: Drainage depression

Soils: *Dominant*: Gn4.31, Gn2, Gn4.11 Brown and red gradational profiles (loam A horizons over silty clay loam B horizons), shallow to deep with variable stone/parent material content depending on topographical position and aspect. Friable in moist areas but may be hardsetting in drier areas and have a less intense colour (Gn4.51, Gn3.91, Gn1). Organic matter content and infiltration rates are greater for the moister areas with strong fine structure but less coarser structure and with a gritty (sandy) component throughout the profile.

Minor: Drier area soils range from shallow stony uniform profiles (Uc) to duplex (Dy, Dr; yellow and red) profiles, occasionally with A2 horizons where there is greater soil accumulation (weak/moderate structure in the B horizon).

Native vegetation: Dry Sclerophyll Forest, Wet Sclerophyll Forest, Cool Temperate Rainforest, Riparian Forest and minor occurrence of Rain-shadow Woodland. Major species include White Stringybark, Red Box, Long-leafed Dogwood, Cherry Ballart, Narrow-leaved Peppermint, Messmate, Silver Wattle, Soft Tree-Fern, Blackwood, White Box.

Stone/rock outcrop: Moderate to very high. Rock exposures are common on steeper units particularly upper slopes, crests, drier aspects.

Pans: Nil or not observed

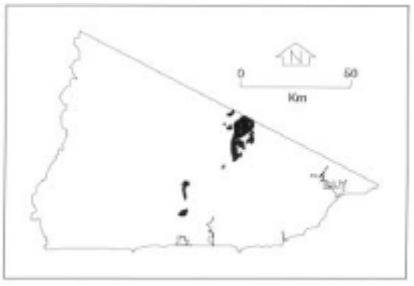
Land use: Snowy River National Park. Formed access to these map units is very limited.

Observed land deterioration: Minor sheet erosion

Susceptibility to land deterioration: Sheet and rill erosion (moderate to very high); Gully erosion (moderately low to very high); Compaction (low to moderately high). Dependant on soil development; Inundation/Waterlogging (very low to moderately low); Mass movement (moderately low to high)

Sites with laboratory data: Nil

B.3.37 Mountains, Granitic, Type 4



MHsGh4, MsGm4, MsGh4, MsGv4, MsvGm4, MsvGh4

These units are associated with the designated Noorinbee Granodiorite; north and south of Cann River township. However, the mountain units are confined to north of the Princess Highway and particularly around the Mt. Kay, Mt. Denmarsh area and extending north into New South Wales. Moister areas occur in the vicinity of the plateau to the north and various areas around Mt. Kaye, Mt. Denmarsh and Wombat Hill. Rocky outcrops often occur on crests, particularly the steeps units (MsGm4, MsGh4, MvGm4 and MvGh4) which have large areas of exposed upper slopes and rocky crests (tors). Soil types include shallow organic friable, sandy Gradational profiles, occasionally uniform. Duplex soils occur in drier areas particularly on lower slopes with Gradational and some Duplex profiles in the moister areas. The vegetation is predominantly Lowland Sclerophyll Forest with Dry Sclerophyll Forest and Wet Sclerophyll Forest at higher elevations and other moister locations as well as Riparian Forest.

Geology: Dgl4; Devonian Granodiorite (Noorinbee Granodiorite).

Rainfall: 700 to greater than 1200 mm per annum.

Slope: 32->100%, generally 32-56%.

Dominant landform element: Slope, rocky crests (tors).

Minor landform element: Drainage depression.

Soils: *Dominant*: Gn4.11, Gn3.11, Dy3.11, Dy3.41, Dy3.42, Dy5.14, Dy3.14. Shallow gradational profiles on upper slopes in moister areas (a sandy component throughout); deeper on mid and lower slopes, particularly in areas of colluvial accumulation. Generally organic surface horizons (A horizons) with whole coloured red/brown subsoils (B horizons), grading into paler/yellow parent material. Drier areas generally have Duplex profiles which, if well developed have A2 horizons, generally bleached. These soils have only minor organic surface horizon and a marked change to a sandy-clay subsoil often grading into parent material.

Minor: There are some shallow coarse Uniform (Uc) profiles close to rock outcrops with variable organic matter content. There are also some soils with organic rich surfaces (A horizon) overlying weathered parent material (C horizon).

Native vegetation: Lowland Sclerophyll Forest is dominant over much of the area with White Stringybark, Yellow Stringybark, Brown Stringybark and Silvertop.

Wet Sclerophyll Forest and Dry Sclerophyll Forest occur around Mt. Kaye and further north: Messmate, Narrow-leaved Peppermint, Mountain Grey Gum and Brown Barrel with *Cassinia spp*. as an understorey. The Riparian Forest includes Mountain Grey Gum, Manna Gum, Hazel Pomaderris and Blackwood, the growth and diversity of species being dependent on the moisture status of the area.

Stone/rock outcrop: Moderate where dissected, high on steeper units particular crests and upper slopes.

Pans: Nil or not observed. There may be some pans in deeply weathered parent material.

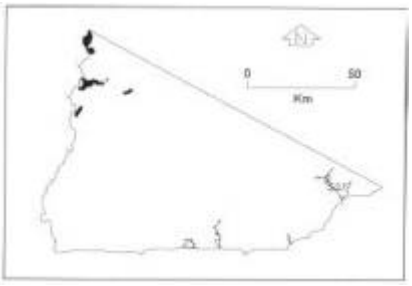
Land use: These units cover a large forested area, some of which is used for hardwood production. Also, there are units within the Coopracambra National Park including Mt. Coopracambra and a reserve at Winnots Creek. Mt. Kaye has a communications tower (Telecom).

Observed land deterioration: Some sheet and rill erosion, minor gully erosion where disturbed (roads), particularly the lower, colluvial/alluvial slopes.

Susceptibility to land deterioration: Sheet and rill erosion (moderate to very high); Gully erosion (low to moderately high); Compaction (low to high on duplex soils); Mass movement (moderately low to high; steeper units); Wind erosion (very low/low).

Sites with laboratory data: Nil**.**

B.3.38 Mountains, Granitic, Type 10



MHvGm10, MsGd10, MsGm10, MsGh10, MvGd10, MvGm10

These units are either steep or very steep units on granodiorite/granitic terrain in a drier climatic zone. These units are all located near the Snowy River from Campbells Knob, Deddick River and north from Beehive Creek Reference Area to the NSW border. The soils tend to have shallow, stony gradational profiles. Investigations are especially difficult in these map units (poor access). Slope length is much greater than for the low hill and hill units. The vegetation is predominantly Rain Shadow Woodland, which is sparse in these map units. Rock outcrop and surface stone is much more prevalent here than on the gentler granitic Type 10 units.

Geology: Dgl; Devonian Granodiorite/Granite. **Rainfall**:

Less than 700 mm – 1000 mm per annum. **Slope**: 32-

100%, occasionally greater than 100%. **Dominant**

landform element: Slope.

Minor landform element: Drainage depression.

Soils: *Dominant*: Gn.4.51, Gn2. Brown and red stony shallow to moderately deep gradational profiles, silty loam grading to silty clay loam texture with a coarse fraction throughout, generally hardsetting with little organic matter, weak to moderate fine structure. Some surface sealing.

Minor: Stony shallow uniform coarse (Uc) profiles apart of some dry surface organic accumulation. Deeper gradational/duplex profiles occur on lower gentler slopes.

Native vegetation: The vegetation is dominated by Rain-Shadow Woodland; White Box, White Cypress Pine and occasionally Blakely's Red Gum with an understorey of grasses and herbs amongst the rocks.

Stone/rock outcrop: High.

Pans: Nil or not observed.

Land use: These units fall within the Snowy River and Tingaringy National Parks and have limited formed access.

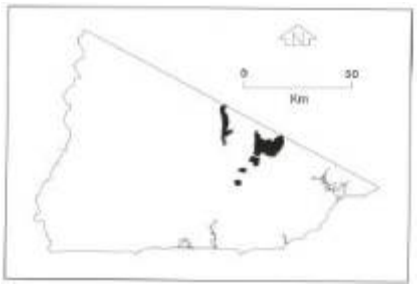
Observed land deterioration: Sheet and rill erosion, rock fall.

Susceptibility to land deterioration: Sheet and rill erosion (moderately high to very high); Gully erosion (moderate to very high); Compaction (low to moderately high); Mass movement (moderate to very high).

Sites with laboratory data: Nil.

Snow River looking north from McKillops Bridge (MsGd/m-1 0/MvSm-1 0)

B.3.39 Mountains, Sedimentary, Type 2



MsSm2, MsSh2, MvSm2, MvSh2, SvSm2, SvSh2, SvSv2

These units lie to the north of the Low hill and Hill map units and are distinguished from these because of their greater relative relief (>300 m) and steep terrain. These units are located adjoining the Mt. Kaye granitic pluton and north of the WB line track within Coopracambra National Park. The soils range from red gradational profiles, generally friable, on lower slopes in moister areas on mid and lower slopes to shallow profiles and deeper structured gradational and duplex (yellow, brown and red) profiles in drier areas (e.g. Coopracambra area). The vegetation generally ranges from Dry Sclerophyll Forest such as Silvertop/Stringybark associations in drier areas to Wet Sclerophyll Forest. Warm Temperate Rainforest and Riparian Forest occur in moister areas, especially in drainage lines.

