SOUTH ESK REPORT

Land Capability Survey of Tasmania

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Department of Primary Industry and Fisheries

Prospect Offices

1996

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South Esk Report

and accompanying 1:100 000 scale map

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Contents

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SUMMARY

This map and report describes and classifies the land resources occurring on privately owned and leased crown land within the area defined by the limits of the South Esk 1:100 000 scale topographic map (sheet No. 8314). The area lies just south of Launceston and includes many smaller centres such as Longford, Cressy, Conara and part of Campbell Town. The mapping area extends over 230 721 ha of predominantly agricultural land.

The land is described and the capability classes defined according to the published system for Tasmania (Noble 1992a). Capability is based on the ability of the land to produce sustainable agricultural goods without impairing the long-term, sustainable productive potential of the land. The system categorises land into seven capability classes with increasing degree of limitation for agricultural production or decreasing range of crops that can be grown as the system progresses from Class 1 to Class 7. Classes 1 to 4 are considered suitable for cropping activities, Classes 5 to 6 suitable for pastoral activities only and Class 7 is considered unsuitable for agricultural use.

The land capability boundaries have been determined by a combination of field work and aerial photo interpretation.

The survey area represents a broad down-thrown basin lying between the uplifted horsts of the Great Western Tiers and The Ben Lomond Hills. The basin has been dissected by a number of river systems and several terrace levels can be identified. The basin comprises predominantly Tertiary sediments with occasional basaltic lava flows while the main uplifted blocks are of Permian and Triassic sediments capped by Jurassic Dolerite. Agricultural activities include cereal cropping in rotation with sheep and beef cattle grazing. The area includes the Cressy-Longford Irrigation Scheme where a greater variety of cropping activities occur including potatoes, peas, various horticultural crops and poppies. The use of water pumped from river systems has further extended the area of land under irrigation. Upland and hill areas are limited to grazing activities on steep or stony ground.

Table 1 below indicates the extent of the separate land classes identified within the confines of the survey area. No Class 1 or 2 land was identified and Class 3 land contributes less than 4% of the area. Class 4 land is the most dominant occupying over 50 % of the area. Classes 5 and 6 land each occupies slightly less than 15% of the area. The major limitations to agricultural use that have been identified are poor soil conditions (poor internal drainage in duplex soil profiles, occurrence of rocks and stones, shallow effective soil depth), topography and erosion. Climate impacts on the range of crops that can be grown but its significance as a limitation to agriculture is not as great as other soil and land characteristics.

Current land use within the area is dominated by grazing for sheep and cattle. Most farmers are also involved in a limited range of cropping activities including cereals, poppies and potatoes. Some farmers are also involved in more intensive activities such as essential oils and tree nurseries. In the north-west of the study area lies the Cressy-Longford irrigation scheme where the agricultural systems are more intensive and a broader range of crops are grown under irrigation. Within the study area

generally there is a tendency towards an intensification of cropping activities resulting in increased pressure on available land resources.

Capability Class	Area (Ha)	% land area of map sheet
1	0	0.00
2	0	0.00
3	8622	3.75
4	117447	50.91
4+5	5063	2.19
5	34439	14.92
5+4	2170	0.94
5+6	8915	3.86
6	34211	14.83
6+5	67	0.03
6+7	1478	0.64
7	4409	1.91
E	13900	6.02
TOTAL	230721	100

Table 1. Extent of Land Classes and Land Class Complexes on South Esk map.

1. INTRODUCTION

This report continues a series of land capability reports published by the Department of Primary Industry and Fisheries as part of a 1:100 000 scale land capability survey of Tasmania's agricultural land first started in 1989. This report and accompanying map describes and depicts the land capability of the agricultural land within the South Esk map (sheet no 8314).

The land capability project aims to: a) identify and map the extent of different classes of agricultural land in order to provide an effective base for land use planning decisions; and b) ensure that the long-term productivity of the land is maintained at a sustainable level, through the promotion of compatible land uses and management practices. It undertakes to achieve these aims through a program of mapping activities and associated extension and awareness programs such as Farmwi$e and Best Farm Practice.

The land capability classification system for Tasmania (Noble 1992a) comprises a seven class classification and is based on the capability of the land to support a range of agricultural uses on a long-term sustainable basis.

The evaluation system takes into account only the land's capability to support sustained *agricultural* production and does not consider suitability for individual crops, forestry, orchards, vineyards or other non agricultural uses. Being one of a series some parts of this report have been reproduced from earlier reports by Noble (1991, 1992b, 1993).

As recently as June 1995 Goss *et al* noted "*if Australian Agriculture continues business as usual, a decline in the condition of natural resources will continue and contribute to Australia's economic position becoming more precarious*." If such an eventuality is to be avoided attention needs to be given to "*addressing sustainability through improved decision making.*" This can be achieved at all levels from private land holders to industry and government leaders - but good decisions have to be based on good information. It is the purpose of this work to provide the necessary information to allow better decision making leading to a reduction in the degradation of Tasmania's agricultural resource.

With ever increasing demands placed on our agricultural land to produce greater yields per unit area, the limitations imposed by extreme climatic conditions and the increasing uptake of good agricultural land for urban development and subdivision, there is a growing risk of Tasmania's agricultural resource being utilised beyond it's capability. Inevitably this will lead to the degradation of the soil resource if it is left unchecked. Thus the conservation of the soil resource is vital for sustained productivity and for Tasmania to continue to support a healthy agricultural industry. The basis for soil conservation is the proper management and use of the land, ie. using land within it's capability. However, much of Tasmania's agricultural land has limitations which restrict the variety of crops that can be grown. The land capability classification system recognises these limitations and uses physical characteristics of the land, together with climatic criteria, to evaluate the capability of an area and classify it accordingly.

This report and map evaluates the land capability of private freehold and leased crown land only, other areas are considered non agricultural and are mapped as exclusion areas.

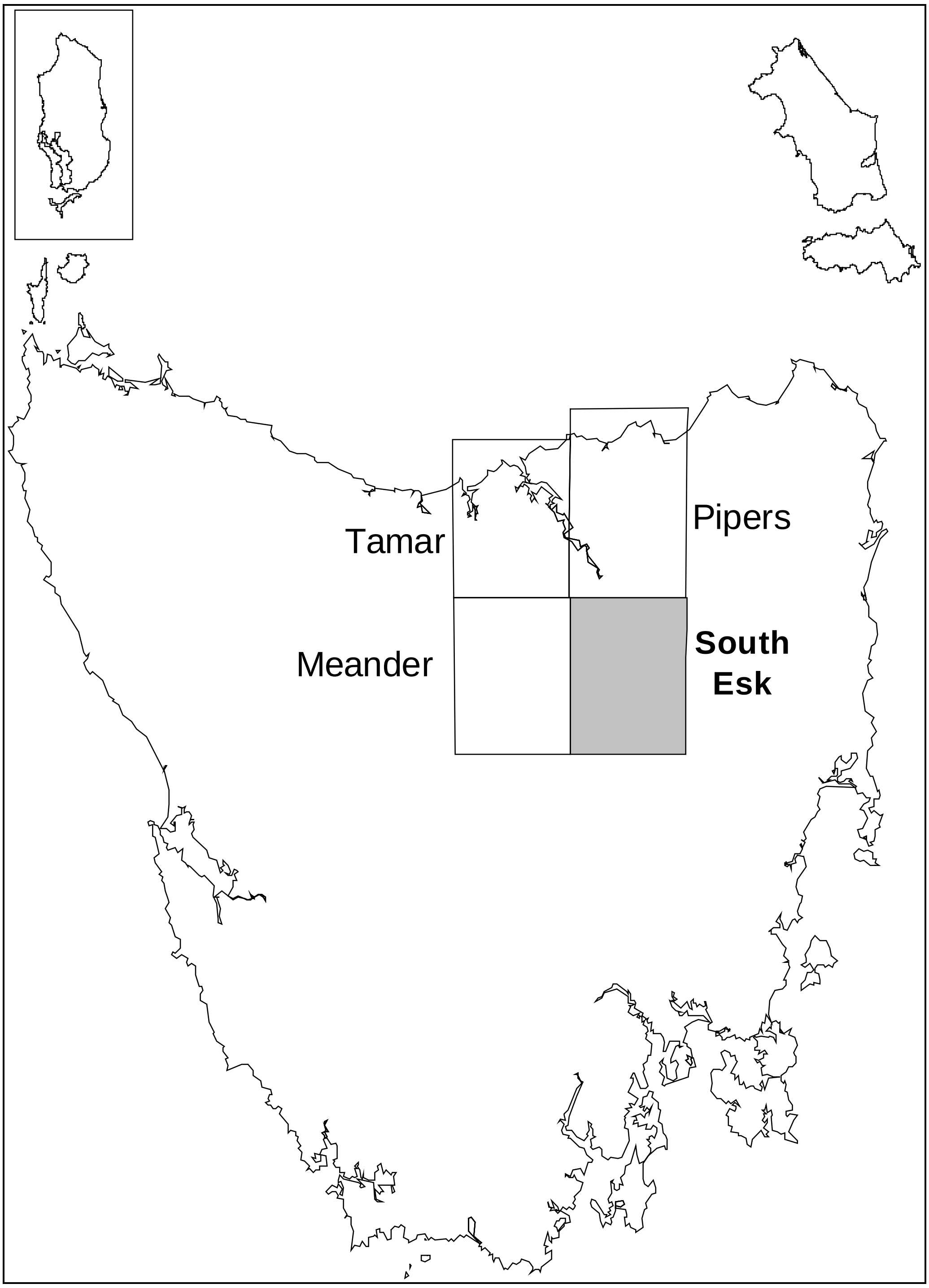


Figure 1. South Esk Survey Location and Previous Land Capability Surveys in Tasmania

2. HOW TO USE THIS MAP AND REPORT

This publication comprises a report and map. It is important that the land capability map be used in conjunction with the accompanying report. By referring to the map, and locating the area of interest, the land capability class assigned to that area can be determined. This is indicated on the map by a class number (1 to 7) and an associated colour shade.

Definitions of the land capability classes are given on the side legend of the map and in Section 4 of the report. Further detail about each of the land capability classes occurring on the South Esk map is given in Section 6.

During the course of the survey land sub-classes have been identified within each land class (see also Section 3). This information is available from the Department of Primary Industries, Land and Water Resources Division, Resource Assessment Branch, for interested users but Sub-Class boundaries have not been included on the published map sheet for a variety of reasons outlined in Section 3.

2.1 Limitations of Scale

Special attention needs to be paid to the "limitations" imposed by the scale of mapping.

It is important that the map be used at the scale at which it is published (1:100 000). **The map should not be reproduced at a larger scale (eg. 1:25 000)**. The land capability boundaries found on this map are accurate only at the published scale of 1:100 000. Errors in interpretation will occur if the map is enlarged. If more detail is required, the area of interest should be remapped at a more suitable scale for the end use, rather than enlarging this map.

Gunn *et al* (1988) indicate that, at a scale of 1:100 000, the standard minimum area for a map unit which can be adequately depicted on the map is approximately 64 ha. There appears to be little consistency however, as Landon (1991) suggests a wide range of "minimum areas" are currently in use. For the purposes of this work a minimum map unit size of 0.25 cm, or 25 ha, is used.

In any mapping exercise there are always areas which are physically too small to delineate accurately at a given map scale and in such cases these areas are absorbed into surrounding units. The map units shown on this map will therefore often contain more than the one land capability class or sub-class. The map units are assigned the dominant land capability class within them but it should be recognised that map units may contain up to 40% of another class. In the majority of cases however, a land capability map unit may be deemed to be about 80%, and in more uniform areas up to 90%, pure.

In some areas, due to the limitations of scale and the complexity of soils and landscape, and where two classes both occupy between 40 and 60% of the area, a COMPLEX map unit has been identified (eg. 4+5) and is shown as a striped unit on the map. The first digit of the map unit label represents the dominant land capability class as does the slightly wider of the two coloured stripes on the map. Further discussion of this issue and the method of labelling units is to be found in Section 3.

The accuracy of the land capability class boundaries depends on a number of factors including the complexity of the terrain, soils and geology. In some cases the class boundaries may be well defined, such as with abrupt changes in topography. Alternatively, changes may be gradual and more difficult to assess such as with a change in soil depth, some soil types, slope, or extent of rockiness. In these cases the boundary is transitional and therefore can be less precisely plotted on the map.

2.2 Interpretation of the Land Capability Information

The scope and range of applications of the land capability information depends on the scale at which the surveys are carried out. This map has been produced at 1:100 000 and is targeted for use at the district or regional planning level.

Larger scale maps such as those at 1:5 000 or 1:10 000 are more suitable for whole farm planning purposes, to plan farm layouts and identify appropriate land uses, soil conservation and land management practices. A scale of 1:25 000 is more appropriate for catchment planning though this is dependent on the size of the catchment.

Best use can be made of this map and report by local government, regional and State land use planning authorities. The information at this scale is **not** intended to be used to make planning decisions at farm level, although the information collected does provide a useful base for more detailed studies. The methodology does however apply to all scales of mapping and can be utilised equally well by local landowners, local, regional or State planning authorities. More detailed discussion of the methodology is available in Section 3.

Examples of other potential uses of land capability information at 1:100 000 scale are:

- Identifying areas of prime agricultural land (Classes 1 to 3) for retention for agricultural use
- Rational planning of urban and rural subdivisions
- Identifying areas for new crops, enterprises or major developments
- Identifying areas for expansion of particular land uses
- Planning for new routes for highways, railways, transmission lines, etc.
- Identifying areas of land degradation, flooding or areas that may require special conservation treatment
- Identifying areas of potential erosion hazard
- Resolving major land use conflicts
- Integrated catchment management (depending on catchment size).

Land capability information combined with other resource data, with the aid of a GIS (Geographic Information System), can greatly enhance the accessibility, interpretation and use of this information.

While intended for use by regional and state planning authorities, the information supplied in this report is useful at catchment and farmer level as a general indication as to the quality of land that may be found in a particular locality. For example, a new comer to the area wishing to purchase good quality land for cropping would be better concentrating efforts in the Cressy-Longford area, where land of Class 3 has been identified, rather than around Campbell Town or Evandale where the land is considered class 4 and below. Describing land capability information through this report and accompanying map is insufficient to ensure the adoption of sustainable land use practices. Change from practices which may be unsustainable will only occur through increased social awareness and education (a recognition that change is needed) together with the development of an appropriate implementation framework, including legislative and administrative support, responsible for putting land use policies into practice.

The land capability maps and reports do not purport to have legal standing as documents in their own right, nor should they attempt to stand alone in planning decisions without being supported by other relevant land resource, economic, social or conservation considerations. The information is intended as a guide to planning development and, where more detailed planning at farm level or for route alignment is required, further fieldwork needs to be undertaken.

The land capability information for the South Esk map sheet is presented in Section 6 of this report and is arranged firstly by class and secondly by geological type on which that class occurs. Definitions for the individual capability classes are presented in Section 4.

2.3 Copyright

The maps, reports and digital information stored on the DPIF databases are copyright, and the data is solely owned by the Department of Primary Industry and Fisheries, Tasmania. Every encouragement is given to individuals who wish to use the information contained in this report and accompanying map to assist with their own property management. However, commercial organisations or individuals wishing to reproduce any of this information, by any means, for purposes other than private use, should first seek the permission of the Secretary, Department of Primary Industry and Fisheries, Hobart.

2.4 Availability of Other Reports and Maps in this Series

An Index of the land capability maps (based on the Tasmap 1:100 000 Series) is shown on the rear cover of this report. The areas already covered are indicated in Figure 1.

Land Capability Publications currently available :

Pipers Report and Accompanying Map
Tamar Report and Accompanying Map
Meander Report and Accompanying Map
Land Capability Handbook

Maps and reports are available for purchase by contacting your nearest Department of Primary Industry and Fisheries Office or direct from

Department of Primary Industry and Fisheries
Land and Water Resources Division
Resource Assessment Branch
GPO Box 46
Kings Meadows, TAS. 7249.

3. SURVEY METHODOLOGY

The land capability map is produced through a combination of field work and aerial photo interpretation. Some limited use has also been made of computer generated gradient maps using 1:25 000 scale contour information (10 m contour intervals). This information has assisted in the identification of some Class 6 and 7 land in upland areas. In the southern half of the South Esk 1:100 000 scale map considerable reliance has been placed on available soil information (Doyle, 1993) while in the northern part, covered by the Longford soil map (Nicolls, 1958), more intensive field work has been undertaken (see also Fig. 2). Extensive field work has been done along public access roads to assess land capability on-site and to check soil type, geological boundaries etc. Soils have been examined using a hand held soil auger or by examination of soil exposures in ditches or road cuttings to determine depth of soil horizons and other soil properties. Additional fieldwork has been done on selected properties throughout the area.

Land capability boundaries have been determined in the field, by using existing soil, geological and climatic data and through interpretation of 1:42 000 scale black and white aerial photographs taken during the early to mid 1980s. These boundaries have been transferred to 1:50 000 scale topographic base maps (enlargements of 1:100 000 scale maps) using an Artiscope Rescaler. Not all map units have been visited. Interpretation of existing land information and the aerial photographs has been used to predict land capability in many areas. This approach is necessary to reduce the time required to produce an end product. It is applicable for areas where a good understanding of the relationships between soil, geology, landform etc and land capability exists. In assessing land capability consideration has been given to a wide range of land factors together with information supplied by farmers and agricultural advisers within DPIF.

Within the study area some 300 site observations have been recorded. Site information is stored on a data card and also in a database using EXCEL software. The data card records a variety of site information relevant to evaluating land capability and records both land capability class and subclass information. An example of a completed site card appears in Appendix A. Base maps, with land capability boundaries appended, have been digitised and information captured and stored in ArcInfo at a scale equivalent to 1:50 000. Final publication scale is at 1:100 000. Field checking of land capability evaluation has been undertaken by peers within the DPIF who have experience in agriculture, soils and evaluation techniques.

Throughout the fieldwork attempts have been made to identify the type of limitation to agricultural use for each map unit and to determine boundaries between areas with different limitations. Despite the obvious value of including this information on the published map this has not been done for a number of reasons. In many parts of the State identification of sub-class boundaries would lead to unnecessary complication and detail when published at 1:100 000 scale. This is particularly so for existing map sheets like Pipers and is likely to be the case for the Forth sheet. Considerable reliance is placed on existing soil maps for interpretation of capability sub-classes. However, the units on soil maps are often associations of soils, that is they contain more than one soil type often of differing capability. It is impossible to map such detail at 1:100 000 scale and soil map units are therefore often considered to be fairly uniform and evaluated accordingly. Where site observations do identify differences in soil and capability attempts have been made to portray this on the map where the units are of sufficient size.

The inclusion of sub-class boundaries on the final map was given some consideration but rejected for a variety of reasons: for example, there is a desire to maintain a level of consistency with earlier, and future, reports; and, given the complexity of subclass boundaries it is unlikely that the intensity of observations undertaken is insufficient to depict these boundaries with the necessary level of accuracy. Sub-class information is available from DPIF for those that are interested but it should be recognised that a number of caveats relating to scale and accuracy apply to the information. Also, sub-class codes are retained in many photographs and text to provide the user with additional examples of the nature of limitations in some areas and on various soil or landform types.