Geology: Ou; Ordovician sediments. Phyllite, siltstones, slates, sandstone.

Rainfall: 700-1200 mm per annum.

Slope: 32-56%.

Dominant landform element: Slope.

Minor landform element: Drainage depression.

Soils: *Dominant*: Gn3.11, Gn4.11, Dy3, Db2, Dr. Moderately deep to deep red gradational profiles occur in the moister areas strongly structured (especially the B horizon) with loam/clay loam A horizon (15-30 cm depth) over silty clay loam to sandy clay B horizons with occasional influence from surrounding geologies (i.e. quartz) and variable stone content. Yellow, brown and red duplex profiles occur in drier areas, often mottled, hardsetting, with a distinct contrast in texture and structure between the A and B horizons, though there may be a gradation to this stage from shallower profiles.

Minor: Gn4.5, Dy3. Shallow stony profiles hardsetting apart from a loose organic surface horizon. Shallow stony profiles (friable) occur on upper slopes in moister areas.

Native vegetation: Dry Sclerophyll Forest with Silvertop, White Stringybark, Yellow Stringybark, Austral Bracken, Wire Grass and Acacia understorey. Other Stringybark associations and peppermint occur in the drier areas with Wet Sclerophyll Forest Messmate, Narrow-leaved Peppermint, Croajingolong Peppermint and some gums in the moister areas. There are also occurrences of Warm Temperate Rainforest and Riparian Forest in the drainage depressions.

Stone/rock outcrop: Minor to moderate surface stone, particularly on ridgelines, crests and upper slopes.

Pans: Nil or minor occurrence associated with duplex profiles in drier areas.

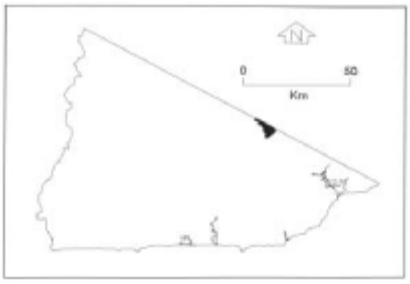
Land use: Predominantly forested, much within the Coopracambra National Park while the remainder (moister areas) is State Forest and is available for timber production.

Observed land deterioration: Sheet and rill erosion, soil creep.

Susceptibility to land deterioration: Sheet and rill erosion (moderately low to high); Gully erosion (moderate to moderately high); Compaction (low to high); Mass movement (low to moderately high).

Sites with laboratory data: 194.

B.3.40 Mountain, Sedimentary, Type 3



MsSm3, SsSm3

This unit consists of steep terrain on Devonian sediments which includes a red-bed formation and quartzitic conglomerate and is located in the Coopracambra National Park in the Genoa River area, near the New South Wales border. This unit has sufficient relative relief to distinguish it as a Mountain unit. The soils tend to be shallow to moderately deep brown uniform or gradational profiles with occasional (yellow, brown) duplex profiles, stony with only moderate subsoil development.

The vegetation is generally Dry Sclerophyll Forest often sparse and stunted on upper slopes and crests amongst rock outcrops with greater growth and some Riparian Forest in the drainage lines.

Geology: Duc; Devonian sediments (Genoa beds). Sandstone, siltstone, mudstone, shale, "red beds", conglomerate.

Rainfall: 700-1000 mm per annum.

Slope: 32-56%.

Dominant landform element: Slope, incised drainage line.

Minor landform element: Drainage depression, flat.

Soils: *Dominant*: Gn3.11, Gn3.71, Um, Uc. Shallow to moderately deep brown gradational and uniform medium profiles with varying depth of organic A horizons over weakly to moderately structured subsoils (B horizons). These profiles are generally stony and are found predominantly on upper to mid-slopes.

Minor: Dy3.11, Dr3.11, Gn. Deeper more developed soil profiles on lower slopes particularly in moister areas; drainage depressions. Greater organic matter accumulation in A horizons and B horizons may be mottled.

Native vegetation: Predominantly Dry Sclerophyll Forest with Narrow-leaved Peppermint and/or East Gippsland Peppermint, White Stringybark, Yellow Stringybark, with occasional Silvertop with sparse and stunted growth on crests particularly around rock outcrop. Taller vegetation occurs on the lower slopes in moister areas especially in drainage depressions where Riparian forest is present with Manna Gum and a moister understorey.

Stone/rock outcrop: Moderate to high; particularly on upper slopes, crests and incised drainage lines.

Pans: Nil or not observed.

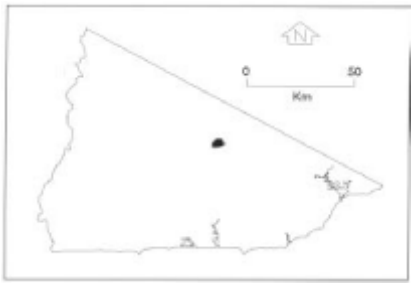
Land use: Forested (except for rock outcrop). This unit lies within the Coopracambra National Park.

Observed land deterioration: Sheet erosion, creep, minor rock movement.

Susceptibility to land deterioration: Sheet and rill erosion (moderate to high); Gully erosion (moderate to high)
Compaction (low to moderate); Waterlogging/Inundation (very low to moderate); Mass movement (moderate to moderately high); Bank erosion (low to moderate).

Sites with laboratory data: Nil

B.3.41 Mountains, Sedimentary, Type 4 MsSm4, MsSh4



This unit consists of a similar geology to the Type 3 unit but due to other characteristics (climate, topography, lithology) has been designated a separate unit. This unit is located south-east of Buldah and includes The Three Sisters and has many of the characteristics of HsSh4 units but principally greater relative relief (greater slope lengths), climate and minor lithological differences. Soils are absent on rock outcrop but elsewhere range from shallow stony profiles, hardsetting, some friable, to deep red gradational and duplex (often stony) profiles on lower slopes. The vegetation is predominantly Dry Sclerophyll Forest with some Wet Sclerophyll Forest and minor Riparian Forest.

Geology: Duc; Devonian sediments (Cann River Beds). Sandstone, siltstone, mudstone, shale, "red beds" and conglomerate.

Rainfall: 1000-1200 mm per annum.

Slope: 32-56%.

Dominant landform element: Slope.

Minor landform element: Rocky crest, drainage depression.

Soils: *Dominant*: Gn3.11, Db1.11, Db1.21, Dr. Hardsetting and friable, shallow to deep brown and red, moderately to strongly structured gradational profiles on all slope positions; the friable profiles are on moister topographic positions and aspects and generally have less stone than on drier and upper slopes. A horizons range from organic loam to silt loam over silty clay loam to medium clay B horizons. Profiles are generally whole coloured. Duplex profiles occur in lower slopes and in drier aspects and may be dependent on lithological variations.

Minor: Gn3.11, Gn3.14, Gn4.11, Gn4.14. Generally moister profiles with greater organic matter content moderately well structured and found in drainage depressions.

Native vegetation: Predominantly Dry Sclerophyll Forest (generally tall open forest) consisting of White Stringybark, Yellow Stringybark, Brown Stringybark, Broad-leaved Peppermint, Narrow-leaved Peppermint and East Gippsland Peppermint. Some Wet Sclerophyll Forest is also present with Mountain Grey Gum. Understorey is generally a low herb/shrub layer with species dependent on aspect and topographic position.

Stone/rock outcrop: Moderate, mainly on upper and mid slopes and crests.

Pans: Nil or not observed.

Land use: This unit is forested, designated State Forest and therefore available for hardwood timber production. The Three Sisters is also a local tourist attraction and a nearby crest acts as a communication focus with a helipad site.

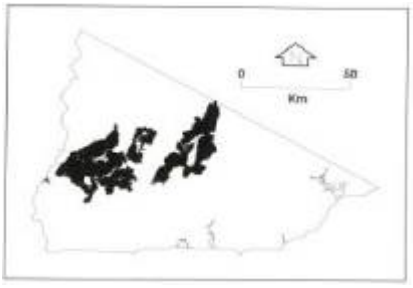
Observed land deterioration: Sheet erosion.

Susceptibility to land deterioration: Sheet erosion (moderate to high); Gully erosion (moderately low to high); Compaction (moderate to moderately high); Mass movement (low to moderately high).

Sites with laboratory data: Nil.

B.3.42 Mountains, Sedimentary, Type 5

MrSh5, MsSm5, MsSh5, MsSv5, MvSm5, MvSh5, MvSv5, SMvSv5



This group of units is generally closer to the Errinundra Plateau than the Hills Type 5 units and consist of part of the Plateau scarp face for this geological type where relative elevation is well over 300 m. This range in elevation has a major effect on soil development and vegetation types with greater climatic influence at higher elevations compared with parent material which is more dominant at lower elevations with less moisture. Some small floodplain units are also associated with this group of units. The soils generally have brown/red gradational profiles more friable where moist, while they may develop to hardsetting duplex (yellow, brown) profiles where drier on lower slopes. The vegetation is predominantly Wet Sclerophyll Forest and Dry Sclerophyll Forest with some Lowland Sclerophyll Forest, Warm and Cool Temperate Forest and Riparian Forest.

Geology: Ou; Ordovician sediments Black shale, phyllite, shale, sandstone, siltstone, minor schist, hornfels, contact rock, breccia, scree, quartzite.

Rainfall: 700 to greater than 1200 mm per annum, generally 700-1000 mm per annum.

Slope: 10-100%, generally 32-56%.

Dominant landform element: Slope.

Minor landform element: Drainage depression, crest.

Soils: *Dominant*: Gn3.11, Gn4.11, Gn3.71, Gn3.91, Gn 4.31, Gn4.51, Dy. Red and brown friable often stony gradational profiles in moister areas shallow on upper slopes and narrow crests, deep on mid- and lower slopes with fine sandy loam A horizons over fine sandy clay loam to light clay B horizons. May be more hardsetting (with less organic matter) on lower and/or drier slopes with light medium clay and moderately to strongly structured B horizons.

Minor: Uc1.21, Dy Depositional profile with organic sandy loam A horizons.

Native vegetation: Predominantly Wet and Dry Sclerophyll Forest with Mountain Grey Gum, Messmate, Brown Barrel, Narrow-leaved Peppermint, White Stringybark, Manna Gum, Silver Wattle, Smooth Tree-Fern, Hazel Pomaderis, Yellow Stringybark, Silvertop and Shiny Cassinia. Cool and Warm

Temperate Rainforest and Riparian Forest with River Peppermint, Rough Tree-Fern, Lilly-Pilly, Blackwood and some species associated with Wet and Dry Sclerophyll Forest.

Stone/rock outcrop: Minor. Low to moderate; greater on crests, upper slopes and ridges.

Pans: Nil or not observed.

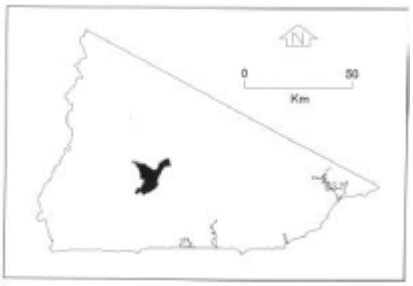
Land use: Forested, the majority of the units are designated State Forest and available for hardwood production. A smaller area of some units fall within the Errinundra National Park.

Observed land deterioration: Sheet erosion.

Susceptibility to land deterioration: Sheet and rill erosion (moderate to very high); Gully erosion (low to moderately high); Compaction (low to high); Surface sealing (very low to moderate); Mass movement (moderately low to high).

Sites with laboratory data: Nil.

B.3.43 Mountains, Sedimentary, Type 8 MsSh8, MsSv8, MvSv8



These units are based on sedimentary terrain which has been metamorphosed, with schists the dominant parent material but have many similar characteristics to the surrounding sedimentary Type 5 map units. These units lie within a very moist climatic area in the region of Greens Road from Mt. Tanglefoot in the south to the granitic outcrop just north of Bee Tree Hill, and the Bola Mine area (Barrs Road). The soils tend to have organic rich (particularly the upper horizons) gradational profiles which often sharply overly the parent material. The vegetation is predominantly Wet Sclerophyll Forest with Warm Temperate Rainforest, Riparian Forest and minor Dry Sclerophyll Forest.

Geology: Omm; Metamorphosed Ordovician sediments. Schist, hornfels, slate, schistose, sandstone, chert.
Rainfall: Greater than 1200 mm per annum.

Slope: 32-100%, generally 32-56%.

Dominant landform: Slope.

Minor landform element: Drainage depression.

Soils: *Dominant*: Gn4.31, Gn3.71, Gn3.11, Gn4.11. Friable organic gradational profiles, brown, occasionally red with moderately well structured horizons though more dense in the B horizons (occasionally strongly structured) with occasional minor mottling loam/clay loam A horizon over silty clay/medium clay. There is often a fine sandy component throughout (with schistose material). Depth varies with topographic position and aspect to a lesser extent.

Minor: Shallow to moderately deep, less moist gradational profiles which can be hardsetting and less organic matter. Deep colluvial (accumulation) profiles may have some duplex characteristics such as an increasingly sharp textured change (medium clay B horizon with depth) and a reduction in structural organisation in the lower A horizon, particularly on drier sites and aspects.

Native vegetation: The vegetation is predominantly Wet Sclerophyll Rainforest with Warm Temperate Rainforest and Riparian Vegetation: Brown Barrel, Messmate, Mountain Grey Gum, Silver Wattle, Smooth Tree-Fern, Rough Tree-Fern, River Peppermint, Long-leafed Dogwood, Hazel Pomaderris and Blanket-leaf. Minor Dry Sclerophyll Forest includes Silvertop, and White Stringybark with a similar understorey to the Wet Sclerophyll Forest.

Stone/rock outcrop: Minor to moderate; greatest on upper slopes especially drier aspects.

Pans: Nil or not observed.

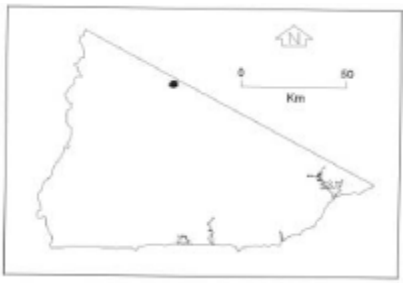
Land use: Forested, designated State Forest and therefore available for timber harvesting, however there is a stream reserve around the Goolengook River. There is an abandoned mine (Bola Mine) off Barrs Road.

Observed land deterioration: Minor sheet and rill erosion with some creep, greater where disturbed for clearing and roading.

Susceptibility to land deterioration: Sheet and rill erosion (and creep) (moderately low to high); Gully erosion (low to moderately high); Compaction (low to high); Inundation (very low to moderate); Mass movement (moderately low to high).

Sites with laboratory data: Nil.

B.3.44 Mountain, Sedimentary, Type 9



MsSm9

These units include a unique landscape feature; the monadnock (residual hill) at Mt. Delegate. This unit is based on sedimentary terrain with some metamorphism. It dominates the landscape and forms a radial drainage pattern. This unit is generally steep, with less steep lower slopes which grade into the surrounding sedimentary/colluvial unit. There is also a river scarp (Queensborough River). Due to the rapid rise in elevation and a range of aspects the soil type varies from shallow stony lithosols to deep red friable gradational profiles in sheltered mid- to lower slopes. This rapid change in elevation also has a marked effect on the vegetation type and its distribution. The main native vegetation type is Montane Sclerophyll Woodland with some Dry Sclerophyll Forest, Montane Forest and Snow Gum Woodland (Mt. Delegate).

Geology: Ou;. Ordovician sediments. Black slate, phyllite, shale, sandstone. Siltstone, minor schist, hornfels, contact rock, breccia, scree, quartzite.

Rainfall: 700 – 1200 mm per annum, generally 700-1000 mm per annum.

Slope: 32-56%.

Dominant landform element: Slope.

Minor landform element: Drainage depression.

Soils: *Dominant*: Gn3.11, Gn3.71, Gn4.11. Red, brown friable gradational profile of organic loam A horizon and a silty clay loam B horizon moderately to strongly structured, very stony and shallow on exposed faces, deeper with less stone in sheltered sites.

Minor: Hardsetting, shallow uniform, gradational profiles, stony on upper slopes and crest (Gn3.91). Duplex profiles on lower slopes especially where drier (aspect, site drainage); strongly structured B horizons and massive or weakly structured lower A horizons (Dy3).

Native vegetation: The vegetation is predominantly Montane Sclerophyll Woodland; Candlebark, Snow Gum, Broad-leaved Peppermint, Silver Wattle, Gorse Bitter-pea and Prickly Bush-pea (*Pultenaea juniperina)*. There is also some Dry Sclerophyll Forest, Montane Forest and Snow Gum Woodland which includes Alpine Ash (*E. delegatensis*).

Stone/rock outcrop: Stone; moderate; high on crest and upper slopes.

Pans: Nil or not observed.

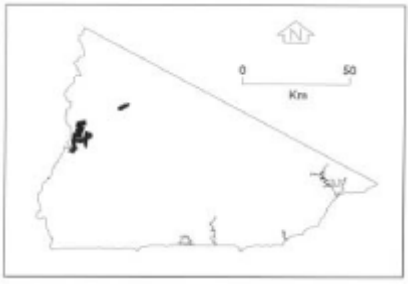
Land use: The majority of the units are forested with most of the Mt. Delegate unit under freehold title. About one-third of this unit is a scenic reserve. There is a communications tower on top of Mt. Delegate.

Observed land deterioration: Some sheet erosion.

Susceptibility to land deterioration: Sheet and rill erosion (low to high); Gully erosion (low to moderately high); Compaction (moderately low to high); Inundation/Waterlogging (very low to moderate); Mass movement (moderately low to high).

Sites with laboratory data: Nil.

B.3.45 Mountains, Volcanics, Type 1



MrsVm1, MsVm1, MsVh1, MvVm1

These units are based on the Snowy River Volcanics geological formation which have a number of lithologies, but are predominantly acid volcanics (rhyodacite). This group of units comprises of the steeper slopes and higher relief along and to the east of the Rodger River. There is also one Mountain unit to the east in the upper reaches of the Rodger River. The general rainfall pattern shows a decrease to the west from the middle section of the Rodger River. However topographic position and aspect are important factors in altering this generalisation. The soils are generally friable gradational profiles often shallow and stony with greater accumulation on footslopes and nearer drainage lines. The vegetation is predominantly Wet Sclerophyll Forest but Dry Sclerophyll Forest and Riparian Forest also occur.