In undertaking the land evaluation of the South Esk area the following approach has been taken:- The Land Capability Classification system is designed to evaluate the general agricultural capability of the land and thus no consideration is given to other potential land uses. Only private freehold and leased Crown land has been mapped with all other areas of State Forests, State Reserves, Conservation Areas, National Parks, Crown Land, Urban areas etc being excluded from the study. These non agricultural areas are indicated on the map by the letter E. The evaluation procedure is as outlined in Noble (1992).

For 1:100 000 scale surveys the issue of irrigation and it's impact on land capability classification has created much discussion. The extent of the beneficial effects of irrigation on land capability will vary considerably, depending upon such factors as availability of water, economics and the skill of the property manager. These factors all require assessment on an individual property basis, a procedure not appropriate at this level of mapping. Also, it is beyond the scope of this survey to identify areas where irrigation water might be available.

While it is recognised that some areas of the State have the potential to attain an improved land capability ranking through the application of irrigation water (ie. those areas with a 'c' limitation due to an inadequate rainfall supply or distribution) this has not been considered during this evaluation and **land capability has therefore been assessed assuming no irrigation potential.**

Photo 1. Field checking land class boundaries.

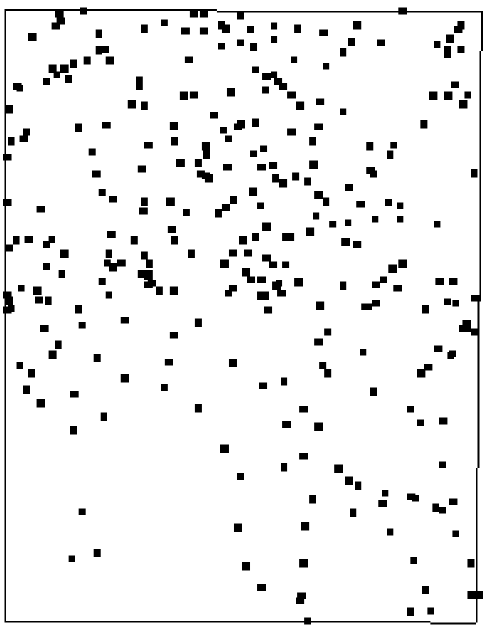


Figure 2.
Distribution of Land Capability Observation Sites on the South Esk Map Sheet.

4. LAND CAPABILITY CLASSIFICATION

Land capability classification is an internationally recognised means of land classification, used to evaluate the capability of land to support a range of land uses on a long-term, sustainable basis.

For the Tasmanian classification, agricultural land uses only are considered, and are defined as broad scale grazing and cropping uses. Land capability ratings for specific land uses are not evaluated, nor is the capability of land for forestry use incorporated into the classification system.

Land capability may be defined as a rating of the ability of land to sustain a range of land uses without degradation of the land resource. It is an interpretive and somewhat subjective assessment based on the physical limitations and hazards of the land, potential cropping and pastoral productivity, and the versatility of the land to produce a range of agricultural goods (Figure 3).

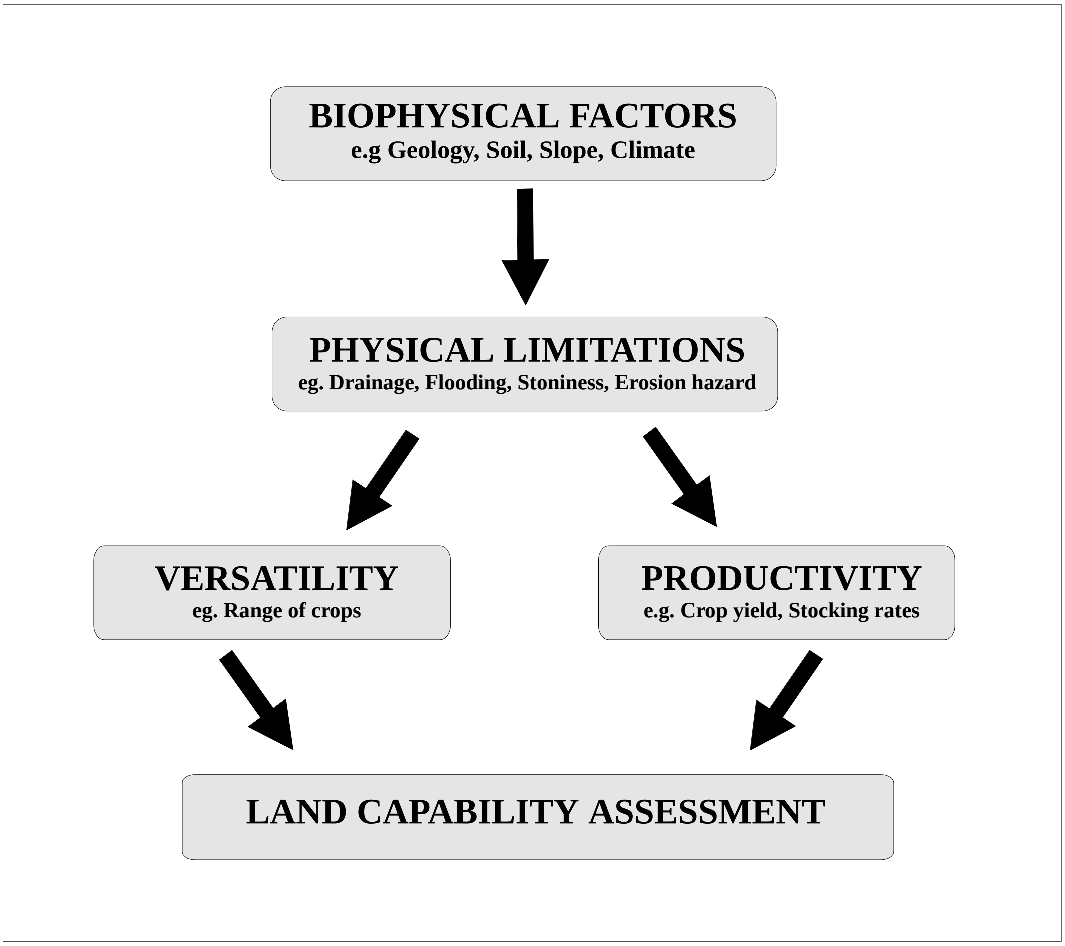


Figure 3: Factors in land capability assessment.

Land capability assessment takes into account the physical nature of the land (e.g. geology, soils, slope) plus other factors (e.g. climate, erosion hazard, land management practices) which determine how that land can be used without destroying its long-term potential for sustainable agricultural production. It also takes into account limitations that might affect agricultural use, e.g. stoniness, drainage, salinity or flooding. Land capability assessment is therefore based on the permanent biophysical features of the land (including climate), and does not take into account the economics of agricultural production, distance from markets, or social or political factors.

Land capability assessment should not be confused with land suitability assessment which, in addition to the biophysical features, may take into account economic, social and/or political factors in evaluating the 'best' use of a particular type of land. Land capability classification gives a grading of land for broad scale agricultural uses, whereas land suitability is applied to more specific, clearly defined land uses, such as land 'suitable' for growing carrots.

The basic principle of land capability brings together both facets of conservation - protection of the land and its potential production. In other words, the balance between use of the land and the risk of degradation.

4.1 Features of the Tasmanian Land Capability Classification System

The Tasmanian system of land capability classifies land into seven classes according to the land's capability to produce agricultural goods. The system is modelled on the USDA (United States Department of Agriculture) approach to land capability (Klingbiel and Montgomery, 1961) and is described in full by Noble (1992). A summary of the system is presented here to assist with the interpretation of the report and accompanying map. The classification does not attempt to portray specific land uses, or rank the value of any particular agricultural land use above another. Neither does it attempt to give an indication of land values.

The Tasmanian land capability classification system is based on agricultural production (cropping and pastoral productivity). It is based on cultivation of the land for cropping purposes and not other land use systems which can sustain 'crops' on steeper land with longer rotations and less risk of erosion (e.g. perennial horticulture, silviculture).

The classification relates primarily to three permanent biophysical features of the landscape - soil, slope and climate - and their interactions. These three factors have a major influence in determining the capability of the land to produce agricultural goods. Other factors which must be taken into account include rock type, erosion hazard, range of crops that can be grown, management practices, soil conservation treatment, risk of flooding and past land use history.

Three levels are defined within the Tasmanian land capability classification:

- The land capability <u>Class</u> - which gives an indication of the general degree of limitation to use

- Sub-class - which identifies the dominant kind of limitation

- and the Unit - which groups land with similar management and conservation requirements, potential productivity, etc.

The land capability system can be used and applied at various scales by mapping to the class, subclass and unit levels. The level at which the mapping is undertaken and presented depends on the purpose and scale of the survey. The levels of the land capability classification system are shown in Figure 4.

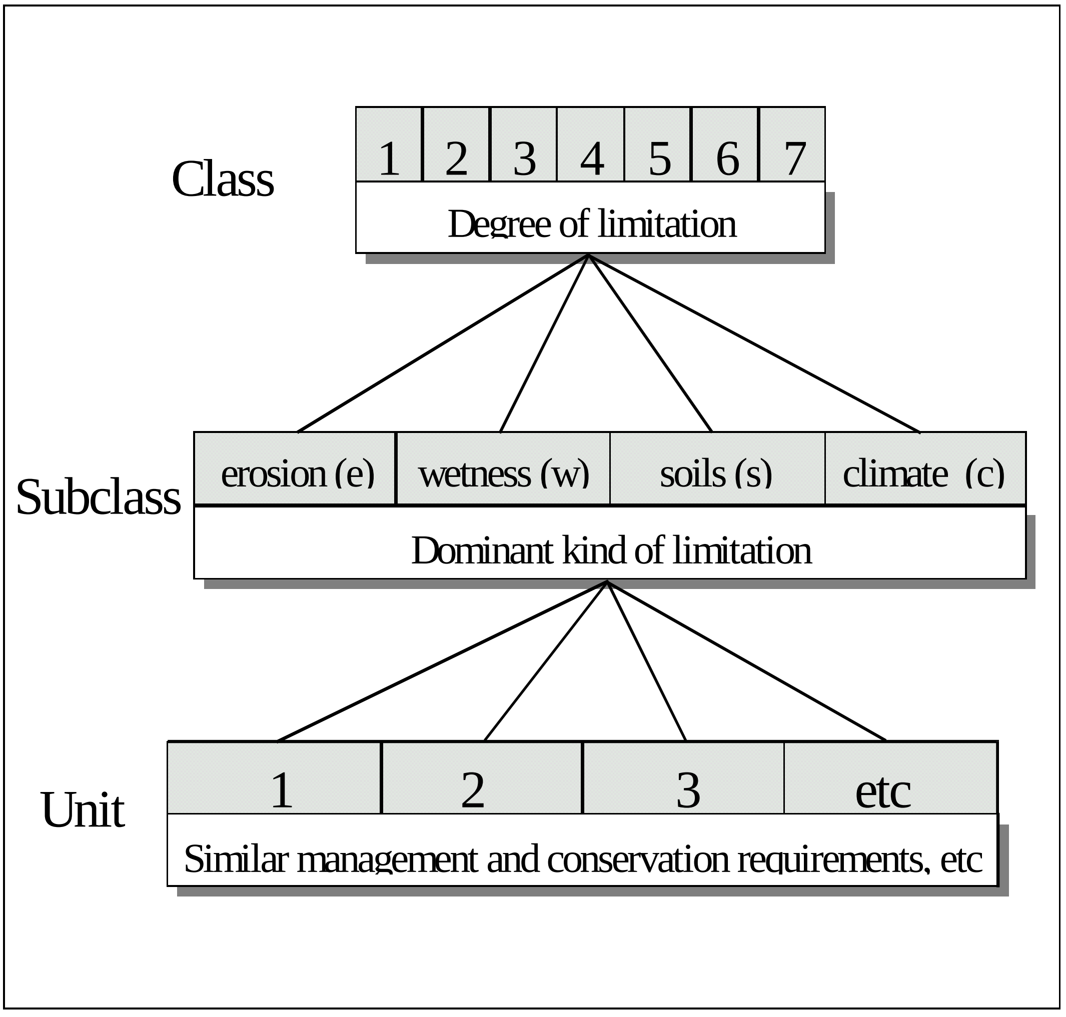


Figure 4: Levels of the land capability classification system.
(Adapted from: National Water and Soil Conservation Organisation, 1979, Our Land Resources. (NWASCO), Wellington, New Zealand.)

The classification system comprises seven classes ranked in order of increasing degree of limitation, and in decreasing order of versatility, for agricultural use. The system is hierarchical. Class 1 land is identified as the best land and can produce a wider variety of crops and pastures at higher levels of production with lower costs, or with less risk of damage to the land, than any of the other classes of land. Class 2 land is similarly superior to Classes 3 to 7, and so on.

Each land class can be subdivided into one of four sub-classes depending on the nature of the dominant limitation or hazard to the use of that land. Limitations may be defined as physical factors or constraints which affect the versatility of the land and determine its capability for long-term sustainable agricultural production. Some limitations are able to be removed or modified through normal management practices or other means. Where such improvements are considered feasible, both physically and economically, land may be classified higher than it's current condition might indicate. Such improvements do not include the use of irrigation water but may include drainage or stone picking.

The limitation classes identified are erosion (e), wetness (w), soils (s) and climate (c). Examples of different kinds of limitations are: erosion hazard, slope, climate, flooding, stoniness, rock outcrops, salinity, poor soil structure, poor internal drainage, low fertility and low soil moisture holding capacity. There may be one or a number of limitations present at any one site, and it is the overall degree of limitation present that determines the capability class.

Each subclass may be further subdivided to unit level. Land capability units are areas of land with similar management and conservation requirements or differences in productivity which may not be significant at higher levels within the classification system. Thus an area identified as class 4e may be further subdivided into 4e1 (class 4e land subject to wind erosion) and 4e2 (class 4e land subject to water erosion).

The system assesses the versatility of the land to produce a range of agricultural goods that are considered typical for Tasmania, and not just those that are specific or suited to localised areas. For example, small scale intensive activities like soft fruit orchards and floriculture are not considered when evaluating the versatility of an area. Opportunities for silviculture is another activity that the system does not consider. The main agricultural land uses that are considered when evaluating land include cereals, poppies, broad scale vegetable production (potatoes, peas, beans, onions etc), pyrethrum and essential oils plus dairy, beef, lamb and wool production.

The system considers degradation of the soil resource and does not take into account the possible effects of agricultural land use on water quality, aesthetics, wildlife, etc.

The classification, in particular at the unit level, takes into account the management strategies and soil conservation requirements the land may need in order to maintain a level of production without long-term degradation. However, the availability of irrigation water is **not** taken into consideration when evaluating the capability of the land (see Section 3).

As with most land classification systems certain assumptions are necessary. These include:

(a) The land capability classification is an interpretive classification based on the permanent biophysical characteristics of the land.

(b) A moderately high level of management is being applied to the land.

(c) Appropriate soil conservation measures have been applied.

(d) Where it is reasonable and feasible for an individual farmer to remove or modify physical limitations (e.g. high water tables, stoniness, low fertility) the land is assessed assuming the improvements have been made.

(e) Land capability assessments of an area can be changed by major schemes that permanently change the nature and extent of the limitations (e.g. drainage or flood control schemes).

(f) The land capability classification is not a productivity rating for specific crops, although the ratio of inputs to outputs may help to determine the land capability class.

(g) Land capability does not take into account economic, social or political factors and is not influenced by such factors as location, distance from markets, land ownership, or skill of individual farmers.

(h) Present and past uses of the land (or similar land elsewhere) are guides to potential, in that they can indicate the limits of the capability of the land. Present land use and vegetation cover are not always good indicators of land capability class. The system of land capability is aimed at assessing the potential sustainable productivity of land rather than current productivity.

(i) Assessments are based on the capability of the land for sustained agricultural productivity, since use of the land beyond its capability can lead to land degradation and permanent damage.

(j) Irrigation, or the feasibility of irrigation, is not considered when evaluating land capability.

(k) The system is consistent across the State.

It is important to remember that the land capability of an area can change as result of improved farming practices, changes in crop variety, technical innovations or just a better understanding of the relationships between soils, farming and the natural environment. The information in this report has a limited lifespan and care should be given to its interpretation in future years. Farming practices that today are only available for the advanced or innovative farmer may become common practice in the future.

4.2 Class Definitions

The following class definitions apply. The criteria used to define the classes are based on observation and experience only, and not on experimental work. Figure 5 outlines the main features of the classification classes. Classes 1-4 only are considered capable of supporting cropping activities on a sustainable basis; classes 5 and 6 are suitable for grazing activities only although pasture improvement may be possible on class 5 land (class 6 land remaining as native pasture); class 7 land is unsuitable for any form of sustainable agricultural activity.

CLASS	LIMITATIONS	CHOICE OF CROPS	CONSERVATION PRACTICES
1	nil	any	none
2	slight	slightly reduced	minor
3	moderate	reduced	major
4	severe	restricted	
5	slight to severe	-	major + careful management
6	severe	-	
7	very severe to extreme	-	

Figure 5: Features of land capability classes.

Also, there is a range of land that can occur in any one capability class. Thus it is often possible, for example, to identify good and poor quality Class 4 land. While the intensity of mapping required to acheive this is not feasible when mapping land classes at 1:100 000 scale it would be possible to map such differences at the unit level.

CLASS 1

Multiple use land with only minor limitations to intensive cropping and grazing. It occurs on flat land with deep, well drained soils, and in a climate that favours a wide variety of crops. It is capable of being cropped eight to nine years out of ten in a rotation with pasture or equivalent without risk of damage to the soil resource or loss of production.

CLASS 2

Land suitable for intensive cropping and grazing. Limitations to use are slight, and these can be readily overcome by management and minor conservation practices. Limitations present increase the risk of damage to the soil resource through over cultivation or the risk of yield loss is such that the length of the cropping phase is reduced to five to eight years out of ten in a rotation with pasture or equivalent during 'normal' years.

CLASS 3

Land suitable for cropping and intensive grazing. Limitations are such that either cultivation for cropping should be limited to two to five successive crops in a rotation with pasture or equivalent to prevent damage to the soil resource, or the risk of crop failure or yield reduction with average climatic conditions is such that significant losses can be expected 5-7 years out of ten. Soil conservation practices and sound management are needed to overcome the moderate limitations to cropping use. The range of crops able to be grown is generally more restricted than on Class 1 or 2 land.

CLASS 4

Land marginally suitable for cropping because of severe limitations which restrict the range of crops that can be grown, and/or make major conservation treatment and careful management necessary. Cropping rotations should be restricted to one to two years out of ten in a rotation with pasture or equivalent to avoid damage to the soil resource or are limited by severe climatic conditions such that there is a very high risk of crop failure or yield decline in most years. This land is well suited to intensive grazing.

CLASS 5

Land with slight to moderate limitations to pastoral use. This land is unsuitable for cropping, although some areas on easier slopes may be cultivated for pasture establishment or renewal. The effects of limitations on the grazing potential may be reduced by applying appropriate soil conservation measures and land management practices.

CLASS 6

Land marginally suitable for grazing because of severe limitations. This land has low levels of production, high risk of erosion, low natural fertility or other limitations that severely restrict agricultural use.

CLASS 7

Land with very severe to extreme limitations which make it unsuitable for agricultural use.