Geology: Dls; Devonian acid volcanics (Snowy River Volcanics). Rhyodacite, tuff, andesite, minor rhyolite and basalt. Also includes coarse sandstone and conglomerate, minor siltstone (minimal in Type 1 map units).

Rainfall: 700-1200 mm per annum

Slope: 10-100%, generally 32-56%

Dominant landform element: Slope

Minor landform element: Drainage depression

Soils: *Dominant*: Gn4.11, Gn4.31, Gn3.11, Gn3.71. Friable, shallow to deep, moderately to strongly (finely) structured gradational profiles with a gritty, coarse component through the profile of loam A horizons over clay loam B horizons. There is an organic rich surface horizon, particularly in the moister areas.

Minor: Gn4.51, Gn3.71, Gn3.91 Um/Uc. Shallow to moderately deep, deep gritty often harder setting (drier) than the dominant soil type. Moderately well structured with variable stone/gravel content. Depositional multi-layered profiles (coarse, medium and fine textures) are associated with drainage lines and lower slopes.

Native vegetation: Predominantly Wet Sclerophyll Forest, Dry Sclerophyll Forest with Riparian Forest; Messmate, Mountain Grey Gum, Narrow-leaved Peppermint, minor occurrences of Brown Barrel, Blackwood, Blanket-leaf, Rough Tree-Fern, White Stringybark, Hazel Pomaderris and Austral bracken.

Stone/rock outcrop: Low to moderate. Stone and some outcrop on the steeper slopes, especially upper slopes and some crests.

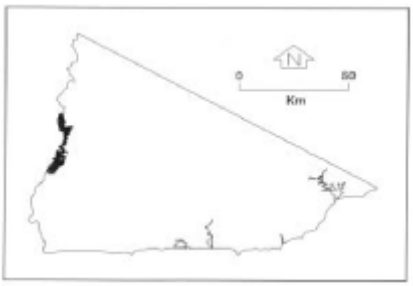
Pans: Nil or not observed

Observed land deterioration: Minimal observation; sheet erosion.

Susceptibility to land deterioration: Sheet and rill erosion (moderately low to very high); Gully erosion (low to high); Compaction (moderately low to moderately high); Inundation/Waterlogging (very low to moderate); Mass movement (low to high)

Sites with laboratory data: Nil

B.3.46 Mountains, Volcanic, Type 2



MsVm2, MvVm2, MvpVm2

These units are based on the Snowy River Volcanics geological formation which have a number of lithologies; predominantly acid volcanics (rhyodacite). The Type 2 units generally consist of a greater proportion of red ignimbrite, and some coarse sandstone and conglomerate compared with Type 1 and 3 units and are generally drier. These units may continue west of the Snowy River (study boundary) in places. The soils tend to range from friable brown gradational profiles in moister areas to hardsetting and stony gradational, uniform profiles occasionally duplex on lower slopes with greater soil accumulation. The vegetation is Dry Sclerophyll Forest, Wet Sclerophyll Forest, Rain-shadow Woodland and Riparian Forest.

Geology: Dls; Devonian acid volcanics (Snowy River Volcanics). Rhyodacite, tuff, andesite, minor rhyolite and basalt. Also includes coarse sandstone and conglomerate, minor siltstone.

Rainfall: Less than 700-1000 mm per annum.

Slope: 32- greater than 100%, generally 32-56%

Dominant landform element: Slope, scarp**Minor**

landform element: Drainage depression

Soils: *Dominant*: Gn4.51, Gn3.91, Um. Shallow to moderately deep, hardsetting occasionally friable gradational and uniform profiles (loam A horizons over clay loam B horizons) with low to moderate organic levels in the A horizon. Profiles are generally stony especially on the drier slopes and shallower soils (depending on topographic position and aspect), and often have a coarse component throughout.

Minor: Gn4.31, Dy, Db. Shallow to deep friable gradational profiles, moderately to strongly structured often with coarse component and found in moister areas, generally lower slopes and areas of moisture accumulation. Minor duplex soil profile occurrences found on lower drier slopes.

Native vegetation: Predominantly Dry Sclerophyll Forest, Wet Sclerophyll Forest, Riparian Forest and Rain-shadow Woodland: Silvertop, White Stringybark, Silver Wattle, Messmate, Mountain Grey Gum, Blackwood, Blanket-leaf, Dogwood, Manna Gum and White Box.

Stone/rock outcrop: Moderate to high stone/rock outcrop particularly on upper slopes and drier aspects.

Pans: Nil or not observed

Land use: Public land with varying amounts of tree cover, given aspect, topographic position and rock outcrop. These units are within the Snowy River National Park and have minimal formed access.

Observed land deterioration: Some sheet erosion

Susceptibility to land deterioration: Sheet and rill erosion (moderate to very high); Gully erosion (moderately low to high); Compaction (moderately low to moderately high). Higher for deeper, clayey profiles; Inundation/Waterlogging (very low to moderate); Mass movement (moderately low to very high).

Sites with laboratory data: Nil

PART C

DISCUSSION

Methodology

The formation and naming of the map units is the result of a developing methodology in land system mapping in which the major factors are identified.

Previous land system mapping has used the major factors such as topography, parent material (geology) and climate, but had grouped the systems and named them according to an example and named them after the location, e.g. Orbost. However, the current methodology uses a parametric approach so that a land system is described according to its constituent parts for example, PlA ml means Plain, level, Alluvial, Type 1, moderately humid. This has developed from work by Rowan (unpublished) for the Land Conservation Council (LCC). While the topographic, geological and climatic factors may account for much of the variation of a land system including associated soils and vegetation, a type indicator is used to allow for other unit characteristics. These may, for example, consist of different lithologies within the same geological type or regional variations which may reflect a variety of environmental interactions. An example of the latter would be the overall effect of climate, of westerly and easterly confluences over East Gippsland. Other examples would include specific and unique soil and vegetation associations.

The interactions between the major land system factors are important in soil and vegetation type distributions. There are a range of interactions and degrees of response between factors which are relevant to understanding the distribution of land systems. The average annual rainfall is used as a climatic indicator and at higher levels (>900 m asl for example) moisture in the regolith for most of the year is correlated with friable, structured gradational profile (earths) soils which form on different parent materials and behave similarly, both hydraulically and the extent of degradation potential. However, drier areas generally tend to highlight differences in parent material with a greater range of erodibility between and on different parent materials. Topography, particularly aspect and topographic position, are important determinants in the local climatic hydrology and need to be considered when looking at variations within and between land systems.

An appreciation of the geomorphology and geographic processes at work help not only in the interpretation of land systems, but also in producing land systems. By gathering geological, topographic and climatic data and using such techniques as stereo photo-interpretation, satellite imagery and other remote sensing methods, it is possible to ascertain a first approximation of land systems. Field work is vital to test the general assumptions inferred from the remote sensing. Such fieldwork is practically limited to time availability and access.

A knowledge of geomorphic processes is very important in streamlining the amount of fieldwork required. It is intended to cover as much of the environmental variation as possible, given the scale and scope of the study.

While much of the assessment can be done in the field, soil samples are taken in order to ascertain particular values, not only for a particular site, but also as part of a sample assessment of the whole area. Factors which may be important for assessing deterioration include: Emerson dispersion test, Atterberg limits (plastic and liquid limits), linear shrinkage, particle size analysis, organic matter content and cation exchange capacity (CEC).

Site numbers refer to sites that have some laboratory data available in Appendix 3.

Only a general assessment of deterioration susceptibility is made at this scale (1:100,000) and degree of detail, which requires the above information in conjunction with topographic, climatic and cover (vegetation) information.

Sample sites are also used for observing vegetation which has been assessed for structure and type composition at most sites using a variation element by the approach of Specht (1970). This is in addition to the type composition stated in the general descriptions. Vegetation distribution, like soil, is influenced by topographic and macro and micro-climatic factors.

The field work consisted of a range of traverses mainly along major access routes in a range of weather conditions during different seasons looking at land performance. An example of the importance of this is shown by the performance of a level to undulating rise, low hill area with sandy soils. This land looks well drained, but in winter water ponds in depressions due to a pan layer at depth. Soil strength is greatly reduced under such conditions, making vehicular difficult without causing some land degradation. Access is reduced and track maintenance is increased if there is no appreciation of such geomorphic mechanisms.

There are just over 200 recorded field sites with a number of other observations on which a generalised assessment of susceptibility of deterioration is made. Some areas which are more remote have had less

checking and, therefore, the reliability of the study may be low for some areas with poor access, e.g. areas within the Snowy, Tingaringy, Coopracambra and Croajingalong National Parks.

Geomorphic Processes

Some general points on geomorphic processes and their importance have already been made. However, it is important to emphasise how relevant these are to understanding a generalised map of land systems and the spatial distribution of land systems and their components.

The East Gippsland study area, east of the Snowy River has been divided into four broad geomorphic units:

- Plateau and elevated uplands
- Dissected hills and mountains
- Lowland plains and low hills
- Coastal plain and dunefield.

This has been outlined previously, but some of the processes involved have not been discussed. The existence of remnant surfaces following various phases of erosion highlights the existence of possible older regolith mantles, soils and vegetation habitats, compared with those areas subject to greater past erosive phases. The older areas generally have leached soils with most of the nutrients contained within the organic matter cycle. Depositional areas and newer weathering fronts generally have higher nutrient status, depending on source materials.

Lithological and geological variations have produced landform, soil and vegetation variations. For example, basaltic cappings protect the underlying geology, but may be unstable at their edges due to differential water movement between the different geologies. Basaltic cappings not only have higher levels of available bases (calcium, magnesium, potassium and sodium) given mineral content and environment, but also a higher water holding capacity which explains greater growth of vegetation and generally lower levels land of deterioration. Examples can be found on the plateau and dissected uplands and the dissected mountains.

The dissection of large areas has led to minor local deposition, but mainly deposition further downstream and differential erosion phases (local and regional) have meant a number of soils forming at different times and differential levels of deposition and erosion given different phases of in-situ weathering. In-situ weathering is complicated by different levels of intensity (high level of leaching in the Tertiary period) as well as the interaction of local erosion and deposition.

While there are some duplex soils formed on upper slopes, particularly in drier areas (for example <900 mm per annum) many of the duplex profiles occur and are best developed on lower slopes which tend to have a colluvial component. The rises, low hills and lowland plains consist of a more recent (Tertiary) depositional phase which can be very difficult to interpret, particularly when in contact with other geologies/lithologies.

Deposition has variable depth and the surface soil may be of minor importance given the underlying material. For example, a sandsheet may overlay sorted or unsorted sands and/or gravel and/or silts and clays. The influence of the subsoil is important on the local and regional hydrology with major differences in behaviour and performance. The presence of a pan may well negate the textural and structural qualities above or below it.

The rapid leaching process evident in profiles of this age (Tertiary) are shown by iron, silicate or humic layers (pans) and deep weathering and oxidisation of clays with characteristic red mottling. Structural contrasts as well as textural contrasts affect not only water movement, but also the susceptibility to deterioration particularly if exposed eg. batters.

The coastal plains and dune systems are environmentally fragile, having to deal with strong winds, high saline levels and low fertility. Wind erosion is one possible agent of deterioration which is important for these topographic features.

The geomorphological processes at work are certainly altered by vegetation type, change and absence. Vegetation can modify the effects of water, wind and temperature on the land. Vegetation reduces the impact of precipitation and running water although tall vegetation may coalesce water droplets which impacts on bare soil if there is not cover at a lower (storey) level.

Density of vegetation cover as well as level (storey) of cover is important to deflect the impact of precipitation while root depth and size are important in anchoring the soil in place. Vegetation thus slows surface and some sub-surface flow and transpires moisture out of the soil.
A change in vegetation type may mean a change in the soil hydrology and a change in the way that the land can cope with increased surface water. For example, deep-rooted plants are required in areas affected by salinity in order to reduce the ground water table level.

Clearing of vegetation breaks the organic matter cycle. The result is greater direct impact on the soil surface and generally greater water velocities and therefore more erosive movement of water through the landscape.

The moister areas are generally more stable given the greater amounts of organic matter and dense vegetation but prolonged clearing and depletion of organic matter would lead to a much greater susceptibility to deterioration.

Land Deterioration

There are many forms of land deterioration, some of which are more easily monitored than others. For example, gully erosion on cleared land is easily visible. However, other forms of deterioration are not so evident, but may be significant. Therefore, it is important that an understanding of processes that lead to deterioration of the land be reached. Short and long term productivity, effects of land use and their interaction with land characteristics need to be understood so that land use will be carried out in a sustainable manner.

Sedimentation from roading and other sources is evident in the major streams mainly as a result of sheet and rill erosion. Other forms of land deterioration includes gully erosion, various forms of mass movement, compaction, nutrient and organic matter decline.

These have been discussed previously in this document but general areas of interest should be noted. The drier cleared areas of the plateau tend to have sodic subsoils which may lead to salinity problems while sheet and rill erosion are a high risk on the granitic terrain where surface is minimal or under stress (grazing, rabbits etc).

Some minor mass movement is evident at the junction of major geology types such as the basalt cappings, particularly at Bonang. Mass movement is also evident along the road network.

Acidification may also be an issue in some of the cleared areas given the existing acidity of soils, particularly where soils (and upper horizons) have light to medium textures.

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APPENDIX 1

Structural Forms of Vegetation in Australia	Touching - overlap d	Touching or slight separated m	Clearly separated s	Well separated v	Isolated i
Trees 20-35m T **Trees 12-20m** **Trees 6-12m** **Trees 3-6m**	V. tall closed forest Tall closed forest Mid-high closed forest Low closed forest	V. tall open forest Tall open forest Mid-high open forest Low open forest	V. tall woodland Tall woodland Mid-high woodland Low woodland	V. tall open woodland Tall open woodland Mid-high open woodland Low open woodland	V. tall isolated trees Tall isolated trees Mid-high isolated trees Low isolated trees
Mallee trees 3-6m M **Mallee trees 1-3m** **Mal lee trees 0.5-1 m** **Mallee trees 0.25-0.5m**	V. tall closed mallee forest Tall closed mallee forest Mid-high closed mallee forest Low closed mallee forest	V. tall open mallee forest Tall open mallee forest Mid-high open mallee forest Low open mallee forest	V. tall mallee woodland Tall mallee woodland Mid-high mallee woodland Low mallee woodland	V. tall open mallee woodland Tall open mallee woodland Mid-high open mallee woodland Low open mallee woodland	V. tall isolated mallee trees Tall isolated mallee trees Mid-high isolated mallee trees Low isolated mallee trees
Shrubs 3-6m S **Shrubs 1-3m** **Shrubs 0.5-1m** **Shrubs 0.25-0.5m**	V. tall closed shrubland Tall closed shrubland Mid-high closed shrubland Low closed shrubland	V. tall shrubland Tall shrubland Mid-high shrubland Low shrubland	V. tall open shrubland Tall open shrubland Mid-high open shrubland Low open shrubland	V. tall sparse shrubland Tall sparse shrubland Mid-high sparse shrubland Low sparse shrubland	V. tall isolated shrubs Tall isolated shrubs Mid-high isolated shrubs Low isolated shrubs
Heath 3-6m Z **Heath 1-3m** **Heath 0.5-1m** **Heath 0.25-0.5m**	V. tall closed heathland Tall closed heathland Mid-high closed heathland Low closed heathland	V. tall heathland Tall heathland Mid-high heathland Low heathland	V. tall open heath Tall open heath Mid-high open heath Low open heath	V. tall sparse heath Tall sparse heath Mid-high sparse heath Low sparse heath	V. tall isolated heath shrubs Tall isolated heath shrubs Mid-high isolated heath shrubs Low isolated heath shrubs
Hummock grasses 0.5-1m H **Hummock grasses 0.25-0.5m** **Hummock grasses below 0.25m**	Tall closed hummock grassland Mid-high closed hummock g'land. Low closed hummock grassland	Tall hummock grassland Mid-high hummock grassland Low hummock grassland	Tall open hummock grassland Mid-high open hummock g'land. Low open hummock grassland	Tall sparse hummock grassland Mid-high sparse hummock g'land. Low sparse hummock grassland	Tall isolated hummock grasses Mid-high isol't. hummock grasses Low isolated hummock grasses
Tussock grasses 0.5-1m G **Tussock grasses 0.25-0.5m** **Tussock grasses below 0.25m**	Tall closed tussock grassland Mid-high closed tussock g'land. Low closed tussock grassland	Tall tussock grassland Mid-high tussock grassland Low tussock grassland	Tall open tussock grassland Mid-high open tussock g'land. Low open tussock grassland	Tall sparse tussock grassland Mid-high sparse tussock g'land. Low sparse tussock grassland	Tall isolated tussock grasses Mid-high isol't. tussock grasses Low isolated tussock grasses

	Growth form		
Height	**T**	**M,S,Z**	**H,G**
Extremely tall	9	6	5
Very tall	8	5	4
Tall	7	4	3
Mid-high	6	3	2
Low	5	2	1

Always record codes using the following format e.g. **T v 5.**
Note that growth form is first, followed by crown cover, then height.

APPENDIX 2 – FLORISTIC LIST

(Names according to L Costermans (1989) "Trees and Shrubs of South-eastern Australia".)