E - Exclusion Areas

Land that is not private freehold or leased crown land and has not therefore been considered during the evaluation.

Note on Class Definitions

The length of cropping phase given for classes 1-4 is intended as a general guide only. Past experience has shown that there is some confusion and concern regarding the figures given. While some land will just not support production beyond the intensity recommended (due to the risk of erosion or soil structure decline, for example), other areas are limited by the risk of loss occasioned by such factors as adverse climatic conditions or flooding.

For example, some parts of the survey area are subject to a significant flood risk. Due to rainfall patterns in recent years it has been possible to cultivate these areas more intensively than might 'normally' be achieved. By cultivating these areas farmers are accepting a high risk of failure or damage to crops from flooding and whether or not a crop is planted in any particular year is dependent, in part, on just how much risk an individual farmer is prepared to accept. In other areas the soils are such that significant periods of cultivation without a break can lead to severe structure decline, hindering germination, water infiltration, soil aeration and increasing the likelihood of erosion.

Also, the classification system takes into account the *variety* of crops that can be grown (see also page 14 for examples of crops considered). Thus Class 4 land might incorporate areas where a relatively wide range of crops could be grown but the risk of damage to the resource is such that cropping should **only** be undertaken one or two years out of ten. Conversely, other areas may support a more limited range of crops but production may be sustainable over a longer period.

It should be noted that capability classes have not been defined on the basis of productivity. This is partly due to problems in comparing the relative value of different agricultural practices and partly due to the lack of data regarding just what is sustainable for each land class. As well, within any particular land class, there is likely to exist a range of land and, at a more detailed level of mapping, it may be possible to distinguish, for example, between good Class 4 land and poor Class 4 land.

5. THE SOUTH ESK SURVEY AREA

5.1 Introduction

This is the fourth in a series of land capability reports for Tasmania and covers the area defined by the South Esk 1:100 000 scale topographic map (sheet no 8314). The information printed here and in the accompanying map is intended for use at a regional planning level and is inappropriate for farm scale planning. However, the system and the methodology can be applied at any level (see Section 2).

The study area lies in the Northern Midlands region of Tasmania, immediately south of Launceston (see also Figure 1). It includes the local centres of Hadspen, Longford, Perth and Evandale in the north-west; Cressy in the West, Campbell Town in the South East, Epping Forest and Conara on the Midlands Highway and Blessington in the north east. The total area is some 2 400 km^2 which includes part of the Launceston Tertiary Basin and upland areas in the north-east and south-west.

Land use throughout the area is principally agricultural, being mainly grazing for sheep and cattle but with some extensive areas of cereal production. Better quality soils in the north-west are used more intensively. The study area includes the Cressy Longford irrigation area which, with its reliable supply of water, is used more intensively than other areas and grows a wider variety of crops, including poppies, potatoes and other vegetables, on soil types that without irrigation would normally be confined to cereals and pasture. An exclusion area is identified in the south-west of the map sheet being mainly State forest. Small, scattered exclusion areas occur across the map sheet most of which are connected with the Hydro Electric Commission (HEC).

5.2 Climate

The climate for the South Esk map sheet is dry temperate, (Doyle 1993). Within this broad climatic type the area experiences a range of climatic conditions relating to variations in topography across the map sheet. Two main climatic zones are identified; areas above 500 m which experience cool temperatures and moderate rainfall; and warmer, drier areas occurring below the 500 m contour.

The upland areas of Millers Bluff, O'Connors Peak, parts of the Blessington area and The Great Western Tiers, experience heavier rainfall and much lower average temperatures throughout the year compared to lower altitude areas, particularly in winter. Agricultural production is limited in these areas due to out of season frosts and shorter growing season, as well as topographic and soil conditions. Rainfall in the hills and higher catchments can result in flooding of the lowland areas particularly in winter and spring.

The main agricultural areas occur at low altitudes and include the local centres of Cressy, Longford, Perth, Epping Forest and Campbell Town. These areas have a more favourable climate although rainfall becomes increasingly more limiting toward the drier south east. A winter dominated rainfall pattern exists with warmer temperatures throughout the year compared to that of the elevated areas.

5.2.1 Precipitation

Figure 6 shows the average annual rainfall for the region redrawn from data collated by the Hydro Electric Commission in 1986.

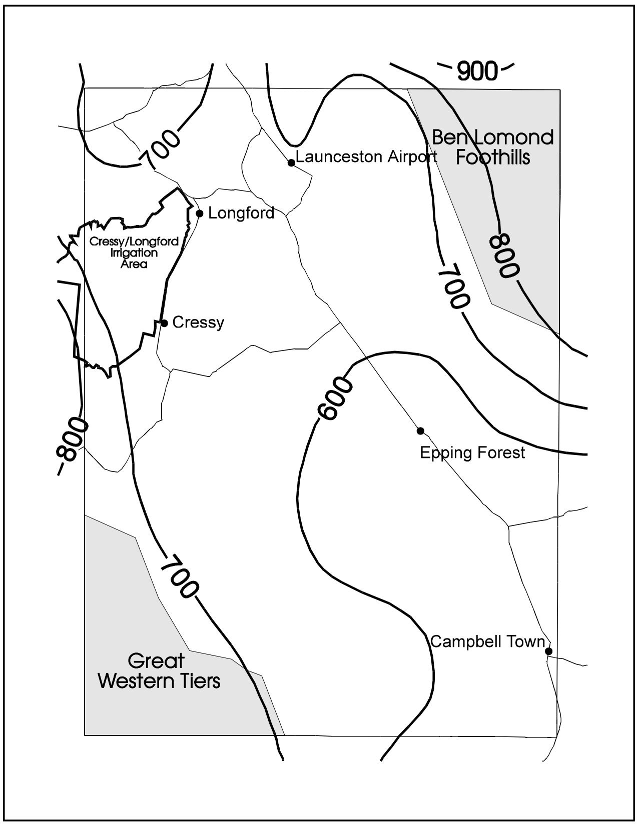


Figure 6. Rainfall isohyet diagram for the South Esk area. (Isohyets in mm/annum)

The influence of topography is clearly evident with upland regions receiving greater rainfall than lower lying areas. A weak rain shadow effect is discernible on the lee side of the Great Western Tiers.

Rainfall within the map sheet is winter and spring dominated with July and August being the wettest months of the year. Fig. 7 shows average monthly rainfall and evaporation figures for selected meteorological stations within the survey area.

The number of recorded rainfall days and average annual rainfall decreases from north to south and there is also a distinct rainfall trough in low lying areas between the Great Western Tiers and the Ben Lomond Plateau.

While the data in Fig 7 and Table 2 represent average values, the occurrence of lower annual rainfall in these areas is not uncommon. The recorded rainfall for Launceston Airport and Campbell Town in the dry year of 1987 for example was only 480mm and 392mm respectively compared to an annual average of 687mm and 543mm (Australian Bureau of Statistics 1988 & Australian Bureau of Meteorology 1995). At such times crop and stock losses can be expected. While periods of low rainfall are not common, they occur sufficiently often to be an issue of some concern to farmers in comparatively low rainfall areas such as the Northern Midlands area.

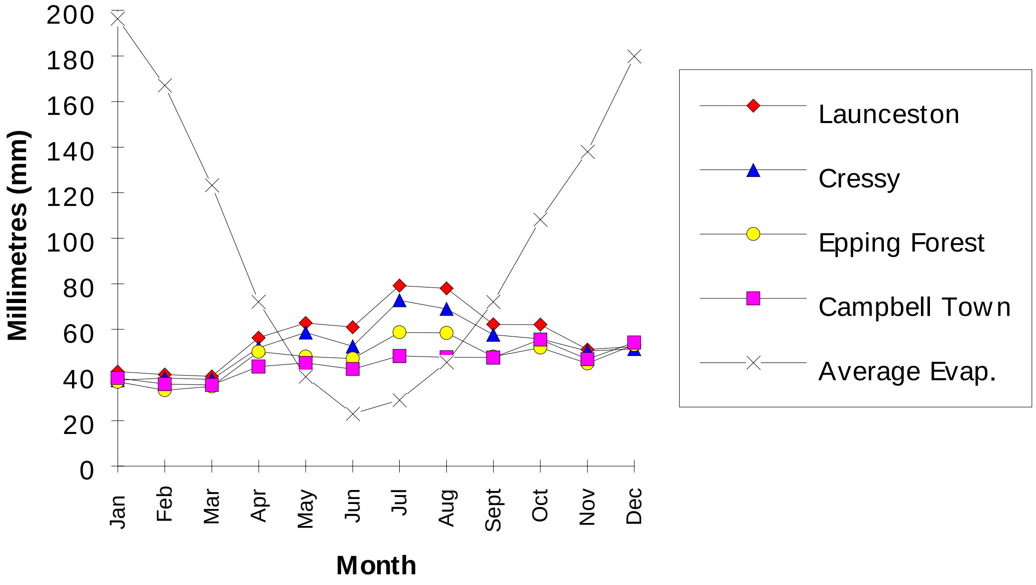


Figure 7. Average Monthly Rainfall and Evaporation
(Source: Australian Bureau of Meteorology, unpublished data 1995.)

Location and years of records	**Altitude (metres)**	**Average Annual Rainfall (mm)**	**Average No. of rain days* per year**
Launceston Airport (1931 - current)	170	687	137
Cressy (1939 - current)	150	635	123
Epping Forest (1927- current)	170	566	99
Campbell Town (1915-1993)	200	543	92

Table 2. Average annual rainfall and number of rain days for selected stations.
(Source: Australian Bureau of Meteorology, unpublished data 1995 and Australian Bureau of Statistics 1988. *Rain day = when 0.2mm or more of rain is reported.)

Snowfalls and hail storms are largely confined to the upland areas of the survey area and snow may cover high hill tops for much of the winter. Snowstorms sometimes extend to the lowlands, but snow rarely settles for more than a few hours. While they occur mainly during winter and spring, snowfalls have been recorded in upland areas at any time of year. On average, Launceston, Campbell Town and Cressy receive snow once every three to four years (Bureau of Meteorology, 1980). Hail storms have a similar pattern of occurrence and localised crop damage may occur in some crops during particularly severe events.

The large catchment size (9000 km^2), sinuous nature of the drainage pattern and flat unrestricted flood plains make this area prone to flooding. Seventy percent of major floods occur in autumn and winter, 21% in spring and 9% occur in summer (Bureau of Meteorology, 1980). "Nuisance" flooding occurs in low lying areas and drainage courses throughout the year, and are often a result of heavy rain storms higher in the catchment. Damage caused by flooding to agricultural crops is dependant on the timing of the event and the duration that crops are inundated. Little information is available on crop damage by flooding except that in some areas it is of significant concern. Levee banks have been constructed in some areas to reduce the impact upon agricultural land and townships with some degree of success.

The South Esk River and its tributaries are all subject to flooding and do so most years. Inundation mostly occurs on agricultural land although in severe floods parts of rural townships such as Longford can be affected. Such floods are normally of only short duration and limited depth and extent but can cause significant damage if they occur at a sensitive time of year.

5.2.2 Evaporation

Evaporation data from within the Launceston Basin indicate the evaporation from an open water surface exceeds precipitation over eight months of the year (see Fig 7). Evaporation data presented has been derived from the monthly averages for three sites within the survey area, Cressy Research Station, Campbell Town and Launceston Airport, and is representative of lowland areas only.

The evaporation data has been used to calculate effective rainfall using Prescott's formula (see following Section on Growing Season). Effective rainfall data for the South Esk area (see Appendix B) indicates a period from January through to March when insufficient rainfall occurs. The formula is designed to estimate effective rainfall for areas under cereal crops in southern Australia and care is therefore required when applying it within Tasmania or to areas under crops other than cereals. However, with the lack of a suitable alternative, the figures present a rough guide to soil moisture conditions.

Winter rainfall in excess of evaporation often results in localised waterlogging and inundation and also impacts upon length of growing season, plant health and trafficability of the ground.

5.2.3 Temperature

Average temperatures indicate a distinct seasonality with average maximum temperature in summer peaking just under 25°C in January and February while average minimums of just over 0°C are recorded in June. The range between maximum and minimum temperatures is smallest in the winter but rarely fluctuates outside the 10-15° range (see Fig. 9).

Figure 9 also indicates that, although the differences are only slight, southern parts of the survey area are likely to experience slightly higher summer maximum temperatures and lower winter minimum temperatures than more northern areas. There is no data for upland areas but average temperatures will be significantly lower and risk of frosts higher than areas within the Launceston Basin.

Photo 2. Flooding on the South Esk River near Belle View Road.
(Grid Ref. E 531450, N 5378850)

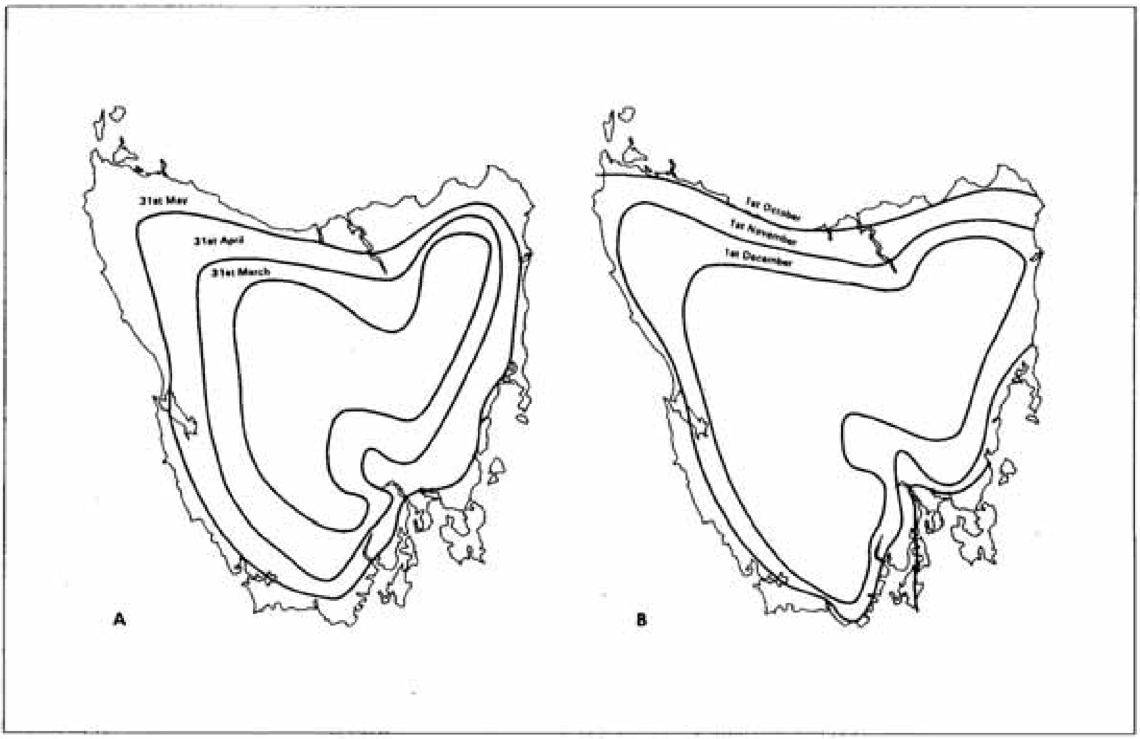


Figure 8. Average dates for (A) first occurrence and (B) last occurrence of air frost in Tasmania
(after Langford, 1965)

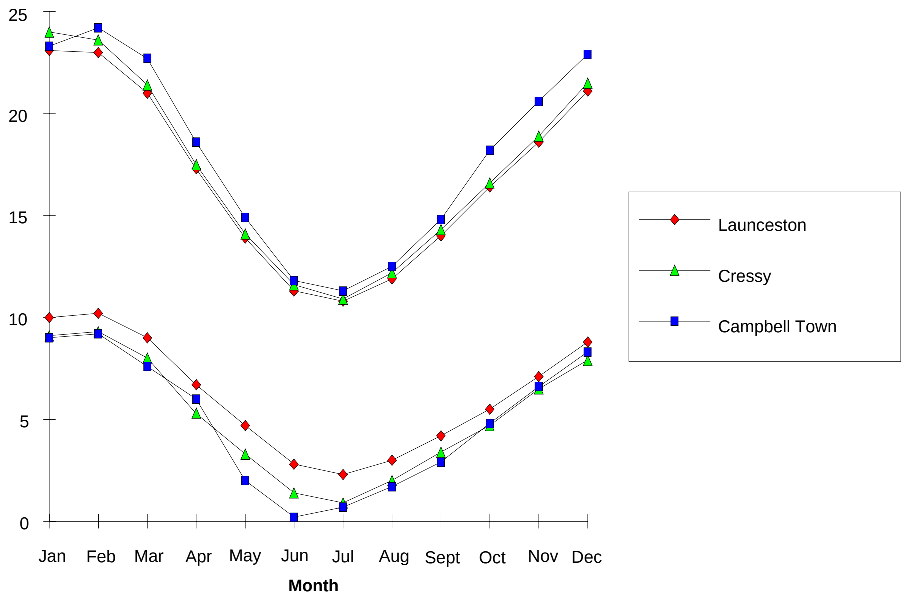


Figure 9. Mean Monthly Maximum and Minimum Temperatures for the South Esk Area (Source: Australian Bureau of Meteorology, unpublished data 1995)

Low temperatures leading to the formation of frost have been recorded in all parts of the survey area. At Cressy nearly 100 frosts occur a year, the majority during the period May to October although frosts have been recorded in all months of the year, (Bureau of Meteorology, 1993). Local factors such as terrain and air movement result in localisation of frosts and will affect their frequency and severity. Inland valley floors are the most prone to severe frosting. Figure 8 indicates the average dates of first and last occurrences of air frosts in Tasmania. However, while frost risk is a factor in considering the variety of crops that might be grown and potential planting and harvest dates, it is a factor which is of secondary importance to other limitations such as erosion risk, flooding or soil type.

Local experience has identified an increasing prevalence of frost within the Launceston Basin with increasing proximity to the Western Tiers. This is a result of cold air from higher altitudes spilling over the Tiers and collecting at lower elevations and displacing warmer air upwards. Such localised air movements have resulted in a slightly higher incidence of frost in some areas than might be otherwise expected. Although the severity of this event is probably insufficient to warrant the down grading of any land it's significance should not be underestimated by property owners below the Tiers.

5.2.4 Wind

The prevailing wind for the State is mainly westerly however this is channelled through the Launceston Tertiary Basin by the topography to result in a predominantly northerly and north westerly air stream within the survey area. Wind strengths are greatest and most persistent in late winter and early spring (Bureau of Meteorology, 1980,1993). In summer northern areas can experience easterly to south-easterly winds in the morning with a north-westerly sea breeze dominating in the afternoon. Further inland the effect of the sea breeze is less intense and more variable wind strengths and directions occur.

5.2.5 Growing Season

The length of growing season in the South Esk area is controlled by temperature (particularly frost occurrence) and effective rainfall. While climate in itself is nowhere considered more limiting than other factors of erosion, wetness and soils except at higher altitudes, it can impact locally on the length of growing season and the variety of crops that can be grown safely. However, little information is available regarding the length of growing season in different parts of Tasmania and the following information is interpretive using indicators and methodologies used elsewhere in Australia to estimate the length of growing season within the survey area.