Genus	Species	Common name
Acacia	*dealbata*	- Silver Wattle
	longifolia	- Sallow Wattle
	mearnsii	- Black Wattle
	melanoxylon	- Blackwood
	mucronata	- Narrow-leaf wattle
	terminalis	- Sunshine Wattle
Ammophila	*arenaria*	- Marram Grass
Angophora	*floribunda*	- Rough-barked Angophora
Atherosperma moschatum		- Southern Sassafras
Banksia	*integrifolia*	- Coast Banksia
	serrata	- Saw Banksia
Brachychiton	*populneus*	- Kurrajong
Bedfordia	*arborescens (salicina)*	- Blanket-leaf
Callistomen	*spp.*	- Callistomen
Callitris	*collumellaris*	- White Cypress Pine
Calyptrix	*tetragona*	- Common Fringe Myrtle
Cassinia	*longifolia*	- Shiny Cassinia
	aculeata	- Dogwood
Casuarina	*littoratis*	- Black She-oak
Cyathea	*australis*	- Rough Tree Fern
Daviesia	*ulicifolia*	- Gorse Bitter-pea
Dicksonia	*antarctica*	- Smooth Tree Fern
Dillwynia	*glabberrima*	- Smooth Parrot-pea
Elaeocarpus	*holopetalus*	- Black Oliveberry
Eucalyptus	*agglomerata*	- Blue-leaved Stringybark
	albens	- White Box
	bauerana	- Blue Box
	baxteri	- Brown Stringybark
	blakelyi	- Blakely's Red Gum
	bosistoana	- Gippsland Grey Box
	botryoides	- Southern Mahogany
	camphora	- Mountain Swamp Gum
	cephalocarpa	- Silver-leaved Stringybark
	consideniana	- Yertchuk
	croajingolensis	- Croajingolong Peppermint
	cypellocarpa	- Mountain Grey Gum
	delegatensis	- Alpine Ash
	dives	- Broad-leaved Peppermint
	elata	- River Peppermint
	fastigata	- Brown Barrel

	fraxinoides	- White Ash
	glaucescens	- Tingaringy Gum
	globoidea	- White Stringybark
	globulus sp. maideni	- Maidens Gum
	gummifera	- Red Bloodwood
	macrorhyncha	- Red Stringybark
	melliodora	- Yellow Box
	muellerana	- Yellow Stringybark
	nitens	- Shining Gum
	obliqua	- Messmate
	ovata	- Swamp Gum
	pauciflora	- Snow Gum
	polyantemos	- Red Box
	radiata	- Narrow-leaved Peppermint
	regnans	- Mt Ash
	rubida	- Candlebark
	saxatilis	- Tingaringy Gum sp.
	sideroxylon	- Red Ironbark
	sieberi	- Silvertop
	smithii	- Gully Gum
	stellulata	- Black Sallee
	viminalis	- Manna Gum
Eugenia	*smithii*	- Lilly-pilly
Exocarpos	*cupressiformis*	- Cherry Ballart
Hakea	*microcarpa*	- Small-fruit Hakea
Juncus	*kranksii*	- Sea Rush
Kunzea	*spp.*	
Leptospernum	*attenuatum*	- Paperbark Tea-tree
	laevigatum	- Coast Tea-tree
	juniperinium	- Prickly Tea-tree
Lissanthe	*strigosa*	- Peach Heath
Livistona	*australis*	- Cabbbage Fan-palm
Melaleuca	*ericifolia*	- Swamp Paper-bark
	squarrosa	- Scented Paper-bark
Pomaderris	*aspera*	- Hazel Pomaderris
Pteridium	*esculentum*	- Austral Bracken
Pultenwa	*juniperina*	- Prickly Bush-pea
Riconocarpos	*pinifolius*	- Wedding Bush
Rubus	*fruticosus spp*	- Blackberry
Tetrarhena	*juncea*	- Wire Grass
Xanthorrhea	*resinosa*	- Spear Grass-tree

APPENDIX 3 – SOIL LABORATORY DATA

Profile No.	Horizon	Depth (cm)	Field Texture	Gravel %	Coarse Sand %	Fine Sand %	Silt %	Clay %	pH Water	pH $CaCl_2$	Ec ds/m x 10-3	Dispersion	Organic Carbon %	Total Nitrogen	1.3 C/N	Liquid Limit %	Plastic Limit %	Plasticity Index	Linear Shrinkage %	Exchangeable Cations Meq/100g									
																				Ca	Mg	K	Na	Total Extractable Bases	Exchangeable Al	Exchangeable Mn	Exchangeable Acidity	Cation Exchange Capacity	Calcium:Magnesium Ratio
1	A11	16.0	ZL						5.5	4.7	30.0	E5(B)	1.82	0.90						0.2	0.5	0.1	<0.1	0.8	0.6		9.2	10.0	0.4
	A13	39.0	ZL									E5(D)							6.0										
	B	86.0	LC						5.5		30.0	E5(B)	0.47						13.0										
	C	200+	LC						5.1	4.3	20.0	E5(A)	0.18	<0.05						<0.1	1.0	0.1	<0.1	1.1	2.8		7.7	8.8	<0.1
2	A1		ZL									E5(B)				48.0	31.0	17.0	9.0										
	A3		ZL						5.4		40.0	E5(C)							18.0										
	C	128	CLks									E5(B)				23.0	17.0	7.0	5.0										
	D	128+	KS									E5(B)																	
4	A1	6	LS									E3																	
	A2	43	CLS									E5(D)							3.0										
	B1	65	KSC									E5(E)							9.0										
	B2	85	MC									E5(A)							17.0										
	C	85+	CLS									E5(A)																	
5	A	?	LS									E3																	
	B	?	SC									E5(E)							17.0										
10	A11	26	LS						4.6	3.6	30.0	E3	3.05	0.70						1.4	0.7	<0.1	0.1	2.2	0.5		10.0	12.2	2.0
	A12	34	LS						5.3	3.9	70.0	E3	2.98	0.60						1.9	1.0	0.2	0.3		0.6				
	B1	58	CLs						5.5	4.3	40.0	E3	1.51	0.70						0.2	0.5	0.1	<0.1	0.8	1.9		14.0	14.8	0.4
	B2	100	CLks						5.6	4.6	10.0	E3	0.64	<0.05					6.0	<0.1	0.4	<0.1	<0.1		0.5				
	C	115	KSC						5.8	5.1	10.0	E5(C)	0.67	<0.05						<0.1	1.0	0.1	<0.1	1.1	0.2		7.3	8.4	<0.1
17	A1	25	FSL									E3																	
	A2	50	FSL									E3																	
	B1	70	FSCL																										
	B2	100	LC																										
20	A11	18	ZCL									E2																	
	A12	33	CL									E3																	
	B1	70	LC									E2							6.0										
	B2	150	LMC									E5(C)							9.0										
21	A	?	CL						5.3		70.0	E5(E)																	
	B	?	MC						5.5		55.0	E5(A)				49.0			15.0										
22	B	?	FSL									E3																	
23	A10	6	L						5.5	4.8	70.0	E5(B)	5.98							6.2	1.3	0.7	0.1	8.4	0.3			4.8	
	A11	35	ZL						5.7	4.8	30.0	E5(B)	2.81	0.23						3.6	0.9	0.8	<0.1	5.5	0.5		17.7	23.2	4.0
	B1	80	ZCL						5.9	5.0	30.0	E5(C)	0.75	0.70						2.8	1.0	0.7	<0.1	4.5	0.3		10.2	14.7	2.8
	B2	105	ZCL+						6.2	5.1	30.0	E5(E)	6.80			33.0			8.0	3.6	1.4	0.5	<0.1	5.5	0.1			2.6	
25	A	30	ZL									E5(B)																	
	B	90	CL									E5(E)				40.0			9.0										
29	A	35	L						4.7	4.3	30.0	E5(C)	5.07	0.24	27.5					<0.1	0.1	<0.1	<0.1	0.1	5.1		32.5	32.6	0.2
	B2	60-100	LC						4.8	4.5	30.0	E5(A)	1.03							<0.1	0.1	0.1	<0.1	0.2	1.8				0.2

Profile No.	Horizon	Depth (cm)	Field Texture	Gravel %	Coarse Sand %	Fine Sand %	Silt %	Clay %	pH Water	pH $CaCl_2$	Ec ds/m x 10-3	Dispersion	Organic Carbon %	Total Nitrogen	1.3 C/N	Liquid Limit %	Plastic Limit %	Plasticity Index	Linear Shrinkage %	Exchangeable Cations Meq/100g									
																				Ca	Mg	K	Na	Total Extractable Bases	Exchangeable Al	Exchangeable Mn	Exchangeable Acidity	Cation Exchange Capacity	Calcium:Magnesium Ratio
30	A11	4	FSL									E5(B)																	
	B1	30-57	FSCL									E3				32.0			9.0										
	B2	57-110+	ZC									E5(D)																	
31	A12	6-19	ZCL						5.6	4.6	20.0	E3	2.80	0.16	22.8					4.5	2.5	0.3	0.1	7.4	0.7		15.3	22.7	1.8
	B1	35	ZCL						5.7	4.5	10.0	E3	1.54	0.90	22.2					1.3	1.5	0.4	<0.1	3.2	1.7		18.7	21.9	0.9
	B2	75	ZC						5.7	4.4	10.0	E2	0.51			33.0			4.0	0.7	1.3	0.3	<0.1						
33	A11	5	SL									E2																	
	A12	31	ZL									E2				26.0			6.0										
	B1	50	LC									E5(D)																	
	B2	90	LMC									E5(D)							12.0										
35	A21	8-30	Lks									E3							0.4										
	B	44-60+	MC									E3							16.0										
38	A11	10	ZL						5.7	4.5	20.0	E3	1.55	0.10	20.1					1.2	1.2	0.2	0.1	2.7	1.2		11.9	14.6	1.0
	A12	25	ZL						6.1	4.5	10.0	E3	0.62	0.50	16.1					0.6	2.0	0.1	0.1	2.8	1.2		7.9	10.7	0.3
	B1	50	LMC						6.3	4.5	30.0	E2	0.43						9.0	1.1	5.7	0.2	0.7	7.7	2.6				0.2
	B2	90	MC						5.9	4.6	120.0	E2	0.41			37.0			9.0	1.3	7.0	0.2	1.1	9.6	1.8				0.2
40	A2	10-32	ZL									E3				15.0			<1										
	B2	62-112	LMC									E5(E)				45.0			9.0										
43	B	30-80	FSCL+									E3				24.0			6.0										
47	A	50	LS									E3				23.0			3.0										
	B3	50-170	CKS									E3				24.0	21.0	3.0	3.0										
53	A	3-30	ZCL									E3				28.0			2.0										
	B	48	ZCL									E3				24.0			9.0										
55	B	35+	SCL									E3				37.0			6.0										
58	A11	15	SL									E3																	
	A12	40	SL						5.7		15.0	E3				15.0			<1										
	A2	65	LS						5.8		20.0	E3				19.0			2.0										
	A3	100	CS						5.6		25.0	E3				26.0			7.0										
	B	120	KMC						6.0		50.0	E2				39.0			9.0										
	C	200+	CS						6.9		30.0	E2																	
65	A	20	FSL						5.6		30.0	E2		0.60		25.0	19.0	6.0	2.0										
	B2	40-100	LC+						5.8		20.0	E3		<0.05		56.0	28.0	28.0	13.0										
82	A2	10-30	FSL						5.3		25.0	E5(E)		0.60		17.0			0.8	0.1	0.5	0.2	<0.1	0.8	0.8		5.4	6.2	0.2
	A3	40	Lfsy						5.6		40.0	E3		0.60		21.0	16.0	5.0	3.0	<0.1	1.1	0.2	0.1	1.4	1.4		5.3	6.7	<0.1
	B	110	LMC						5.5		25.0	E5(E)		0.19		47.0	21.0	26.0	11.0	0.1	7.2	0.3	0.2	7.8	3.7		11.5	<0.1	
108	A1	20	ZL						5.7		25.0	E3	1.26	<0.05		19.0	18.0	1.0	<1	1.6	0.7	0.3	<0.1	2.6	0.7		8.6	11.2	2.3
	A2	40	ZCL						4.9		45.0	E5(D)	0.58	<0.05		22.0	16.0	6.0	3.0	0.8	1.1	0.1	<0.1	2.0	1.8				
	B	80+	HC						5.4		19.0	E5(D)	0.66	0.60		62.0	21.0	41.0	15.0	3.5	6.2	0.4	0.2	9.3	6.7		19.0	29.3	0.6
111	A11	15	SL						5.6		30.0	E5(E)				21.0	16.0	5.0	4.0										
	A12	30	SL						5.8		20.0	E3				21.0	16.0	5.0	3.0										
	A3	40	LS						5.9		15.0	E3				16.0	15.0	1.0	2.0										
	B1	80	SCL									E2				37.0	18.0	18.0	9.0										
	B2	100	SC						7.0		75.0	E2				38.0	20.0	18.0	8.0										

Profile No.	Horizon	Depth (cm)	Field Texture	Gravel %	Coarse Sand %	Fine Sand %	Silt %	Clay %	pH Water	pH $CaCl_2$	Ec ds/m x 10-3	Dispersion	Organic Carbon %	Total Nitrogen	1.3 C/N	Liquid Limit %	Plastic Limit %	Plasticity Index	Linear Shrinkage %	Exchangeable Cations Meq/100g									
																				Ca	Mg	K	Na	Total Extractable Bases	Exchangeable Al	Exchangeable Mn	Exchangeable Acidity	Cation Exchange Capacity	Calcium:Magnesium Ratio
117	A2	7-25	LSks									E3				17.0	16.0	1.0	0.8										
	A3	35	LSks									E3				17.0	15.0	2.0	2.0										
	B	68	MCks									E3				65.0	25.0	40.0	15.0										
120	A1	25	ZL						5.0		30.0	E5(C)				54.0	37.0	17.0	8.0										
	B1	80+	MC						5.8		15.0	E5(C)				44.0	20.0	24.0	13.0										
123	A11	10	L	<1		27.0	41.0	24.0	4.1		40.0	E5(C)	5.97	0.41	18.9	64.0	51.0	13.0	5.0	0.3	0.3	0.3	<0.1	0.9	6.9		46.5	47.4	1.0
	A12	55	ZL	<1		23.0	45.0	20.0	4.4		25.0	E5(B)	3.26	0.25	16.9	53.0	42.0	11.0	8.0	0.1	0.1	0.2	<0.1	0.4	4.4		34.5	34.9	1.0
	B	95	ZCL	1.0		21.0	44.0	25.0	4.6		25.0	E5(D)	1.70	0.90	14.6	45.6	35.0	10.0	9.0	0.1	0.1	0.3	<0.1	0.4	4.3		28.4	28.9	1.0
	C	130	LC	<1		20.0	30.0	41.0	4.4		25.0	E5(D)	1.01	0.13	17.0	40.0	31.0	9.0	9.0	0.1	0.1	0.2	<0.1	0.4	4.7		23.8	24.2	1.0
128	A21	5-23	SL									E3				21.0	18.0	3.0	3.0										
	A3	33	SL									E3				24.0	18.0	6.0	3.0										
	B	65	SCL+									E2				45.0	28.0	17.0	8.0										
133	A11	5-30	FSL									E3		<0.05		16.0	15.0	1.0	0.0	0.1	0.4	0.1	<0.1	0.6	1.1		7.7	8.3	0.2
	A2	60	FSL									E2		0.50		12.0	-	-	0.0	<0.1	0.4	0.1	<0.1	0.5	0.4		2.6	3.1	0.1
	B	140	LMC									E3		<0.05		41.0	15.0	26.0	10.0	0.6	6.6	0.2	0.7	8.1	0.3		7.5	15.6	<0.1
136	A	70	SL						5.6		95.0	E5(B)		0.18		36.0	29.0	8.0	7.0	2.6	2.5	0.2	<0.1	5.3	0.2		15.3	20.6	1.0
	B	150+	MC									E5(E)		0.70		55.0	27.0	28.0	11.0	8.3	5.6	0.2	0.3	14.4	-		13.7	27.8	1.5
143	A	25	ZL		2.0	25.0	36.0	33.0	5.7		30.0	E5(D)				51.0	33.0	18.0	8.0										
	B	50-100+	ZCL+		2.0	35.0	38.0	28.0	5.6		105.0	E3				36.0	23.0	14.0	9.0										
147	A2	20-58	FSL	4.0					4.9		200.0	E5(E)	0.35	<0.05		24.0	16.0	8.0	1.0	0.3	1.1	0.4	0.1	1.9	1.0		6.8	8.7	0.3
	B	88	KSC	2.0					4.9		140.0	E5(E)	0.24	<0.05		42.0	21.0	21.0	11.0	0.3	1.8	0.4	0.1	2.6	1.4		6.7	9.3	0.2
	C	144	SCL	2.0					4.8		155.0	E5(E)	0.18	<0.05		43.0	20.0	23.0	10.0	0.3	2.5	0.5	0.1	3.4	1.3		7.2	10.6	0.1
149	A1	3-26	LS	15.0					5.4		50.0	E3	1.42	0.70	26.4	23.0			<1	0.7	1.1	0.3	0.2	2.3	0.8		2.8	5.1	0.7
	A3	82	KCS	24.0					5.7		30.0	E3	0.10	<0.05		18.0			<1	0.6	1.3	0.3	0.1	2.3	0.2		11.0	13.3	0.5
	B	100+	SC	12.0					5.4		50.0	E5(C)	0.15	<0.05		31.0	18.0	13.0	8.0	1.2	3.9	0.3	0.2	5.6	0.3		4.4	11.0	0.3
151	A2	20-130	S	4.0					6.0		25.0	E3	0.31	<0.05		14.0			<1	0.4	0.3	0.2	<0.1	0.9	-		2.8	3.7	1.3
	B	140+	SC	5.0					5.5		50.0	E5(D)	0.30	0.50	7.8	57.0	26.0	31.0	13.0	2.4	4.8	0.6	0.2	8	-		7.4	15.4	0.5
152	A1	10	SL	33.0					5.6		45.0	E5(B)	2.74	0.14	25.5	36.0	30.0	6.0	3.0	2.7	1.2	0.4	0.1	4.4	0.2		13.3	17.7	2.3
	A2	35	LS	28.0					6.1		45.0	E5(B)	0.56	0.70	10.4	24.0	13.0	11.0	2.0	1.6	1.3	0.4	0.1	3.4	-		4.2	7.7	2.3
	B	80+	SC	24.0					5.8		50.0	E5(E)	0.28	0.70	5.2	61.0	21.0	40.0	12.0	2.5	3.4	0.5	0.1	6.5	-		5.9	12.4	0.7
153	A1	5	LS	13.0					5.0		40.0	E3	2.13	0.15	18.5	2421	24.0	0.0	0?	0.5	0.4	0.3	<0.1	1.2	0.5		11.2	12.4	1.2
	A2	15	LS	20.0					4.8		45.0	E3	1.29	0.80	21.0	22.0	-	-	11?	<0.1	0.3	0.2	0.1	0.6	0.5		6.5	7.1	0.2
	B1	35	FSC	17.0					4.8		50.0	E5(E)	0.47	0.60	10.2	26.0	16.0	6.0	5?	<0.1	0.3	0.2	<0.1	0.5	1.2		7.8	8.3	0.2
	B2	40+	KSC	33.0					4.7		40.0	E5(E)	0.37	<0.05			22.0	4.0	6?	<0.1	0.3	0.2	<0.1	0.5	1.1		8.4	8.9	0.2
154	A	30	LS	25.0					5.2		45.0	E5(D)	1.42	0.90	20.5	21.0	19.0	2.0	2.0	1.2	0.7	0.2	0.1	2.2	0.7		11.4	13.6	1.7
	B	60	MC	<0.1					4.9		50.0	E5(D)	0.12	<0.05		35.0	18.0	17.0	11.0	0.2	3.2	0.3	0.2	3.7	3.1		6.8	11.0	<0.1
164	A	18-38	Lfsy	11.0					4.9		40.0	E5(A)	1.23	0.10	16.0	30.0	23.0	7.0	5.0	0.4	0.9	0.3	<0.1	1.6	2.8		13.0	14.6	0.4
	B	60	LC	13.0					5.0		20.0	E3	0.29	0.60	6.3	34.0	25.0	9.0	6.0	0.1	0.9	0.3	<0.1	1.3	2.8		8.6	9.9	0.1
165	A12	4-28	Lfsy	<1					5.9		40.0	E5(D)	0.53	0.50	13.8					2.3	1.4	0.7	<0.1	4.4	-		3.4	7.4	1.6
	A13	88	FSL	<1					6.4		65.0	E5(C)	1.04	0.10	13.5	30.0	24.0	6.0	3.0	11.4	4.1	0.3	<0.1	15.8	-		5.2	21.0	2.8
165(A)	B			22.0					4.8		60.0	E5(D)	0.72	0.50	18.7					0.5	1.3	0.6	0.1	2.5	0.8		8.6	11.9	0.4
166	B	90-150+	CS+	<1					4.7		30.0	E5(D)	0.12	<0.05						<0.1	0.1	0.1	<0.1	0.2	1.4		4.2	4.4	0.5
	B*	90-150+	CS+	<1					4.7		35.0	E5(C)	0.11	<0.05						<0.1	0.1	0.1	0.1	0.2	1.1		4.1	4.4	0.5