Temperature has a limited impact on the length of growing season at lower altitudes within the Launceston Basin but the impact is far greater with increasing altitude and distance from the moderating effect of coastal sea breezes. An average of 6°C is commonly accepted as the minimum temperature for crop growth. Average monthly temperature data presented in Table 3 indicate this minimum temperature is reached during three months of the year at Campbell Town and in one month at Cressy. These data also indicate a transition to lower temperatures in the southern part of the survey area.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Launceston	17	17	15	12	9	7	7	7	9	11	13	15
Cressy	17	16	15	11	9	7	6	7	9	11	13	15
Campbell Town	12	12	11	9	7	6	5	6	7	8	9	11

Table 3. Average Monthly Temperatures (Bureau of Meteorology, 1995, unpublished data)

Rainfall also exerts a significant control on the length of growing season. However, rainfall figures should not be considered in isolation as it is the balance between rainfall and evaporation that determines the soil water balance. 'Effective rainfall' is defined as the amount of rainfall required to start germination and maintain soil moisture above wilting point and therefore allow plant growth.

The following formula provides an estimate of effective rainfall (after Prescott and Thomas, 1949):

$P = CE^{0.7}$ where P is effective rainfall (mm),
E is monthly evaporation (mm),
C is a constant equal to 1.4.

This formula has been designed for cereal growing areas in South Australia and may not be entirely accurate for Tasmanian conditions. When moisture deficit/surplus data are calculated for the Launceston Airport, Cressy, and Campbell Town stations average monthly rainfall falls short of effective rainfall in December, January, February and March at Launceston Airport and in January, February and March at Cressy and Campbell Town. Effective rainfall figures are presented in Appendix B.

Using the temperature and effective rainfall figures two periods become evident where plant growth is possible if irrigation is not used. The major window occurs between September and late December with a second, more minor window of opportunity, in April and May. These figures are supported by the planting strategy of most farmers who may sow winter cereals in April/May that will be grazed during the winter and then allowed to mature in the following spring/summer together with a spring sowing in September/October for summer crops.

In many areas, low summer rainfall during December to March necessitates the use of irrigation, if the soils are under intensive use, to avoid crop losses or yield reduction particularly for those crops with high water requirement or on soils with low water holding capacities. Growers who do not have access to irrigation water will be restricted to a narrower range of crops and be confined to a shorter cropping season than those who can irrigate.

The growing periods identified above are generally sufficient for the majority of crops grown in the South Esk region. However hot dry summers and severe winter conditions can further shorten the growing season as well as influence the range of crops that may be grown.

5.3 Geology

The South Esk survey area is covered by two geological maps, 'Lake River' 1:50 000 (Matthews, 1974) in the south and 'Longford' 1:63 360 (Blake, 1959) in the north.

This area is part of a wider region that has undergone a complex and diverse geological evolution. As discussed in Section 5.4 the present day topography has largely been determined by a variety of geological events. The more important of these events include the intrusion of dolerite magmas into older sediments, a period of faulting and folding and the occurrence of basaltic lava flows. Geomorphic processes have also occurred to further shape the landscape through erosion and deposition. Figure 10 outlines the geology of the survey area in relation to topography.

The survey area is dominated by the Launceston Tertiary Basin (Johnstone, 1875) formed as a result of normal faulting during the early Tertiary period (approx. 65 million yrs BP) and subsequent partial infilling of the basin by material eroded from the surrounding uplifted blocks. Dolerite ridges and scattered basaltic lava flows are today a prominent feature of the basin. To the north-east and south-west the basin is bordered by the Ben Lomond Plateau and the Great Western Tiers respectively.

The geology of the Launceston Tertiary Basin comprises unconsolidated clays, sands and gravels. These materials have been interpreted as lake and river sediments (Matthews, 1974), which have been deposited during the mid to late Tertiary period after being eroded from the surrounding uplifted areas. As the lake waters drained from the basin, river systems cut through the landscape to form a series of flat terraces. These are discussed in Section 5.5.3 and may be seen at Cressy, Longford and other parts of the basin.

Quaternary alluvium occurs along major river courses, including those of the current South Esk, Macquarie, Lake and Elizabeth rivers. Inundation and over-bank flow over many thousands of years has led to a significant build up of these deposits which are locally important for agriculture.

Overlying some of the alluvial sediments and older terrace levels, are scattered deposits of windblown (aeolian) sands originating from the basin's lake and glacial sediments. These deposits may be seen as gentle rolling hummocks and crescent dunes often on the lee or eastern side of alluvial depressions. Examples may be seen on the footslopes of Mt Augusta, around Diprose Lagoon and on many alluvial plains. Often these sediments occur in association with other rock types or as a thin deposit overlying other sediments.

Dolerite rock occurs extensively throughout the survey area. It is of Jurassic age (210 million yrs) and has been intruded into older Permian and Triassic sediments (Matthews, 1983). Following the intrusion by these dolerite magmas a period of faulting occurred which left some areas uplifted and others downthrown. Erosion removed the caps of the older and softer Permo-Triassic sediments overlying the dolerite and deposited them into the basin below resulting in the series of landforms seen around the area today. Plateaux and steep hills make up the majority of dolerite landforms together with scree slopes and colluvial fans. The foothills around Blessington, Mt Arnon, Hummocky Hills, Dicks Banks, the Macquarie Tier and The Great Western Tiers all display examples of dolerite rock.

Areas of Tertiary Basalt can also be found within the survey area but these are of limited extent in comparison to the dolerite. Basaltic lavas were vented from fissures and cracks during the Tertiary Period and can today be seen as outcrops along Nile road at Viney's Sugarloaf, at Breadalbane and around Campbell Town.

During the Permian and Triassic periods Glacio-marine and freshwater mudstones and siltstones, some containing leaf fossils and sometimes coal seams, were deposited (Matthews, 1983). These sediments occur below the dolerite cap at The Great Western Tiers and the Blessington hills from which they are separated by banded or bedded sandstones and shales. These sediments are mainly shielded from erosion by the more resistant dolerite but where incision of the dolerite has occurred they have become exposed and often form cliffs or steep rock outcrops. Some areas of Permian mudstones occur in depressions within the dolerite hill country north of Perth and east of Evandale. How these sediments have been retained in these locations is unclear. They may have been cupped and uplifted by intruding dolerite sills or they may represent areas where dolerite has not yet been uncovered through erosion or in fact where the dolerite has failed to intrude altogether.

Also found below the dolerite caps are the oldest rock types of the survey area, the Precambrian rocks. These occur where the Lake River has incised removing the overlying younger Permian and Triassic sediments (Matthews, 1983). They are often seen as foliated slates, phylites and volcanic tuffaceous rocks, and are identified only at the base of O'Connors Peak, Little Billop and west of Stevensons Lookout.

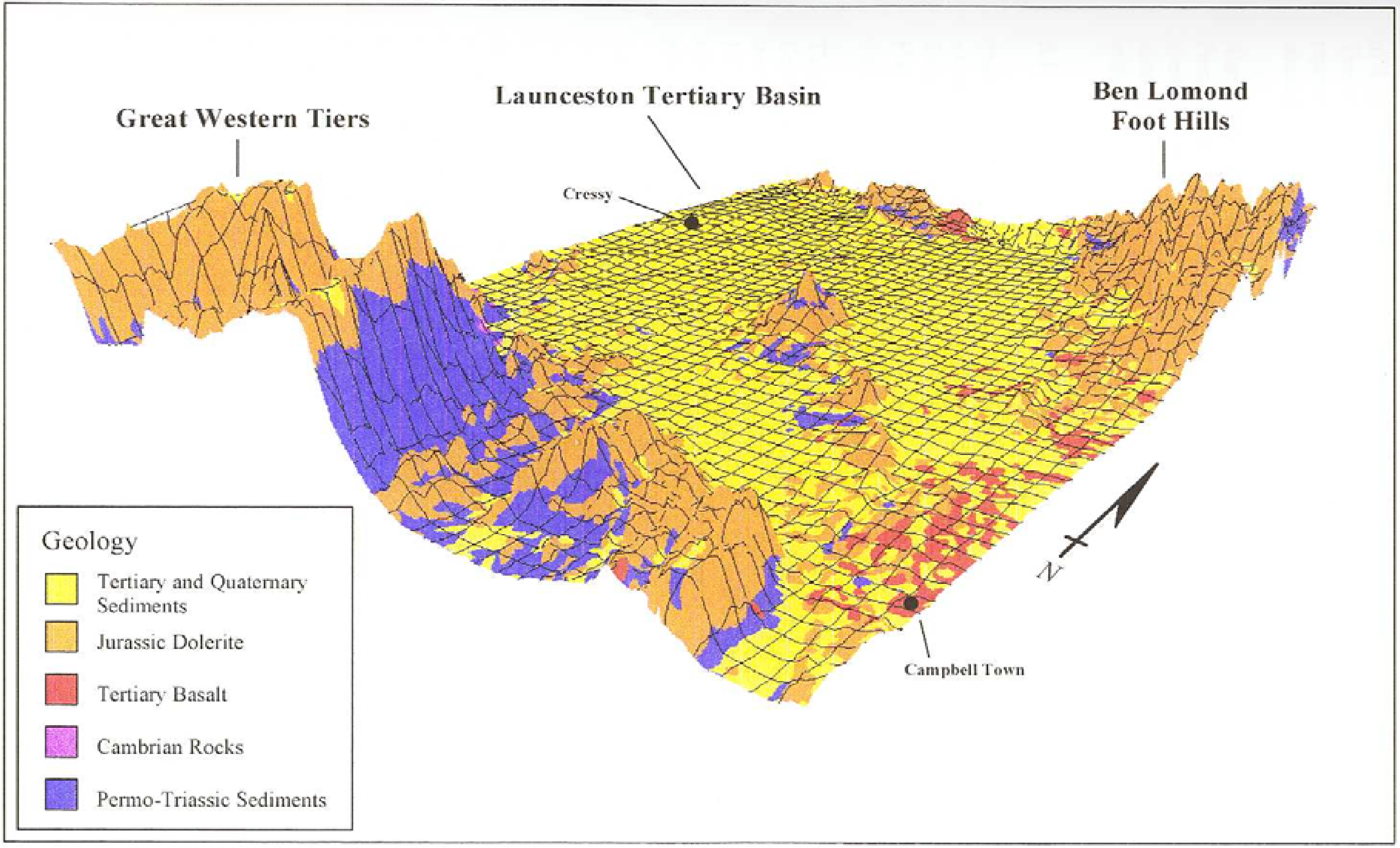


Figure 10. Digital elevation model and dominant geological types, South Esk Survey area.

5.4 Topography and Geomorphology

The topography of the area is dominated by the broad open expanse of the north-west - south-east aligned Launceston Tertiary Basin, the upland areas of the Great Western Tiers and Central Plateau in the south-west and the lower ranges of the Ben Lomond Plateau in the north-east. These geomorphological features are clearly visible on the digital elevation model presented in Figure 10.

The Launceston Basin forms a down thrown graben between the uplifted horsts of the Central Plateau and Ben Lomond Plateau. The basin, a result of regional extension of the earth's crust and block faulting during the Tertiary period (Carey, 1947; Matthews, 1974 and 1983) comprises Tertiary sediments incised by streams and rivers creating a system of relict land surfaces, terraces and flood plains. These sediments are predominantly lacustrine in origin and cover extensive areas of the survey area.

In the south-west of the survey area, Macquarie Tier and Jacobs Sugar Loaf rise to over 500 m and form the foothills of the Great Western Tiers which themselves rise to over 1200 m within the study area at Millers Bluff. Outcrops of Permian and Triassic sediments can be found below the dolerite capping of the Tiers and alluvial fan deposits are common in this area. As well, the Permian sediments are prone to slumping and minor landslips are often observed where Permian rocks occur at or near the surface. Despite the suggestion of Nicolls (1958) to the contrary, extensive glaciation is not believed to have occurred within the Launceston Basin since Tertiary times. However, glaciation was extensive on the Central Plateau and remnants of glacial deposits, nowhere extensive, can be found along the margins of the Launceston basin (Hannan, 1993).

Around Campbell Town are a series of undulating low hills rising to 328 m (Mt Augusta) but more generally at 200-250 m and formed predominantly of outcrops of dolerite and basalt lava flows. North of the Tiers a ridge of resistant dolerite (Hummocky Hills and Dicks Banks) rises to 478 m. In the north-east corner of the map dolerite capped hills form the foothills of the Ben Lomond Plateau with altitudes reaching 699 m at Castle Hill. A further outcrop of dolerite is to be found at Mt Arnon (314 m), to the north of Longford, which is associated with other dolerite hills immediately north of the survey area and forms the northern margin of the Launceston basin.

As discussed above, the basin sediments comprise Tertiary clays, sands and gravels which have become eroded and incised to form a sequence of erosion surfaces and river terraces. The terraces grade with distance up stream and have approximately the same grade as the existing river systems. This lends further evidence to the suggestion that the terraces have alluvial origins - the implication being that river gradients have not changed appreciably in this area for many millions of years. To the north of Evandale the old lake bed sediments have been deeply dissected by Rose Rivulet and its tributaries. Again a series of minor terraces can be identified in the area reflecting fluctuating sea levels. Minor landslips are a feature of many of the steeper valley sides and landslip processes continue to be active in the area and are an important consideration in the evaluation of land capability in the area.

The Brickendon Terrace is found at the next level down from the Woodstock. Like the Woodstock it is graded to a stream profile, cuts across Tertiary Basin sediments and incorporates much reworked material, particularly waterworn quartz gravels. Both the Woodstock and Brickendon Terraces have undergone varying degrees of laterisation during late Tertiary or early Quaternary times and ironstone gravels are a common feature particularly of the Woodstock terrace.

The Brumby Terraces are the third terrace level and are estimated to be of Pleistocene age (early Quaternary) and are related to climatic fluctuations and associated sea level changes (Nicolls 1960). These terraces show no evidence of the lateritic processes that are evident on the older terrace levels.

The lowest terrace level is the current flood plain of the existing river systems and has been named Canola by Nicolls (1960). Areas of this terrace are prone to seasonal inundation and flooding. The flood plains vary in width from narrow strips to extensive flats with cut-off channels and oxbow lakes.

There is considerable evidence of windblown or aeolian sands throughout the basin. Occurring predominantly on the current floodplain, aeolian sands may also be found on virtually all terrace levels. Nicolls (1958a) associates them with a drier cooler period during late glacial conditions.

Scattered throughout the basin are a number of depressions or lagoons some of which may exceed 2 km^2 in size (eg. Diprose Lagoon, south of Epping Forest and Woodstock Lagoon west of Longford). These lagoons are associated predominantly with the Woodstock Terrace and may represent depressions in the former Tertiary lake bed floor. Associated with the lagoons are lunettes, low ridges of windblown material rarely of a size worthy of mapping. Many of these lagoons contain poorly drained organic rich, almost peaty, soils. They are often inundated or have high ground water levels during winter but some have been drained and are occasionally cultivated.

The drainage systems of the area remain largely a superimposed system on Tertiary sediments and Jurassic dolerite although the basalt lava flows that occurred towards the end of the Tertiary resulted in some alterations to the overall drainage pattern. The major river systems are those of the South Esk and Macquarie, Lake, Elizabeth and Nile rivers, most of which are aligned with the basin in a south-east to north-west direction. The Elizabeth River joins with the Macquarie west of Campbell Town; Lake River and Brumby Creek join the Macquarie River just south east and east of Cressy respectively. The South Esk and Macquarie Rivers themselves join at Longford and join with the Meander River at Hadspen in the extreme north west of the study area. The South Esk river appears to have been diverted westwards by a basalt flow at Evandale and again swings south at Perth before turning west and north and joining with the Macquarie river.

Photo 3. View of Terrace flats and Ben Lomond Foothills from Pleasant Banks
Town of Evandale in middle distance. (Grid Ref. E 519100, N 5395600)

Photo 4. Brumby Terrace rising to the Brickendon Terrace in middle distance.
(Grid Ref. E 518100, N 5394000)

To the North of Evandale the old lake bed sediments have been deeply dissected by Rose Rivulet and its tributaries. Again a series of minor terraces can be identified in the area reflecting fluctuating sea levels. Minor landslips are a feature of many of the steeper valley sides and landslip processes continue to be active and are an important consideration in the evaluation of land capability in the area.

5.5 Soils

The soils of the South Esk 1:100 000 map area have been previously described by Nicolls (1958b) and Doyle (1993). Also, an area covering Macquarie Estates, south of the junction of Lake and Macquarie rivers was mapped by CSIRO (Hubble, 1947, unpublished) and the Cressy Longford area by Stephens *et al* (1942). The soil maps that accompany the more recent reports (Nicolls and Doyle) have been relied upon heavily during the preparation of this land capability report and many land capability boundaries coincide with soil boundaries. Map units in these publications correspond to soil associations - that is, they are complex units containing several soil types that generally occur in a regular pattern and containing a single, defined, dominant (>60%) soil type. However, neither publication discusses the more minor soil types in a great detail and, as the capability of some minor soil types can vary significantly from the dominant soil type, this will lead to some local discrepancies in land capability evaluation.

The soils of the area show considerable complexity - a result not only of the general complexity of the parent materials but also of the soil forming processes involved. Identification of different soil types may be assisted by relating soil type to the landform in which it occurs. Three major landform categories can be identified within the study area and the soils associated with each are described below.

5.5.1 Upland areas of the Great Western Tiers and Ben Lomond foothills

This region includes the Great Western Tiers and the higher areas of the Ben Lomond foothills. Significant parts of this region lie within forest reserves and thus outside the scope of this report. Remaining areas are dominated by soils developed on dolerite, scree slopes and solifluction material. The major limitations for land use are shallow, stony soils, steep terrain and cool, wet climate. The soils in these areas are mapped as Deddington by Nicolls, particularly hill areas around Deddington and Blessington; and as M1 and Eastfield soils in the Great Western Tiers by Doyle. Soil profiles tend to be relatively leached, are very variable in depth and contain rocks and stones varying from the occasional 'floater' to profiles dominated by large rocks. Soil depth varies from very shallow with extensive areas of surface rock to deeper profiles which could have some agricultural value. The majority of these soils remain under forest or occasional pasture. The soil types occupy upland areas throughout the map sheet, particularly Hummocky Hills, Great Western Tiers, Jacobs Sugar Loaf and the Deddington/Blessington area..

5.5.2 Foothills and lower slopes

This region includes the lower footslopes of the Great Western Tiers, including Little Billop, O'Connors Peak, lower slopes below Millers Bluff, Jacobs Sugarloaf and the Macquarie Tier, Temple Hill, Castle Bar and The Retreat. Soils of the region are a mixture of gradational and duplex profiles developed on dolerite, Permian and Triassic sediments and include Deddington and Eastfield associations, MEa, M2, Millers, Quamby, Blessington and Glen associations. Small outcrops of Arnon association have been mapped by Nicolls on the Longford sheet to the north of Perth and some 8 km east of Evandale.

Deddington and Eastfield soils have been described earlier. MEa soils are related to Deddington and Eastfield associations and occur on steep to very steep gradients and are often shallow and rocky with much dolerite talus. M2 soils have developed on Cambrian and Precambrian rocks, around O'Connors Peak. Once again gradients may be steep and the soils are frequently shallow and acidic in nature.