Profile No.	Horizon	Depth (cm)	Field Texture	Gravel %	Coarse Sand %	Fine Sand %	Silt %	Clay %	pH Water	pH $CaCl_2$	Ec ds/m x 10-3	Dispersion	Organic Carbon %	Total Nitrogen	1.3 C/N	Liquid Limit %	Plastic Limit %	Plasticity Index	Linear Shrinkage %	Exchangeable Cations Meq/100g									
																				Ca	Mg	K	Na	Total Extractable Bases	Exchangeable Al	Exchangeable Mn	Exchangeable Acidity	Cation Exchange Capacity	Calcium:Magnesium Ratio
173	A	15-60	ZCL	5.0					4.9		50.0	E3	1.92	0.10	25.0	30.0	22.0	8.0	6.0	1.4	1.7	0.4	<0.1	3.5	1.1		12.2	15.7	2.0
	B	110	LC	<1					5.1		35.0	E5(A)	0.53	0.50	13.8	48.0	27.0	21.0	9.0	0.3	2.7	0.4	0.1	3.5	4.0		11.6	15.1	0.1
	B3	130+	MC	3.0					5.0		50.0	E5(A)	0.22	<0.05		61.0	31.0	30.0	4.0	0.1	3.3	0.3	0.2	3.9	3.9		12.1	16.0	<0.1
178	A	30	Lks	4.0	33.0	45.0	14.0	5.0	4.9		55.0	E5(E)	2.11	0.50	54.9					1.3	0.5	0.2	0.1	2.1	0.9		10.7	12.8	2.6
	B	80	CSLks	<0.1	29.0	34.0	10.0	25.0	4.7		40.0	E5(B)	0.20	0.50	8.7	38.0	21.0	17.0	10.0	0.2	0.5	0.2	0.1	1.0	1.9		6.3	7.3	0.4
181	A12	8-32	L	23.0					5.2		80.0	E5(D)	5.30	0.24	28.7	46.0	38.0	8.0	6.0	7.3	2.2	0.9	0.6	12.0	1.1		27.1	38.1	3.3
	B1	67	ZC	10.0					5.3		50.0	E5(A)	0.81	0.90	11.7	41.0	24.0	17.0	4.0	1.5	2.0	0.6	0.4	4.5	1.3		12.2	16.7	0.8
	B2	100	LMC	27.0					5.2		45.0	E5(A)	0.59	0.70	11.0	49.0	28.0	21.0	11.0	1.4	2.7	0.6	0.3	5.0	1.2		13.0	18.0	2.0
182	A	30	ZL	3.0	25.0	42.0	17.0	14.0	5.1		50.0	E5(B)	2.17	0.12	23.5	29.0	23.0	6.0	5.0	0.9	0.9	0.3	0.2	2.3	1.6		17.0	19.3	1.0
	A2	43	CL	4.0	12.0	14.0	22.0	14.0	5.3		45.0	E3	1.45	0.11	17.1	26.0	22.0	4.0	5.0	0.9	1.0	0.3	0.3	2.5	1.1		12.2	14.7	0.9
	B	80+	ZC	15.0	18.0	31.0	10.0	38.0	5.3		40.0	E5(D)	0.47	0.50	12.2	42.0	25.0	17.0	9.0	1.2	2.8	0.2	0.4	4.6	0.9		12.6	17.2	0.4
190	A1	50	L	10.0	47.0	33.0	12.0	6.0	5.1	4.3	<0.05	E7	2.69	0.15						1.7	1.2	0.3	<0.1	3.2	1.2		15.8	19.0	1.4
	1B2	85	Lfsy	62.0	43.0	37.0	11.0	8.0	5.4	4.3	<0.05	E7	0.75	<0.05						0.4	0.6	0.3	<0.1	1.3	1.0		7.3	8.6	0.7
	2B2	130+	MHC	5.0	7.0	18.0	3.0	70.0	5.3	3.9	<0.05	E5(B)	0.51	<0.05		76.0	28.0	47.0	20.0	3.3	11.0	0.3	0.8	15.4	2.8		21.9	37.3	0.3
191	A	2-15	ZL	39.6					4.6		45.0	E5(C)	3.30	0.13	33.0	31.0	29.0	2.0	2.0	0.9	1.0	0.3	<0.1	2.2	4.8		22.6	29.6	0.9
	B	45	CL	3.1					5.2		25.0	E3	0.40	<0.05	10.4	38.0	24.0	14.0	9.0	0.2	1.8	0.5	<0.1	2.5	6.6		14.1	16.6	0.1
192	A1	25	L+	7.3	14.0	.35.0	40.0	9.0	6.1		72.0	E5(D)	6.80	0.47	18.8	63.0	53.0	10.0	8.3	26.1	7.3	0.7	0.1	34.2	-		23.3	57.5	3.6
	B1	50	CL	14.6	19.0	29.0	28.0	22.0	6.2		43.0	E5(B)	2.10	0.17	16.1	49.0	31.0	18.0	12.0	16.7	10.9	0.2	0.4	28.2	-		23.0	51.2	1.5
193	A11	3-16	CL	2.9	17.0	4.0	31.0	70	5.4		38.0	E5(A)	3.10	0.16	25.2	50.0	33.0	17.0	6.0	0.6	1.2	0.6	<0.1	2.4	1.6		30.6	33.0	0.5
	B1	34	LC	<1	19.0	23.0	12.0	45.0	5.8		21.0	E3	0.50	0.50	13.0	47.0	26.0	21.0	12.0	0.1	3.8	0.5	<0.1	4.4	-		11.7	16.0	<0.1
194	A1	14	L	53.7	22.0	31.0	21.0	20.0	4.7		86.0	E5(C)	7.40	0.26	37.0	57.0	47.0	10.0	4.0	2.8	1.7	1.0	0.3	5.8	9.7		54.6	60.4	1.6
	B2	45	ZCL	30.0	18.0	31.0	28.0	21.0	4.9		40.0	E3	2.30	0.11	27.2	37.0	27.0	10.0	5.0	0.6	1.1	0.6	<0.1	2.3	7.7		28.9	31.2	0.5
195	A11	20	Lfsy	14.5					4.9		27.0	E5(A)	1.30	0.90	18.8	27.0	21.0	6.0	3.0	0.2	0.3	0.2	<0.1	0.7	3.8		15.3	16.0	0.7
	B2	48-80	FSC	<1					5.4		16.8	E5(A)	0.20	<0.05	5.2	36.0	23.0	13.0	6.0	<0.1	0.8	0.1	<0.1	0.9	2.9		9.6	10.5	0.1
196	B2	30-180	LC	2.9					5.4		25.0	E5(E)	0.10	<0.05	2.6	50.0	40.0	10.0	13.0	<0.1	2.9	0.2	0.2	3.3	1.5		17.7	21.0	<0.1
197	A2	12-30	FSL	0.0	3.0	65.0	24.0	4.0	5.6		31.2																		
199	A1	25	KSL	33.0	44.0	27.0	16.0	12.0	4.9		50.0	E3				32.0	30.0	2.0	<1										
	A2	60	FSL	26.0	39.0	28.0	15.0	17.0	4.4		70.0	E5(A)				26.0	22.0	4.0	2.0										
	B	120	CLks	20.0	20.0	15.0	28.0	37.0	4.7		45.0	E5(A)				50.0	32.0	18.0	11.0										
201	A12	27	L	8.0	4.0	21.0	21.0	20.0	5.7		25.0	E3				15.0	14.0	1.0	2.0										
	B2	105+	MC	2.0	1.0	15.0	15.0	51.0	5.2		35.0	E5(A)				74.0	34.0	40.0	16.0										
202	B	?	SCL	30.0	37.0	28.0	8.0	26.0	5.9		50.0	E5(B)				41.0	28.0	13.0	8.0										