Miller, Quamby and Blessington associations occur on Permian and Triassic mudstones, sandstones and tillite. While the soils of these associations are very variable they all occur on rolling to steep ground, are relatively shallow and sodic to a greater or lesser degree, making them prone to dispersion and, on steeper gradients, erosion. Most of these soil types are best left in pasture although occasional profiles on gentler gradients and more sheltered climatic conditions, may be suited to occasional periods of cropping. Blessington soils occur in at the base of Millers Bluff, The Great Western Tiers and also at Blessington in the north-east. Only small areas of Miller soils occur around Little Billop and O'Connors Peak.

Glen soils have developed from alluvial fan deposits comprising dolerite gravel and detritus with occasional Triassic and Permian rocks. The soils are only slowly permeable and usually poorly drained, shedding much surface runoff during winter and spring rains. While Glen association soils are generally excellent pasture soils they have limited cropping potential. Quamby and Glen soils are found in small units at the base of Millers Bluff and the Great Western Tiers.

5.5.3 Launceston Tertiary Basin and dissected terraces

This region contains the majority of the agricultural soils of the South Esk map sheet and a wide variety of soil types. Most soils are developed on Tertiary sediments which have undergone various periods of weathering, transportation and deposition and the different terrace levels described in Section 5.4 reflect different periods of erosion and incision.

The soils are dominated by duplex profiles with occasional gradational or uniform profiles on recent alluvium, weathered basalt or aeolian sand. The duplex profiles have a number of special problems which, in themselves, pose significant problems in the agricultural use of those soils. Under the climatic conditions prevalent throughout the region, duplex soils typically dry out in summer and are wet in winter. Many profiles have a bleached A2 horizon which is deficient in nutrients and has a poor structural condition. Cultivating into this A2 layer and mixing with better A1 layers can seriously affect productivity (B. Chilvers, pers.comm.). These duplex soils fall into categories known as Chromosols, Kurosols and Sodosols by the new Australian Soil Classification of Isbell (1996) (Podzolics and Solodized-Solonetz of Stace *et al* 1968) and generally have low agricultural potential due to inherent soil physical and chemical properties.

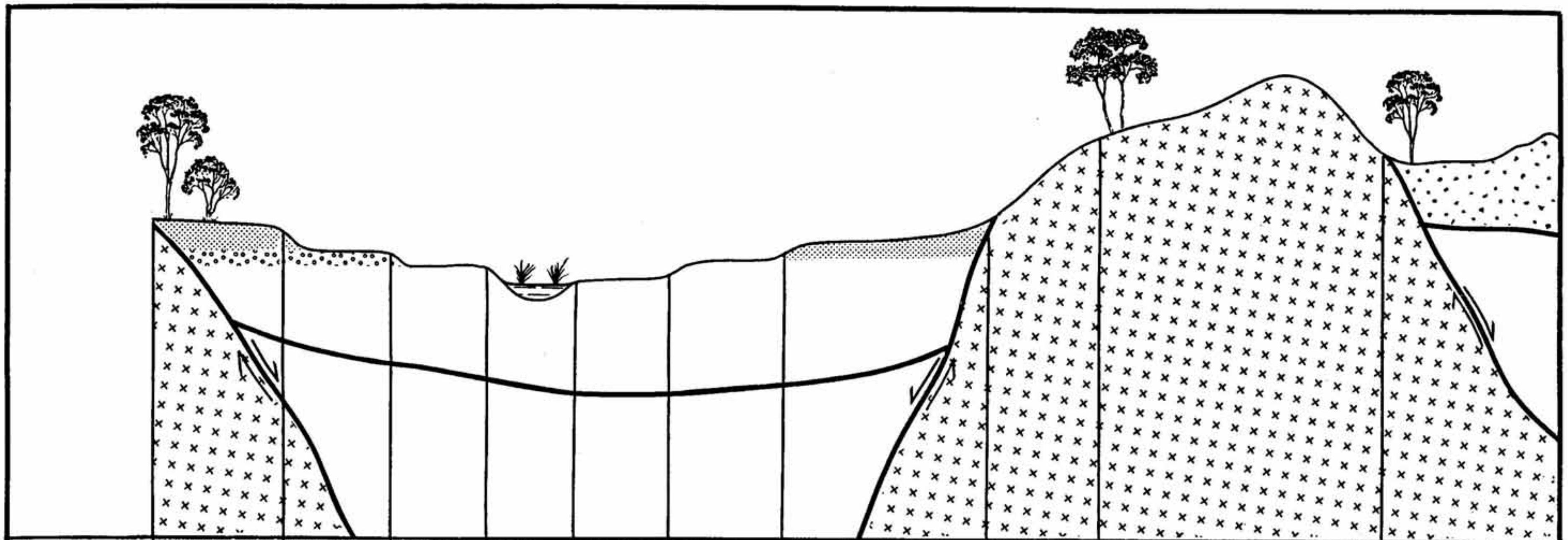
The older terraces have undergone more extremes of weathering and leaching and as a consequence, soils found on the Woodstock and Brickendon surfaces tend to be more acidic, more intensively leached and are deficient in major nutrients such as potassium and phosphorous. In contrast the soils of the Brumby and Canola surfaces are younger and less leached and may contain appreciable amounts of calcium and sodium. The Brumby soils in particular tend to be high in sodium, particularly in the subsoils, and are prone to dispersion and structural decline. The Canola soils, found on the current flood plains of the major rivers, are typically deep cracking clays, often of high pH and with calcium carbonate at depth, and are relatively fertile but difficult to work without causing degradation. Canola soils are to be found along the current flood plain of most of the major rivers and extensive areas of Brumby occur along Poatina Road and at Symmons Plains.

Nile Association soils are similar to those of the Brumby Association with which they are contiguous. Within the survey area the soils are confined to the terraces of the Nile River and are of limited extent. Nile soils differ from Brumby soils in that they contain varying amounts of waterworn dolerite stones and gravel.

Soils on the Woodstock and Brickendon surfaces have undergone variable intensities of laterisation whereby there has been significant leaching of iron and aluminium from the upper soil horizons and a corresponding accumulation lower in the profile usually in the form of "ironstone" gravels. In some areas these gravels may form a discontinuous cemented sheet which is a hindrance to root penetration and reduces moisture availability. Laterisation has also occurred on basalt and dolerite rock types but subsequent erosion has resulted in only remnants remaining. These soils belong to the Kurosols, Chromosols and Sodosols of the Isbell classification (lateritic podzols of Stace). Areas of Woodstock and Brickendon soils occur throughout the survey area. An extensive area of Woodstock can be found along the Midlands Highway from Epping Forest to Conara and a similar area of Brickendon occurs between the Lake river and the Midland Highway.

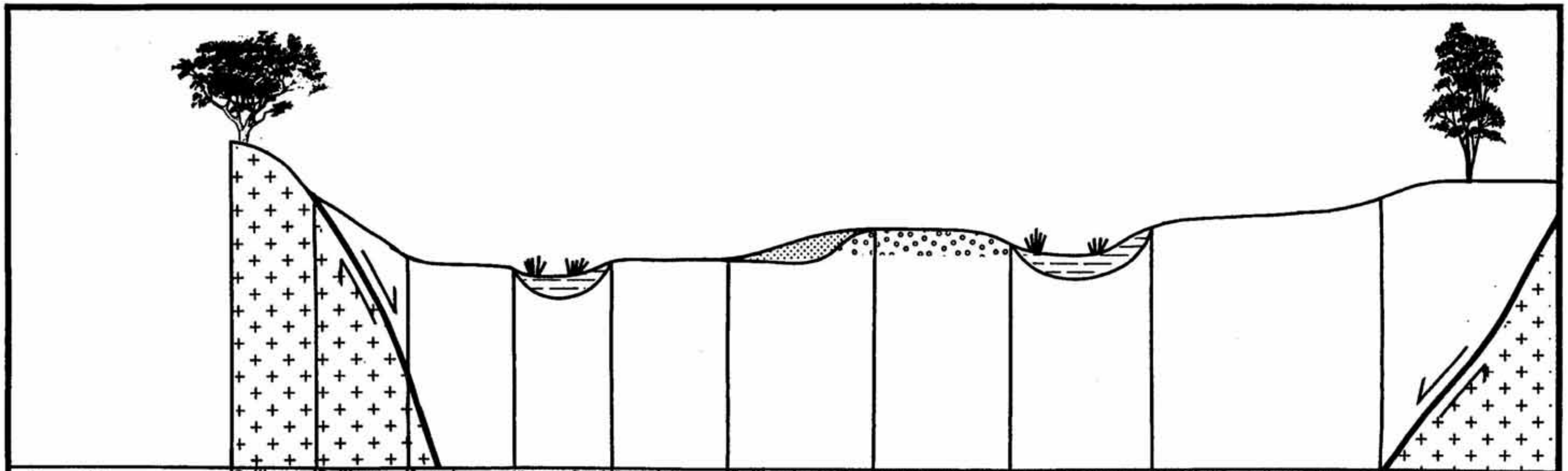
Other soil types identified in association with the terraces include the Newham, occurring on gentle gradients between the Brickendon and the Brumby; and Macquarie which is found on the Brickendon surface but differs from the Brickendon soils in the greater proportion of ferruginous gravels. Newham soils occur in generally small areas scattered throughout the western half of the survey area. Macquarie soils are found in association with Brickendon soils along Macquarie and Barton roads.

Windblown sands have been identified on all terrace levels and where they are greater than about 75 cm deep have been classified as Panshanger sands. These soils have severe erosion problems, even on relatively gentle gradients where wind may be the main erosive agent. Elsewhere windblown sands may form a shallow cover over other soil types making them more prone to erosion. Eroded dune remnants have been classified as Tara soils where sandy or loamy topsoils of aeolian origin overlie heavier sub soils. These soils may also be at risk from erosion but also have many problems associated with other duplex soils. Panshanger soils are found throughout the survey area but particularly along Mount Joy road and Valley Field road where they are found in association with Bloomfield, Eastfield, Canola and Brumby soils.



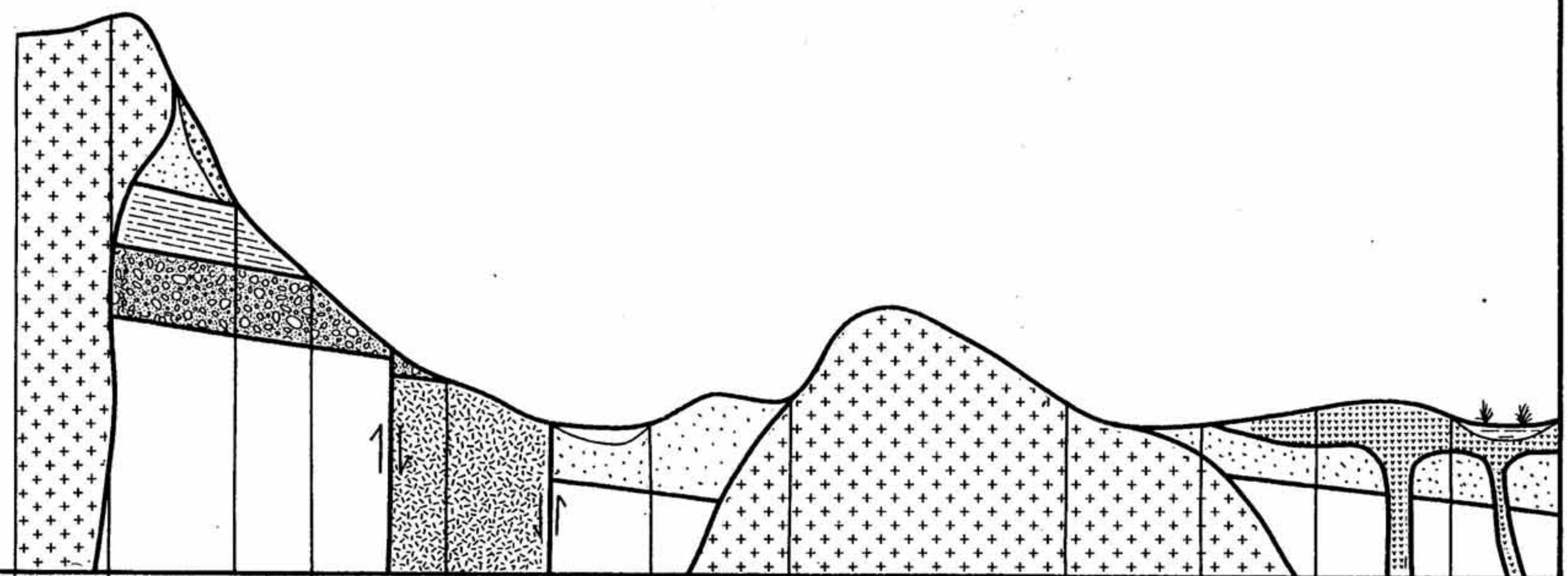
Landform	High level erosion surface (Woodstock surface)	High river terrace (Brickendon surface)	Low river terrace (Brumby surface)	Recent flood plain	Low river terrace	Low river terrace (Brumby surface)	High level erosion surface (Woodstock surface)	Rolling to steep land	Plateau top, rolling to steep land.	Rolling to steep slopes
Geology	Tertiary clays	Tertiary clays with quartz gravels	Quaternary alluvium	Quaternary alluvium (silts and clays)	Quaternary alluvium	Quaternary alluvium	Tertiary clays	Jurassic dolerite	Jurassic dolerite	Knocklofty sandstone and shale
Soils	Woodstock assoc.	Brickendon assoc.	Brumby assoc.	Canola assoc.	Nile assoc.	Brumby assoc.	Woodstock assoc.	Eastfield assoc.	Eastfield assoc.	Blessington assoc.
Slope	Flat to undulating 0-10%	Flat to gently undulating 0-5%	Flat to gently undulating 0-3%	Flat to gently undulating 0-3%	Flat to gently undulating 0-3%	Flat to gently undulating 0-3%	Flat to undulating 0-10%	Gentle to moderate 5-40%	Gentle to steep 10-60%	Gentle to moderate 5-40%
Limitations	- Stoniness - Soils	- Stoniness - Soils - Seasonal wetness	- Soils - Sodicity - Seasonal wetness	- Flooding - Sodicity - Wetness	- Soils	- Soils - Sodicity - Seasonal wetness	- Stoniness - Soils	- Stoniness - Rock outcrops - Gradient	- Rock outcrops - Gradient - Altitude	- Erosion - Rock outcrops - Climate
Land Capability Class	4,5	4	4,5	4,5	4	4	4,5	5,6	5,6,7	5,6

Figure 11. Stylised south-west cross-section from west of Nile to Blessington area.



Landform	Rolling to steep land	Rolling to steep land	Low river terrace (Brumby surface)	Recent flood plain	Low river terrace (Brumby surface)	Rolling dunes of low relief	High river terrace (Brickendon surface)	Sinuous drainage lines	Undulating gradients often below Woodstock surface	High level erosion surface (Woodstock surface)
Geology	Jurassic dolerite	Permian tillite	Quaternary alluvium	Quaternary alluvium (silts and clays)	Quaternary alluvium	Windblown sand	Tertiary clays with Quartz gravels	Quaternary alluvium (silts and clays)	Tertiary clays	Tertiary clays
Soils	Eastfield assoc.	Miller assoc.	Brumby assoc.	Canola assoc.	Brumby assoc.	Panshanger assoc.	Brickendon assoc.	Kinburn asssoc.	Cressy assoc.	Woodstock assoc.
Slope	Gentle to moderate 5-40%	Undulating to steep 10-60%	Flat to gently undulating 0-3%	Flat to gently undulating 0-3%	Flat to gently undulating 0-3%	Gently undulating to rolling 3-20%	Flat to gently undulating 0-5%	Flat to sloping 0-5%	Gently undulating to undulating 3-10%	Flat to undulating 0-10%
Limitations	- Stoniness - Rock outcrops - Gradient	- Soils - Stoniness	- Soils - Sodicity - Seasonal wetness	- Flooding - Sodicity - Wetness	- Soils - Sodicity - Seasonal wetness	- Soils - Erosion	- Stoniness - Soils - Seasonal wetness	- Wetness	- Drainage soils	- Stoniness - Soils
Land capability class	5,6	4,5,6	4,5	4,5	4,5	4,5	4	4	3	4,5,6

Figure 12. Stylised south-north cross-section from Little Billop to west of Longford.



Landform	High level plateau	Escarpments & steep hills	Mid-lower slopes of escarp-ments	Rolling & steep foothills	Rolling to very steep hillslopes	Alluvial fans	Rolling to steep slopes	Rolling hills	Rolling to steep hills	Rolling to undulating rises	Rolling to undulating rises	Lower river terrace
Geology	Dolerite	Dolerite Tallus	Permian Mud-stone	Permian Tillite	Cambrian & precambian volcanics	Alluvium	Knocklofty Sandstone & shale	Dolerite	Dolerite	Tertiary basalt	Tertiary basalt	Quaternary alluvium
Soils	Peats	Eastfield & assoc. soils	Quamby	Miller	M2	Glen	Blessington assoc.	MEa Eastfield	Bloomfield	Breadalbane	Campbell Town	Canola
Slope	<5%	>45%	10-56%	10-56%	10-56%	5-32%	5-40%	18-56%	10-56%	5-32%	5-32%	0-3%
Limitation	-climate -drainage	-climate -soils -rock outcrops	-erosion -soils	-erosion -soils	-erosion -soils	-drainage -soils	-erosion -rock outcrops -climate	-rock outcrops -soils -erosion	-soils -erosion	-soils -climate	-soils -climate	-flooding -sodicity -wetness
Land Capability Class	E,6,7	E,6,7	E,5,6	4,5	5,6	4,5	5,6	4,5,6,7	4,5,6	4,5	4,5	4,5

Figure 13. Stylised west-east cross-section from Macquarie Tier to Campbell Town

The Cressy soils and associated Kinburn soils are classified as Ferrosols and Dermosols by the Isbell system (lateritic podzolics by Stace). The soils of the associations are somewhat variable in appearance but the majority are gradational reddish brown to grey brown friable clays with a reasonable developed structure. Kinburn soils, due to their lower position in the landscape, are normally poorly drained. Both profiles may contain variable amounts of ironstone shale or gravels. Cressy soils are found at the margins of the Woodstock terrace and are some of the best soils in the area. The Cressy soils have been favourably compared to other ferrosols of the north-west areas but are less resilient and more susceptible to structural decline if over cultivated. These soils have been used intensively in post war periods and many have been significantly degraded as a result. Extensive areas of Cressy soils are to be found south and west of Cressy, with Kinburn soils in intervening drainage lines.

To the north of Evandale and around White Hills is an area defined by Nicolls as being Relbia Association. This association appears to contain an even wider range of soil types than is reasonable for a reconnaissance soil map. Relbia association soils occur on a range of terrace levels and boulders of massive laterite may occur at any level. Soils similar to the Brumby, Woodstock and Panshanger soils have all been mapped within the Relbia Association. At higher altitudes within the association soils resembling the Cressy soils have been identified. Landslips are a feature of Relbia soils on many steeper valley sides.

In some southern and eastern parts of the survey area remnants of basalt lava flows occur. The soils that have developed here, Breadalbane and Campbell Town soils, tend to be more fertile and less acidic than elsewhere and have been generally classified as Dermosols, Chromosols or Ferrosols (brown and red earths by Stace). However, these soils are generally considered to be inferior to Ferrosols identified in more northern parts of the State and also have severe climatic limitations for agricultural development. Examples of these soil types are most prevalent around Campbell Town in the south-east of the survey area.

Stylised cross sections through the survey area are presented as Figs 11, 12 and 13. While providing an incite to the landforms of the survey area the diagrams also indicate the relationships between geology, soil, landform and capability.

5.6 Vegetation

The vegetation of the study area has been described by Kirkpatrick and Dickinson (1984) and a summary only is presented here.

Remnant vegetation is confined to upland areas of the Central Plateau and Great Western Tiers in the south-east and the foot hills of Ben Lomond in the north-west. Much of this land is owned or leased by Forestry Tasmania or private forestry concerns and is farmed for woodchips and other timber products.

Other small areas of forest occur on privately owned land in lower lying areas, particularly where the soils are more acid and nutrient poor. Such areas occur often on Woodstock soils around Epping Forest and Conara.

Kirkpatrick and Dickinson identify the dominant tree species as *E. viminalis, E. ovata* (Black or Swamp Gum), *E. pauciflora and E. amygdalina.* The forests are relatively open in nature with an understorey of shrubs, tussock or pasture. At higher elevations dry sclerophyll forest continues to dominate but with *E. delagatensis. E. dalrympeana* and *E. rodwayi* taking dominance. Small areas of wet sclerophyll forest with *E. obliqua* also occur.

5.7 Land Use

The majority of lowland areas have been extensively cleared for agriculture and land use is dominated by grazing for sheep, fat lamb production and cattle on improved pastures. Natural pasture remains on hilly areas or areas of shallow or stony soils or as ground cover in some open forest areas. These latter areas are used for rough grazing with very low stocking rates despite often having a very high proportion of surface stone or rock. Timber extraction, either for firewood or on a more commercial basis, is an additional enterprise in some of these areas. Cereal cropping is undertaken on most properties on an occasional basis in rotation with pasture or a legume. Other agricultural activities include deer and goat farming and the cropping of oats turnips and peas as fodder crops with additional cash cropping of oats, wheat, malting barley, peas and triticale on a regular basis.

Within the Cressy-Longford area irrigation water is available from hydro electric supplies. This water has been channelled through a number of open ditches to many areas north of Cressy and west of Longford (see also Fig. 6. for irrigation scheme boundary). This reliable source of water has led to many farmers using their land more intensively, particularly where Cressy soils occur, and the area has seen increased production of potatoes poppies, peas, beans and a wide range of horticultural crops. The impact of these activities on the various soil types is cause for concern as little is known as to how the soils will respond to this more intensive cultivation. In other areas, irrigation water is being pumped straight from rivers and applied to duplex soils. Chilvers (*pers. comm.)* has expressed much concern regarding the application of irrigation to duplex soils due to the drainage and sodicity problems often associated with them. Top level management is required to prevent degradation of these soils under irrigation.

Also, the approach in the past has been to transfer farming systems from other areas of the State which have quite different soils to these generally more fragile areas. While such techniques may have been appropriate for soils like the Ferrososls they are often inappropriate for the Chromosols and Kurosols soils found within the South Esk survey area with the result that soil degradation has occurred. As general farmer and community awareness increases many of these techniques are being replaced by more suitable ones.

6. SOIL MANAGEMENT OPTIONS FOR SUSTAINABLE AGRICULTURE

by Bill Chilvers, Soil Management Officer, DPIF

Occurring within the survey area are a wide range of soil types the distribution and complexity of which are beyond the focus of this report. However, each soil type has different properties and consequently is suitable for different forms of land use. Also each soil type has different management requirements if it is to be used in a sustainable manner and without degradation. Fortunately it is possible to identify each soil type in the area with one of the soil management groups listed below. The following information is provided to assist farmers with the management of these soils but further information should be sort from Chilvers (1996).

6.1 Soil Management Groups

Black cracking clay soils

The major characteristic of these soils is their self mulching ability (the formation of a surface tilth comprising 0.5-1.0 cm aggregates created by repeated cycles of shrink/swell activity). The key to long term successful management lies in promoting and using the self mulch seedbed rather than forcing the seedbed by intensive tillage. Tillage and stocking at high moisture contents on these soils rapidly destroys the self mulching characteristic and forms clods with very high soil strength. Stocking of winter forage crops, most commonly oats, is highly detrimental to the structure of these soils. Growing a dryland cereal in between years of irrigated crops will promote deep cracking and self mulching structural rejuvenation.

These soils often occur on current flood plains and are often difficult to work being either too wet or too dry. Drainage is critical in avoiding wet tillage operations. Install broad, shallow surface drains that use the topography by linking hollows and following drainage lines. Alluvial black cracking clays may be suited to mole channels and subsurface drainage where cropping is more intensive.

Cressy Clay Loams and Kinburn Association Soils

These soils are less well drained and structurally less resilient than the Krasnozem soils of the NW Coast. Structural decline, seen as clods and hardpans, is a major challenge as cropping becomes more intensive. Wet tillage, stocking winter forage crops and wet harvests are key things to avoid. Ensure all tillage operations are carried out at the friable moisture content.

These soils, particularly the Kinburn occurring along drainage lines, are suitable for subsurface and mole drainage. However, most drainage can be achieved with surface drains. Some Cressy soils have highly permeable gravel layers at depth, making deep surface ditches very effective.

Duplex soils (sandy loam over clay)

These are the most common soils in the Midlands region and comprise soils with an abrupt texture change - sand over clay loam or sandy loam over clay for example. Paddock variability, wind erosion, waterlogging in the hollows and decline of organic matter levels are the major challenges of these soils under cropping. Direct drilling and/or shallow topworking with tines and discs are the best management options. The chisel plough and s-tine are good implements. Mouldboard plough only where there is no risk of wind erosion. Do not plough shallow duplex soils. Gradual mixing of subsoil with the topsoil has been a common practice to deepen topsoils. However, the subsoil is of very low fertility, highly acidic, and structurally unstable which dramatically lowers the quality of your topsoil if mixed with it. The weak structure of duplex soils is easily destroyed by overworking. Powered implements should be avoided if possible, or used shallowly with great care. Deep ripping into the pale subsoil layer or underlying clay is not recommended. The unstable structure and poor fertility of these layers mean benefits are very short lived and in some cases tunnel erosion can be initiated.

Drainage options are very limited for these soils. Broad, shallow surface drains that link hollows and use the topography will be most effective. Think carefully about planting layout to promote drainage down slope. Do not plant irrigated crops, especially potatoes, through these hollows. Subsurface drains following hollows or drainage lines are an option where cropping is more intensive. Mole drains are not appropriate and carry a high risk of failure.

Deep sands

The prevention of wind erosion is the key to managing these soils under cropping. Never mouldboard plough sandy soils. Direct drilling is an essential tool for sustainable cropping of these soils. Establish shelter belts and use cover crops wherever possible. Shallow topworking with tines and discs, ensuring at least a 30% cover of coarse organic material remains on the surface, should be the most intensive tillage these soils receive.

7. SOIL SALINITY IN THE SOUTH ESK MAP SHEET

by Julie Finnigan Salinity Officer, DPIF

7.1 Introduction

The occurrence of salt affected land in Tasmania is not as widespread as in many mainland states but it is of significant concern to some farmers including those in parts of the South Esk area. Soil salinity is a serious form of land degradation affecting millions of hectares of agricultural land Australia wide and about 20 000 ha across Tasmania (Grice 1995, Working Party on Dryland Salting in Tasmania 1982).

Naturally occurring saline soils are located in several coastal areas of the state. However, man induced salinity, often referred to as secondary salinity, dominates in inland agricultural areas of Tasmania. This form of salinity is widely considered a direct result of land clearing which leads to reduced water uptake by vegetation and increased recharge to the groundwater system, causing a rise of possibly saline groundwater levels. Within the South Esk survey area there are many examples of soil salinity including Chintah Rd near the junction with Powranna Rd, Maitland Rd north-west of Cressy, Cressy Rd at Woodlands Corner, and Macquarie Rd near the junction with Delmont Rd. While these areas are often too small to map at 1:100 000 scale it is appropriate to include some discussion on this important issue here.

7.1.1 Causes of Salinity

Salts are a natural component of many soils and result from the physical and chemical weathering of rocks and sediments, and also through deposition by wind and in rain. The salts most commonly found affecting soils in Tasmania are sodium chloride (common table salt), magnesium chloride and calcium chloride (Hoare pers.comm.). These salts have accumulated in our soils over a great period of time mainly through deposition in rainfall (Walker 1995).

Prior to European settlement, the occurrence of salt in the ground had reached a point of stable equilibrium with the natural environment. Since then however, widespread land clearing and the introduction of agricultural practices has created major changes to our delicate ecosystem. Such changes have resulted in significant alterations to the natural water balance, leading to noticeable rises in groundwater levels. As groundwater rises it has the potential to mobilise and carry soluble salts present in the soil profile towards the ground surface. Once rising groundwater reaches a critical depth of approximately 3 meters, capillary rise and evaporation can occur, leading to the concentration of salts at the soil surface. This concentration of salts affects the growth and productivity of plants, and often leads to erosion and other serious forms of land degradation through the dispersive effects of the salt.

7.1.2 The impact of Irrigation Water

While scattered areas of saline land have been identified throughout much of the South Esk survey area they are typically isolated occurrences and of very limited extent. With the increased use of irrigation water, either by direct pumping from the major river systems or within the Cressy-Longford Irrigation Scheme, there exists increased potential for recharge to the groundwater system by excess irrigation water. Areas using flood irrigation have the greatest recharge potential and thus are possibly at greatest from salinity. However, any area where irrigation has become a normal part of farming practice is at risk (Walker 1995).

The Cressy-Longford Irrigation Scheme itself covers 10,200 hectares of agricultural land located in the north-west of the South Esk map sheet. Salinity assessment within this scheme has identified that 12.1% of the total scheme area has soils affected by salinity within a depth of 6 m of the ground surface (Finnigan 1995). Occurrences of surface soil salinity do occur but are generally small in area, and typically located in drainage lines and topographic lows.

Where mid slope seepages occur, for example where the flow of groundwater is obstructed and diverted by an impermeable subsurface layer, evaporation can lead to a surface build-up of salt. Soil types identified as most prone to this problem include the Brumby soils on the lower river terraces, while other areas of salinity have also been identified on Newham and Brickendon soils. Modern flood plains tend to exhibit variable salinity levels due to periodical flushing of salts from the soils during times of flood. According to Nulsen (1995), careful management of our soils, appropriate drainage and efficient irrigation practices are essential to maintain groundwater levels, and therefore salt stored in the soil profile, at a safe depth (below 3 m).

Photo 5. The occurrence of salt in drainage lines is evident in some parts of the survey area, Macquarie Road. (Grid Ref. E 515800, N 5370900)

Within the Cressy-Longford Scheme the majority of soils identified as saline (based on apparent conductivity levels) fall within the Low-Moderate category, ranging between 1 and 1.5 dS/m. Thirty percent of soils are classed as High, falling between 1.5 and 2.0 dS/m, and less than 1% of soils are classed as Severe, possessing conductivity levels in excess of 2.0 dS/m. For comparative purposes, sea water has a conductivity level of 54.7 dS/m. Soils moderately affected by salinity may not show any surface evidence, but may produce significantly reduced yields.

Areas of surface salting are easily identified by the presence of salt tolerant 'indicator species'. In areas of Low to Moderate soil salinity, yellowing of foliage, tree decline and reductions in plant growth and vigour (most noticeable under cropping conditions) are common. In areas of High soil salinity the presence of Buck's Horn Plantain (*Plantago coronopus*) and Sea Barley Grass (*Hordeum marinum*) are most common. Coastal Sand Spurrey (*Spergularia media*), Australian Salt Grass and Annual Beard Grass are also known to occur. In areas of Severe salting, Water Buttons (*Cotula coronopifolia*) are commonly found, combined with the presence of bare patches of soil showing dampness in winter and crusting in summer.

The occurrence of salinity in other areas of the South Esk Map Sheet appear to follow similar patterns and processes to those discussed in the Cressy/Longford Irrigation Scheme. Visible evidence of salting can be seen along a number of sections of the Midland Highway, and further west in the Macquarie Settlement. These saline areas were evident more than 50 years ago, occurring typically as dryland salinity. In more recent years however, small scale irrigation has been introduced to these areas, resulting in noticeable minor increases in the extent and severity of salinity. Saline stream flow has also been identified north of Evandale in the tributaries of Rose Rivulet. As well, many dams within the Cressy-Longford Irrigation Scheme have recorded quite high conductivity levels (up to 18 dS/m), although this may vary significantly according to seasonal fluctuations.

The Resource Assessment Branch of the Department of Primary Industry and Fisheries is currently conducting soil and water salinity studies in various parts of the State including the Cressy-Longford area and Northern Midlands. This assessment work has provided us with a good general understanding of the salinity levels and processes occurring within the study areas. However, it has also highlighted what we don't know, and the areas in which future research and monitoring should be directed. Given the relatively short period of assessment it is very difficult to determine trends in the extent and severity of salinity. It is possible that with increased irrigation and little thought behind adequate drainage or appropriate irrigation scheduling, that salinity problems could increase.

7.1.3 Management of Salinity

Australian research into salinity first began in the 1950's, and has since covered all areas of assessment and management at both local and national scales (Ockerby 1995). As a result of this work, the implementation of management practices in select mainland areas has now enabled the productive use of once unproductive saline land.
There are many techniques and management practices that can be applied to help control and improve salt affected soils and water. Firstly, discharge areas displaying the symptoms of high salt levels should be fenced off from all stock, or at least

stocked at much lighter rates. This helps to minimise the impact of stress on any existing plant cover, and reduces the levels of soil compaction which prevents the successful establishment and growth of plants. Remnant vegetation stands should be maintained and, where possible, deep rooted trees and shrubs planted in strategic mid and upper slope areas. This tree cover ultimately helps to reduce groundwater recharge by intercepting and utilising rainfall before it can access the groundwater. Tree establishment also provides other benefits such as shelter for stock and minimising the impact of wind erosion.

Sowing deep rooted perennial pastures and high water using winter crops in mid and upper slope positions also helps to utilise rainfall and decrease accessions to the groundwater. Recommended perennial pastures include Cocksfoot (*Dactylis glomerata*), Phalaris (*Phalaris aquatica*) and Lucerne (*Medicago sativa*). Oats, Barley and Tama Rye Grass are recommended winter crops which are high water using. In highly saline discharge areas salt tolerant grasses and clovers can also be planted. Tall Wheat Grass (*Agropyron elongatum*) and Puccinellia (*Puccinellia ciliata*) are suited to areas of severe salinity, and Tall Fescue (*Festuca arundinacea*) and Strawberry Clover (*Trifolium fragiferum*), are well suited to areas of moderate salinity.

The installation of appropriate drainage is essential in order to divert or remove excess water from waterlogged sites. Poorly drained soils are usually less productive due to decreases in oxygen, nitrogen and other soluble plant foods. The accumulation of salts in the soil surface compounds this problem. Adequate drainage can therefore alleviate this problem and help to leach salts from the soil surface. Extended fallow periods should also be avoided if possible. With lack of vegetative ground cover, groundwater accession is increased and higher levels of evaporation occur resulting in increased levels of salinity. Once again the need for accurate irrigation scheduling is essential to the successful management of salinity, combined with local knowledge of groundwater conditions on your property. Sprinkler irrigation is far less wasteful of water than flood irrigation and it should be recognised that some soils are just not suited to irrigation.

Although these management options have been trialed and proven beneficial in various states on the mainland, little management has yet been applied in Tasmania. Essentially the reason for this is that we still need to know much more about the processes controlling salinity at local, catchment and regional scales before successful management practices can be applied. The Department of Primary Industry and Fisheries, jointly funded by the National Landcare Program, is continuing with soil and water salinity assessment and monitoring in Tasmania with the aim of improving our knowledge of the processes that control the spread of salinity. Future research, combined with improved community education and participation, will hopefully increase the awareness of farmers and the public in general to this issue and help prevent further degradation of our the soils by salt.

8. LAND CAPABILITY CLASSES ON THE SOUTH ESK MAP

The following sections of this report describe the different classes of land that have been identified during the course of the survey. General information on the nature of the land, soil type and geology are given together with an assessment of the major limiting factor and any other information that is considered relevant. Additional information, including a summary of land capability sites recorded, is presented in the various appendices.

In undertaking the field mapping considerable reliance has been placed on the available soil information and location of soil boundaries. This applies particularly to the southern half of the map where far fewer observation sites have been recorded as is indicated by Fig. 2 (page 9). It should be noted that soils have been mapped as associations (ie. a complex of more than one soil type) but map units have frequently been considered to be uniform when evaluated for land capability.

Throughout the text references are made to subclass codes. While sub-classes do not appear on the map they are used in the text to give the reader further information relating to the nature of limitations in some areas. Also, for each class of land a simple diagram is presented indicating the distribution of that land class across the map together with the hectares each occupies. These figures include areas of complex map units. When determining the extent of a particular land class it should be remembered that these complexes represent a ratio of the two land classes identified in the range 60-40 to 50-50 (ie Class 4+5 represents an area of 50-60% Class 4 land plus 40-50% Class 5 land).

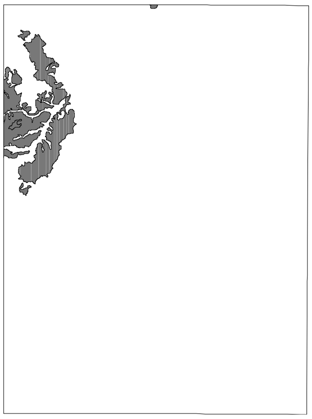
Table 1, presented at the beginning of this report, summarises the extent of each of the land classes identified within the survey area.

8.1 CLASS 1 AND 2 LAND

No Class 1 and 2 land has been identified in the South Esk survey area. Poor soil conditions and low fertility, moderate to high erosion risk and areas of undulating to steep terrain restrict land to Class 3 and below.

8.2 CLASS 3 LAND

Class 3 8 663 ha



Class 3 Land on Unconsolidated Tertiary Sediments

Areas of Class 3 land on unconsolidated sediments are confined to north-western parts of the survey area. It occurs on gently inclined erosion surfaces west of the Lake and South Esk Rivers, around Armstrongs Lane, Bishopsbourne Road, Saundridge Road, Green Rises Road and generally adjacent to the Cressy Main Road. A small area of Class 3 land is identified near White Hills. Class 3 land represents the best land to be found on the South Esk map sheet and is suitable for a more intensive cropping cycle than other land in the area.

Class 3 land is associated with Cressy Shaley Clay Loams, except at White Hills where it is found on some soils of the Relbia Association. Topography is typically very gently sloping to undulating and often associated with eroded remnants of the Woodstock Terrace to the west and north of Cressy. Slopes rarely exceed 10-12% and soil erosion is not a significant problem. The soils generally are slowly permeable and, where topography is almost level, open ditches will help remove surface water. The major limitation to agricultural production on Class 3 land within the South Esk area is the risk of soil structure decline resulting from over intensive use. If the land is over used the soils become prone to surface crusting, subsurface compaction and cloddy soils leading to poor seed bed conditions. Erosion can be a problem on these degraded soils on rare instances where gradients exceed about 18%. Rainfall in this area is around 700 mm p.a. or below and is at the limit for land to be considered Class 3. Overall, however, climate is not considered to be a major limiting factor for Class 3 land on the south Esk map.

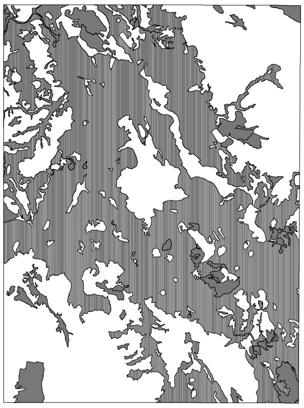
Historically many areas of Class 3 land have been subject to intensive land use and there is some evidence that degradation has occurred. The development of irrigation practices in the area has led to further intensification and significantly improved yields but also to increased risk of degradation. Careful management is still necessary to maintain soils in this capability class in the best condition. Compacted, cloddy soils are to be found in some areas and will require years of attention to return them to a Class 3 condition. Today, a wide range of crops are grown on this land, mostly under irrigation. Cereals, potatoes, poppies, peas plus small areas of other horticultural crops are grown in rotation with pasture.

Photo 6. Class 3 land. Cressy soils under irrigation at Green Rises Road (Grid Ref. E 504000, N 5386700)

Photo 7. Class 4 land on basaltic soils north of Campbell Town. (Grid Ref. E 539500, N 5360000)

8.3 CLASS 4 LAND

Class	4	117 320 ha
Class	4+5	5 063 ha
Class	5+4	2 170 ha



Class 4 land is the dominant land class found on the South Esk map. It is widespread through central areas where it occurs on the Tertiary sediments of the Launceston Basin. Limitations range from poor soil conditions to wetness and erosion. Besides the Tertiary sediments, Class 4 land can be found on a wide range of other parent materials including basalt, dolerite and alluvium.

Class 4 Land on Basalt

Scattered outcrops of basaltic lava occur in northern and eastern parts of the survey area. Specifically, Class 4 land on Basalt has been identified at Breadalbane near Launceston Airport, on Nile Road south of Nile; between Epping Forest and South Esk River; and extensive areas between Conara and Campbell Town.

Class 4 land on basalt is associated with deeper phases of the Campbell Town and Breadalbane soil associations, both of which have been described in detail by Doyle (1993). Soil depth is variable but a minimum depth of about 70 cm is considered necessary for land to be considered Class 4. Breadalbane soils often occur with outcrops of basalt and basalt floaters throughout the profile which affect ease of cultivation and crop root development.

Class 4 land on basalt occurs in gently undulating to undulating terrain with the basalt often forming the ridge crest. Gradients are normally in the range 0-15% but occasional steeper gradients do occur. In some areas minor landslips have occurred. Where excessive stoniness occurs (30-45% of the soil profile or land surface), or where the soil is shallow, a soil limitation (s) is identified. Where Campbell Town and Breadalbane soils occur in low lying depressions and severe or extensive mottling of the subsoil suggests periods of imperfect drainage, a wetness limitation (w) is identified and where they occur on gradients between 18-32% an erosion (e) limitation applies.

Class 4 on basalt near Campbell Town occurs in an area where rainfall may be as low as 550 mm and out of season frosts are common. This area is at the climatic limit of Class 4 land. However, the lack of soil depth and the general stony nature of the soil are still considered the prime limitations for agricultural use. Land use in the area is predominantly grazing for sheep and cattle with occasional crops of cereals. Small areas of irrigated crops or pasture may be found using water pumped directly from Elizabeth River.

Class 4 Land on Recent Alluvium

Recent alluvium occurs along many of the river valleys throughout the survey area. The main areas of Class 4 land on alluvium include upper parts of the Lake River valley on Connorville Road; Macquarie, Isis and Nile River valleys; and extensive areas of the South Esk flood plain. Scattered small areas are found in most other minor stream valleys and have also been mapped in some shallow basins amongst dolerite hills. Parts of these areas are subject to occasional flooding, the frequency, duration and timing of which have important implications for the ability of that land to grow crops (short-term, mid growing season flooding less likely to be damaging to a crop than early or late growing season inundation). These areas would generally be identified as Class 4w land if mapped at subclass level.

The soils developed on recent alluvium, normally mapped as the Canola Association and dominated by the Canola soil series, have significant management problems. Typically the soils are very sticky when wet and dry almost overnight to a very hard consistence, thereby providing only a narrow window when they are at a suitable moisture content for cultivation. Cultivation outside this window can lead to the development of subsoil compaction and smearing, and a degraded or cloddy topsoil structure. As well, the soils may exhibit a gilgai micro-relief (a series of small basin-like depressions and intervening rises), a result of the marked shrink-swell properties of the clay minerals, and which can cause additionasl cultivation problems. These soils may also be sodic in some areas and prone to dispersion leading to surface crusting and gullying even on gentle gradients. Due to their low position in the landscape, proximity to creeks and to groundwater tables some Canola soils are prone to salinity. When mapped at subclass level these areas would be Class 4s.

Cropping of this Class 4 land is confined to cereal and forage crops. Occasional paddocks of peas or poppies are grown but there is a significant risk of crop loss by flooding or poor soil drainage. Surface drains would greatly assist in the removal of surface water. Subsurface hydraulic conductivity is likely to be low and subsurface drainage may have little impact or be expensive to implement. There is a significant risk of soil damage or crop loss on this land without very careful management.

Class 4 Land on Unconsolidated Tertiary Sediments.

Class 4 land on Unconsolidated Tertiary Sediments is the most extensive land type in the area on which agriculture occurs and is also the most varied with respect to soil type. Class 4 land on Tertiary sediments can be found throughout the central portion of the survey area where it occurs on level to gently inclined land of former river terraces and on steeper slopes separating the different terrace levels.

A feature common to most of the Class 4 land on these terraces is the duplex nature of the soil types. Duplex soils have an abrupt texture increase at some depth within the soil profile and this has important implications for water movement through the soil profile. Also, most duplex soils have a bleached A2 layer of variable thickness and depth between the organic rich A1 layer and the underlying, heavier B horizons. This layer is typically moderately acidic, has poor nutrient levels and often structural

Photo 8. Class 4w land on recent alluvium showing the effect of seasonal wetness.
(Grid Ref. E 514400, N 5404400)

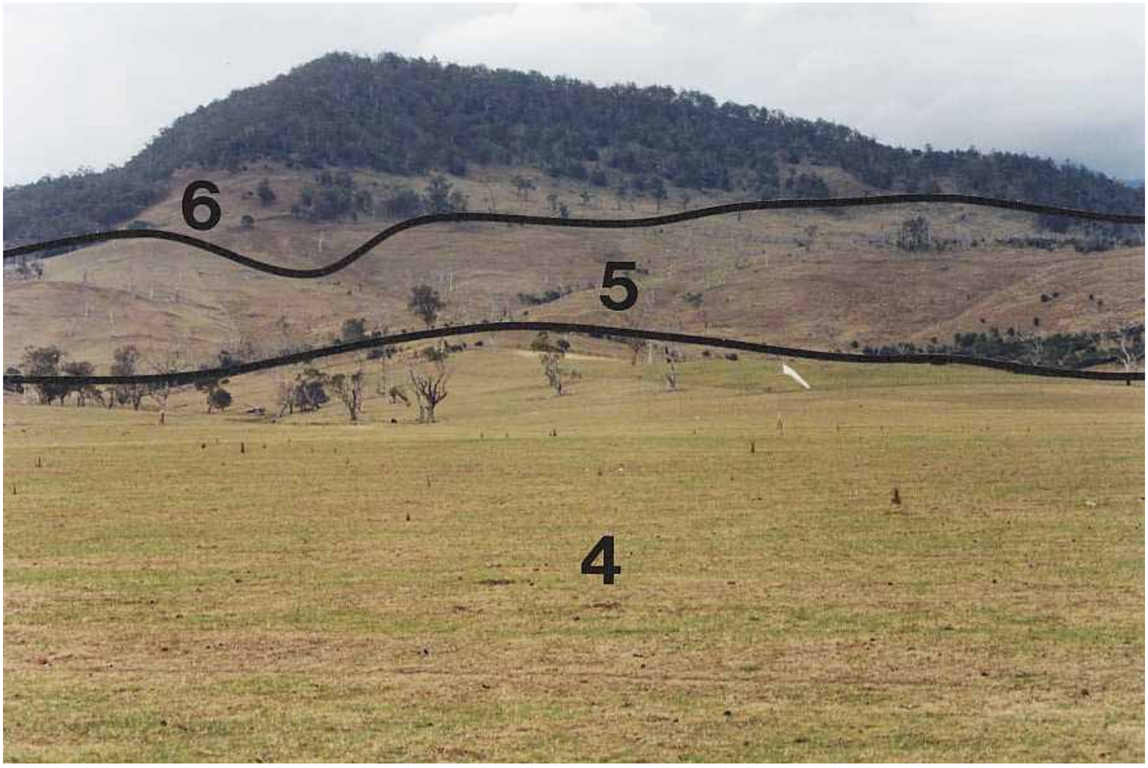


Photo 9. Class 4s land on Tertiary sediments with Class 5s and 6s on dolerite in the background.
(Grid Ref. E 508500, N 5368700)

problems. These soil characteristics in their own right restrict the land to capability Class 4s, if mapped at subclass level, while other land or soil characteristics, such as gradient, topsoil texture and stoniness, result in some land having a poorer classification or alternative limitation. While climatic considerations are important they are not as significant in this area as erosion, wetness or soil characteristics.

As mentioned above, the terrain forms a series of terraces which may merge almost imperceptibly or, more often, be separated by prominent steep terrace faces 5-10 metres high. The terraces themselves are level to gently undulating with gradients typically 5-10%. Steeper gradients may occur along terrace margins. Different terrace levels are most prominent to the east of the Midlands Highway, along the South Esk River, and at Evandale.

The upper terrace is known as the Woodstock surface and comprises the Woodstock soil association. Where Class 4 land occurs here it is limited by the duplex nature of the soil (which affects soil water movement) and the high proportion of ironstone gravels, which in some areas may be cemented into sheet laterite. These gravels are extremely abrasive on machinery, reduce the available water capacity of the soil and further limit productivity. Poor nutrient levels and low pH are also problems associated with these soils.

The second terrace level is known as the Brickendon surface. The soils are again duplex in nature and contain variable amounts of waterworn quartz gravels. Management issues are similar to land on the Woodstock terrace. In addition, some soils may also be slightly sodic and dispersive, prone to crusting and structural decline and therefore require particularly careful management. If mapped at subclass level such areas would be classified Class 4s. Occasionally, where the land forms minor depressions, wetness and perched water levels can occur above the clay B horizon resulting in poor conditions for crop root development. Where such land occurs it would be mapped as Class 4w at subclass level. In some instances top soils are particularly shallow and sandy and prone to erosion by wind. These would be classified as Class 4e at subclass level.

Class 4 land associated with Newham soils occurs on slopes between the Brickendon and the Brumby surfaces. The terrain typically forms gently undulating to rolling landforms, intersected by many natural drainage lines carrying run-off water from the terraces above. These drainage areas would be classified as 4w. Where appreciable amounts of windblown sand have accumulated, the land is would be identified as subclass 4e to indicate the risk of erosion. Elsewhere, the duplex nature of the Newham soils would generally limit their subclass capability to Class 4s.

In some western areas of the map sheet soils with prominently mottled subsoils, indicating significant periods of waterlogging, occur in depressions and drainage lines. If mapped at subclass level these areas would be considered Class 4w. These areas are often adjacent to Class 3 land but are slightly lower lying. Gradients are gentle, generally not exceeding 10% and the soils are typically of the Kinburn association.

The Brumby terrace is the lowest terrace level above the existing flood plain of the major rivers and streams. The topography is essentially level or very gently inclined although some areas may include dune remnants with Panshanger soils. The soils are relatively stone free but are often highly sodic. The duplex soils and the typically moderate to high sodicity encountered limit much of this land to Class 4s if mapped at subclass level. In addition, many parts of the Brumby terrace are often poorly drained or subject to occasional inundation and where such areas occur the land would be identified as Class 4w at subclass level.

In the north east of the survey area, particularly to the north and north-east of Evandale, Class 4 land has been mapped on a variety of terrace levels separate from others identified within the Launceston Basin. The topography of the area is deeply dissected with a range of gradients which can reach 30%. The soils contain ferruginous gravels and variable amounts of boulders or massive laterite. The land on which Relbia soils are identified would generally classified 4s if mapped at subclass level. On gradients of 10-20% rill and gully erosion can occur on exposed soil surfaces during the winter and early spring. These areas, which often exhibit signs of slumping and land slip, would be classified 4e at subclass level. In some areas the soils are imperfectly to poorly drained and a wetness (w) limitation would be identified if mapped to subclass level. Many soils in this area are associated with the Relbia Association.

Class 4 land on Tertiary sediments has also been identified associated with a range of other more minor soil types including Bicton and Macquarie associations. Here, limitations relate primarily to stoniness or rockiness, low soil pH and low nutrient availability. The associations include duplex soils with ferruginous gravels and weak sodicity (ie prone to dispersion).

Land use is dominated by grazing of sheep and cattle with occasional crops of cereals, In some areas the land is irrigated and a wider range of crops are grown including potatoes, peas and other horticultural crops. In many instances the use of irrigation water on these duplex soils is resulting in waterlogging as a direct result of poor irrigation practices.

Class 4 Land on Windblown Sand

Class 4 land on windblown sand is associated with soils of the Panshanger association and can be found in small areas throughout much of the Launceston Basin, often associated with other soil types. The sands have been blown from river valleys and depressions and deposited as sand sheets and dune systems. The soils are low in nutrients, have a low water holding capacity and are prone to drought. They do have some potential for limited cropping activities but great care is needed to protect these soils from erosion by wind and water. Land with Panshanger sands would be classified as Class 4e at subclass level, even on relatively gentle gradients where wind is the prime erosion agent.

Photo 10. Class 4e land. Landslips - a feature of Relbia Association soils White Hills Road. (Grid Ref. E 522250, N 5400500)

Photo 11. Class 4e land. Panshanger sands prone to severe wind erosion. (Grid Ref. E 533500, N 5379400)

Class 4 Land on Sandstones, Mudstones and Tillites

Class 4 land on sandstones, mudstones, and tillites is found in small scattered areas across the survey area. Class 4 land on Permian sandstone occurs in association with Blessington soils found in the foothills of the Great Western Tiers and around York Lagoons. The topography is typically rolling to moderately steep (10-32%) and while steeper country does occur it is generally of a lower class. With rainfall approaching 800 mm, and the fragile nature of the soils, areas of land on steeper gradients are particularly susceptible to erosion and great care is needed to prevent degradation.

Small areas of Class 4 land are identified on Permian mudstones and have been mapped in south-western parts of the survey area where gradients are generally 10-18%. At subclass level these areas would be mapped as Class 4s. The soils are of the Quamby association and are typically shallow, acidic and often sodic. On gentler gradients, poor internal drainage and the footslope location would lead to a 4w classification at subclass level. The moderate gradients and poor physical condition of these soils also put them at risk of erosion if not protected by vegetation.

Other Class 4 land on Permian mudstones and siliceous metamorphic rocks is found in depressions and small basins within the dolerite hill country. North of Perth a basin comprising Arnon soils on Permian mudstones crosses the Midlands Highway from north-west to south-east. Such basins receive much run-off from the surrounding dolerite hills and remain wet for much of the year resulting in poorly and imperfectly drained soils with only limited capability for cropping. Even better drained land is limited by shallow, stony soils suitable for only occasional cropping. At subclass level these areas would be classified as 4ws.

Complexes.

Two complexes (Class 4+5 and Class 5+4) that include Class 4 land have been identified. Class 5+4 is described under Section 6.4.

Class 4+5 land is identified where both Class 4 and Class 5 land occur together and the pattern is such that neither class is mappable as an independent unit. Class 4 is the dominant land class being up to 60% of the unit. Class 4+5 land is identified to the east of Mt Arnon in the north west, south of Dicks Banks, east of the junction of Deddington and Nile roads and just north of Campbell Town. They typically represent areas where rock outcrop and shallow soils occur in association with deeper soils. Rock outcrops are usually of basalt or dolerite protruding through Unconsolidated Tertiary Sediments. In some instances the distribution of Class 5 land may be such that cultivation is impractical throughout the unit.

Other Class 4 Land

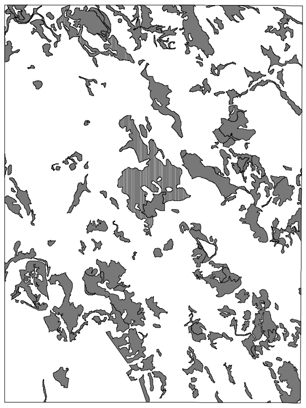
Scattered areas of Class 4 land have been identified on Eastfield soils which have developed on dolerite. Stoniness or rock outcrop are the main limiting factors (Class 4s at subclass level) in such areas. Also, the topography tends to be irregular with minor areas of what would be 4w land at subclass level, associated Canola soils in narrow stream lines which are often too small to map at this scale.

Scattered throughout the survey area are a number of lagoons some of which remain dry in most years while others may be inundated during the winter season. Where drainage has occurred or is considered a feasible option some of these lagoons have been classified as Class 4.

On some river terraces adjacent to the Nile River and associated with Nile soils, variable amounts of dolerite gravel and stones occur which can reach 40% of the soiul profile. Such high stone contents are very hard on machinery, as well as reducing moisture holding capacity and nutrient potential of the soil, and this land would be classified as Class 4s if mapped at subclass level.

8.4 CLASS 5 LAND

Class 5	34 282 ha
Class 4+5	5 063 ha
Class 5+4	2 170 ha
Class 5+6	8 908 ha
Class 6+5	68 ha



Scattered areas of Class 5 land have been identified throughout the survey area but tend to be more extensive in southern parts and in association with foothills and upland areas.

Class 5 Land on Tertiary Sediments

Class 5 land on Tertiary sediments is identified where stone and gravel contents exceed 45% of the soil or where shallow soils occur over sheet laterite. Many such areas are to be found along the Midland Highway but significant areas occur throughout the survey area. Many of these areas are associated with Woodstock or Brickendon soil types where the natural vegetation remains or has been partially cleared. Due to the high gravel content many areas have been disturbed for gravel extraction resulting in significant degradation of the upper soil horizons. In many cases little subsequent rehabilitation work has been attempted and these areas remain Class 5 where rehabilitation remains feasible but have been down graded elsewhere. Compared to similar land classified as Class 4, topsoil depths are usually significantly shallower and soil condition is generally poorer. The majority of this land would be mapped at 5s if mapped at subclass level. Some land has gradients exceeding 25% and, where soils are sandy, would be classified 5e at subclass level.

Photo 12. Nile soils are typically of capability Class 4s.(Mills Plains south of Nile) (Grid Ref. E 527700, N 5387700)

Photo 13. Class 4s and 5s land on Eastfield soils over dolerite. Main limitations are stoniness, soil depth and rock outcrop. (Grid Ref. E 540050, N 5404850)

Other areas of Class 5 land have been identified where steeper slopes occur (>18%) and there is evidence of landslip (Class 5e land at subclass level). Such areas are able to support good pasture but are inappropriate for cultivation and cropping which could accelerate the landslip processes. These areas occur in the north east where dissected terrain with Relbia Association soils are dominant.

Class 5 Land on Recent Alluvium

Parts of the major valley systems are identified as being prone to seasonal flooding. While this flooding is rarely severe, at least one major flood can be expected in most years, often during the early summer, and which can linger for several days. The risk of crop loss is considered to be severe in such areas and the land would be classified 5w at subclass level. In some areas, on the South Esk River south of Longford, embankments have been constructed to protect agricultural land from inundation with some degree of success.

Land is also classified 5 where the soils, usually of the Canola Association, are poorly drained and high groundwater levels persist, or the soil remains saturated, for at least part of the normal growing season. Evidence of such conditions is usually indicated by prominent mottling in the subsoil together with some topsoil mottling. The Canola soils are difficult to manage at the best of times, due to a short working window, and any conditions which further increase management problems or increase risk of soil damage or crop loss are likely to result in a Class 5 evaluation.

Class 5 Land on Dolerite

Dolerite rock type outcrops extensively throughout the survey area and particularly in association with the upland areas of the Great Western Tiers and the Ben Lomond Plateau. Class 5 land on dolerite is found on undulating to rolling terrain with gradients up to 56%. The soils are particularly shallow or contain a high proportion of dolerite rocks and stones (Eastfield and Deddington associations). In some areas dolerite outcrops may also be a common feature. Where stone content is of the order of 45-60%, or where rock outcrop is sufficient to severely limit or prohibit cultivation, the land is classified 5s at subclass level. In upland areas there may be little evidence of stone on the ground surface but the soils are often shallow or contain a high proportion of subsurface stone. Such land would also be classified 5s.

Class 5 Land on Basalt

Areas of Class 5 land on basalt have been identified in the vicinity of Campbell Town and along Nile Road. Shallow, stony soils and prominent rock outcrops are the man limitations to agricultural use and such areas correspond to areas of Breadalbane Soil Association. Rock outcrops are common along breaks in slope and, together with short steep slopes, would be considered Class 6e or 6s but are typically too small to be mapped as separate units. Such areas are usually included with areas of Class 5 or, where Class 6 land constitutes at least 40% of a map unit, mapped as complexes. Longer slopes with 25-32% gradients are classified as 5e if mapped at subclass level.

Complexes

Several complexes involving Class 5 land have been identified. Class 4+5 has been described earlier in Section 6.3, Class 6+5 land is described in Section 6.5.

Class 5+4 land occurs around Campbell Town and Dicks Banks in areas of gently undulating to rolling terrain with considerable outcrops of basalt or dolerite rock, or shallow soils, which severely limit the agricultural capability of the land. The pattern of rock out crop or shallow soils is such that 50-60% of the map unit is considered unsuitable for cultivation. Class 4 land occurring within this unit may be cultivated but it's extent will be limited and it's distribution patchy.

Class 5+6 land is typically identified where rock outcrop and very shallow soils of land Class 6 are widespread and amount to 40-50% of the map unit, separated by less stony ground or slightly deeper soils of land Class 5. Such areas predominantly occur on moderate to steep slopes in areas of dolerite hills. Pasture improvement and good grazing are available on areas of Class 5 but other areas offer very poor grazing potential.

A single area of Class 5+6 land is identified which is subject to frequent flooding and very poor soil drainage. It occurs on the South Esk River east of Epping Forest and includes significant areas of swampy ground of very limited grazing potential mixed with slightly higher, better drained land of significantly better quality.

Other Class 5 Land

Other Class 5 land has been identified on a range of soil types. Land associated with Bicton soils, along Isis Road, would be classified 5s at subclass level where they are shallow and/or stony, or 5w where they lie wet for substantial periods during the winter season. Land associated with Blessington soils would be subclass 5s where they are stony. At Blessington Class 5 land lies generally above 500 m and is considered to have limited cropping potential due to high frost risk. Such areas would be classified 5c at subclass level. At the foot of the Western Tiers alluvial fans occur with Glen Soil Association. These soils are duplex, poorly drained and contain significant, though variable, amounts of dolerite stone or gravel. These areas would generally be considered Class 5s at subclass level. At Tee Tree road in the north-east, other Class 5 land has been mapped where it is associated with Arnon soils and is particularly shallow and stony (subclass 5s) or occurs in depressions and lies wet for a significant period (subclass 5w).

Some lagoons, where drainage is impracticable and where the soils are not saturated or inundated other than for a few months over the winter period, are assessed as Class 5.

Photo 14. Class 5s land on Tertiary Sediments limited by stoniness and soil depth.
(Grid Ref. E 506125, N 5376725)

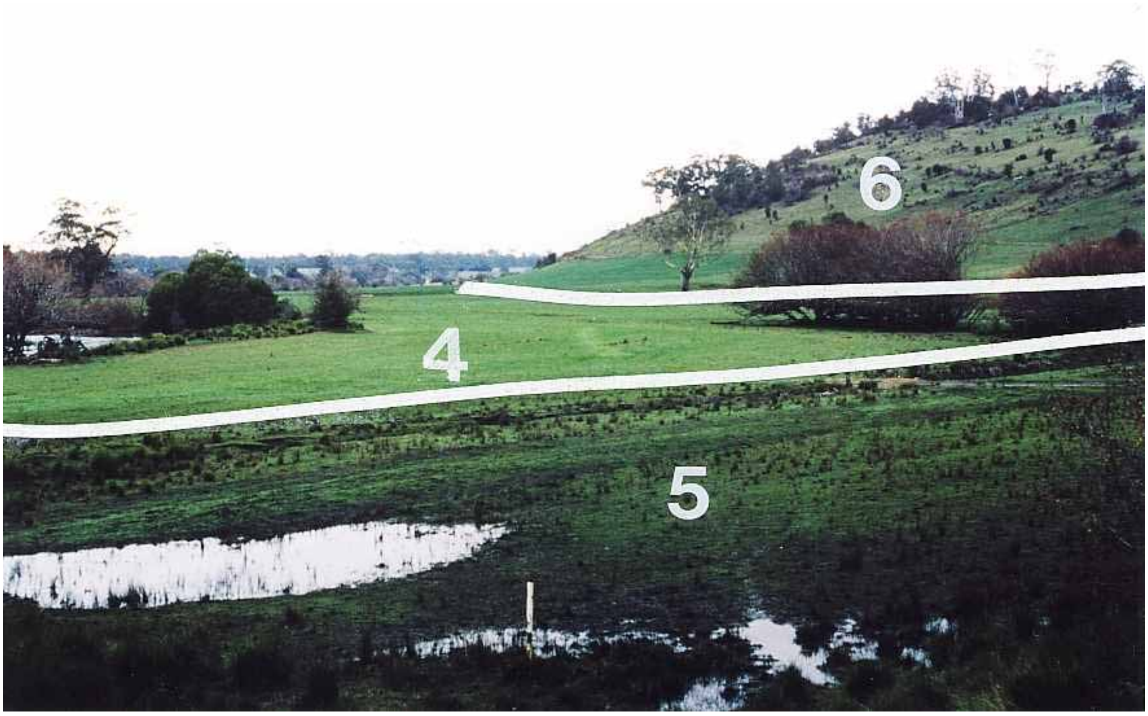
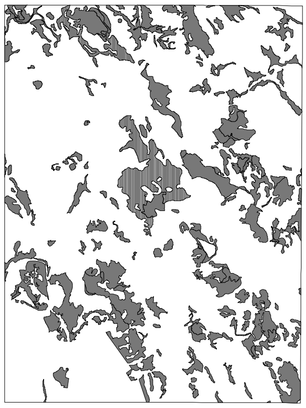


Photo 15. Poorly drained or frequently inundated Canola Association soils are capability Class 5w,
Meander River flood plain at Hadspen. (Grid Ref. E 504000, N 5404700)

8.5 CLASS 6 LAND

Class 6	34 171 ha
Class 5+6	8 908 ha
Class 6+5	68 ha
Class 6+7	1 478 ha



Areas of Class 6 land are associated predominantly with dolerite outcrops and foothills in the north-east and south-west parts of the survey area and around Hummocky Hills and Dicks Banks. Other small areas of Class 6 land occur scattered throughout the survey area.

Class 6 Land on Dolerite

Class 6 land on dolerite is mapped throughout the hill areas around The Retreat, Temple Bar, Coxs and Castle Hills in the north-east corner of the survey, Hummocky Hills and Dicks Banks in the centre and the Great Western Tiers, Jacobs Sugar Loaf and Macquarie Tier in southern and south-western parts. These areas include gentle to steep slopes (5->56%), plateau tops and dolerite scree slopes with Eastfield and Deddington soil associations. Much of the land supports a dense eucalypt woodland and land use is confined to rough, poor quality grazing due to excessive stoniness, boulders and rock outcrop. Improvement of native pastures in such areas is generally difficult or impossible and the land is assessed as Class 6. While stone cover presents a formidable limitation to the grazing potential of this land, the land is often used during winter periods to provide shelter and limited grazing.

On upper parts of the Western Tiers climate creates an additional limitation further limiting the grazing potential of this land and permitting only summer grazing activity. However many of these areas fall within the area identified as an exclusion area and therefore fall outside the scope of this report.

Complexes

Several complexes of Class 6 land have been identified. Class 5+6 has been described previously in Section 6.5.

Class 6+7 land is of limited extent and is confined to midslope areas of Jacobs Sugarloaf which contain a mixture of open forest and extensive scree slopes on steep to very step gradients. The unit has limited grazing potential and is lightly stocked with sheep.

Other Class 6 Land

Other Class 6 land is confined to areas of Brickendon and Woodstock soils which have undergone considerable disturbance where extraction of gravels has been undertaken. It is considered that rehabilitation of such areas will be exceedingly difficult and is beyond the capacity of most land owners. Much topsoil has been removed exposing the underlying massive, infertile clays. In such condition this land would be classified as Class 6s if mapped to subclass level.

Class 6 land associated with Canola Association or Lagoon soils are subject to frequent substantial inundation or high groundwater levels which pose a significant limitation to grazing activities. Such areas would be classified with a ‘w’ (wetness) limitation if mapped to subclass level. Class 6 land has also been identified in association with Blessington soils where they are particularly shallow and have frequent outcrops of sandstone. Such areas are to be found predominantly around the settlement of Blessington and would be Class 6s at subclass level.

8.6 CLASS 7 LAND

Class 7	4 365 ha
Class 6+7	1 478 ha

Much of the Class 7 land occurring within the South Esk map sheet falls within exclusion areas around the Great Western Tiers. Smaller scattered areas have been mapped as part of this survey around Macquarie Tier and O'Connors Peak in the south and Stringy Bark Tier in the north-east.

Class 7 land on Dolerite

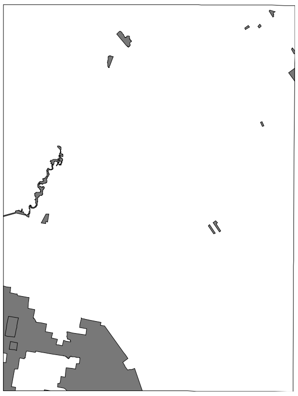
Class 7 land on dolerite has been mapped where scree slopes or excessive stoniness occur (subclass 7s) and the land has no agricultural value. Class 7 land is also identified where topographic gradients are very steep (>100 %) or where cliffs or rock outcrops are dominant and an ‘e’ (erosion) limitation would be allocated if mapped at subclass level. Many areas of Class 7 land are upland areas which currently support a very poor natural vegetation. These areas would be easily degraded if cleared or grazed, leading to extensive erosion of any shallow soils that do occur.

Photo 16. Class 6 land on Deddington Association soils, limited to very rough grazing, Blessington Road. (Grid Ref. E 527100, N 5404550)

Photo 17. Class 7 land unsuitable for agriculture, Pinchgut Hill, Deddington Road. (Grid Ref. E 5394425, N 5399075)

8.7 EXCLUSION AREAS

Exclusion areas 14 279 ha



The exclusion areas for the South Esk Survey area represent those areas other than Private Freehold and Leased Crown Land. The land tenure units which have been collectively termed Exclusion Areas by this study include; State Forests, Reserves, Conservation Areas, National Parks and Wildlife areas, Recreation Areas, Hydro Electric Commission areas and Commonwealth Administered areas.

The boundaries for these areas have been identified for the South Esk Survey by TASMAP in Sept 1983 and by Forestry Tasmania more recently (Feb 1996) in their digital land tenure coverage for the state. Where Forestry Tasmania has indicated a deletion or an addition DPIF has made the appropriate modifications to the land tenure class on the South Esk Land Tenure Index Series map by TASMAP.

9. DISCUSSION

During the course of the field work attempts have been made to try and improve the system and the end product presented to the public. Consideration has been given to increasing the number of limiting factors beyond the current four. This was to be achieved primarily through addition of a stoniness limitation (r), topographic limitation (t) and a flooding limitation (f). The potential exists for the addition of further limiting factors (eg salinity, wind erosion, water erosion). While the concept of identifying limitations to land use is very useful the practice has significantly increased the amount of time spent on field work and led to considerable useful discussion on how to identify different limitations (eg wetness versus flooding; wetness as a soil limitation). At this point in time, however, the sub class information available continues to be the standard four limitations. The additional limitations have been identified and recorded on the site cards but further work needs to be done to determine the usefulness of introducing additional subclass codes.

A valid criticism of the current system is that it is very subjective and is dependent on the interpretation of the surveyor who undertook the survey. This can make consistency a problem. To combat this, attempts have been made during this survey to identify core data sets which would be used in evaluations for a wide range of purposes and to identify class intervals for various land qualities applicable to different land class ratings. It is hoped that this approach will help to create a more quantifiable and uniformly applicable system. This approach is dependent on suitable research data being available for different soils and the relationships to productivity. However, there is a significant shortage of this type of information for Tasmanian soils and other relevant baseline information is often at the wrong scale or in a format which is currently difficult to incorporate into a GIS. For example, the best available digital geological data is at 1:250 000 scale - less than ideal for 1:100 000 land capability mapping. As a result, class intervals for a variety of land characteristics and qualities are being adapted from those used in other Australian States. The limitations and dangers of this approach are recognised but it is the best alternative currently available. Additional research could help provide more relevant information and make the system more Tasmanian oriented. It is hoped that the importance of gathering base line information in the future will not be underestimated as it allows a relatively cost effective way of producing a variety of end products depending on the requirements of the client, as well as providing more accurate interpretations for Tasmanian conditions rather than relying on data from other states.

Despite these many problems, land capability information remains a valuable interpretative tool for long term regional and State planning and the system can be applied relatively easily at a more detailed level for local and farm planning. There is already an increasing demand for this type of information from local government, landcare and catchment management groups. The system is being applied at farm level through the Whole Farm Planning workshops and Best Farm Practice program.

Assessment of land capability in districts with access to irrigation continues to be an area of concern. As no climate limitations have been identified within the Cressy-Longford irrigation district, other limitations being considered more dominant, the application of irrigation water will not substantially improve the capability classification of this land.

Potential users of the information should be aware of the problems of trying to use the information at a larger scale. Users should also be aware that additional information relating to sub classes identified in the survey area is available from DPIF's Prospect Office.

The authors welcome constructive comment and criticism of the report and accompanying map and, in the unlikely event that significant errors in classification be identified, they should be reported to the field officers concerned.

For any information regarding land capability maps and the land capability system contact should first be made with staff at your local DPIF office or with staff of the Resource Assessment Branch at the Department’s Prospect Office.

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APPENDICES

APPENDIX A. Example of Completed Land Capability Site Cards

Agricultural Land Capability Classification Form

Site No.: 232	Describer: R. Moreton	Date: 7-9-95
Grid Ref: E512125 N5387525		Soil Type: Brickendon assoc.
Land Cap. Class: (Circle Below)	Map No.: 5038	Map Name: Cressy
1 2 3 (4) 5 6 7 E	Altitude (m): 155	Slope Range (%): 1-3
Sub Class: (circle below) 4ec	Photos: Y (N)	Rainfall (mm): 655

(e) Erosion w Wetness s Soil (c) Climate f Flooding r Rockiness t Topographic o Other........	Stoniness: n/e	Erosion Type: wind
	Current Land Use: Grazing.	
	Location Note: Panshanger property, 500m south of Chintah and Panshanger road corner.	

General Note: 30 cm of windblown sand over Brickendon.

Agricultural Land Capability Classification Form

Site No.: SE 242	Describer: C. Grose	Date: 12-9-95
Grid Ref: E531150 N5383200		Soil Type: Panshanger
Land Cap. Class: (Circle Below)	Map No.: 5238	Map Name: Nile
1 2 3 (4) 5 6 7 E	Altitude (m): 200	Slope Range (%): 3-10
Sub Class: (circle below) 4e	Photos: Y (N)	Rainfall (mm): 605

(e) Erosion w Wetness s Soil c Climate f Flooding r Rockiness t Topographic o Other........	Stoniness: nil	Erosion Type: wind / rill
	Current Land Use: Grazing	
	Location Note: Junction of Fernhill road and Nile road.	

General Note: Prominent windblown dunes with Brumby soil types between.

APPENDIX B. Climatic Data for the South Esk Area

Four main Meteorological stations have been used to indicate climatic conditions within the South Esk Survey area, these are Launceston Airport, Cressy Research Station, Epping Forest and Campbell Town. The data in tables below have been used to generate the majority of the graphs and tables found in the climate section of this report.

Rainfall - Average Monthly (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Launceston Airport	42	40	39	56	63	61	79	78	62	62	51	53	687
Cressy	38	39	38	52	59	53	73	69	58	56	51	52	635
Epping Forest	37	33	35	50	48	47	59	59	48	52	45	53	566
Campbell Town	39	36	36	44	45	43	48	48	48	56	47	54	543

Temperature - Average Monthly (°C)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Launceston Airport max	23	23	21	17	14	11	11	12	14	16	19	21
Cressy max	24	24	21	18	14	12	11	12	14	17	19	22
Campbell Town max	23	24	23	19	15	12	11	13	15	18	21	23
Launceston Airport min	10	10	9	7	5	3	2	3	4	6	7	9
Cressy min	9	9	8	5	3	1	1	2	3	5	7	8
Campbell Town min	9	9	8	6	2	0	1	2	3	5	7	8

Monthly Evaporation (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Launceston Airport	214	182	143	81	47	27	31	47	78	118	156	198
Cressy	186	164	118	69	37	21	25	43	69	102	132	164
Campbell Town	189	155	109	66	34	21	31	47	69	105	126	177
Average Evaporation	196	167	123	72	39	23	29	46	72	108	138	180

Effective Rainfall and Moisture Deficit/Surplus Data collated for each station

Launceston Airport	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Effective rainfall required (mm) A	60	53	45	30	21	14	15	21	30	39	48	57
Average Rainfall received (mm) B	42	40	39	56	63	61	79	78	62	62	51	53
Moisture deficit/surplus (mm) C	(18)	(13)	(6)	26	42	47	64	57	33	23	3	(4)

Cressy	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Effective rainfall required (mm) A	54	50	39	27	18	12	13	19	27	36	43	50
Average Rainfall received (mm) B	38	39	38	52	59	53	73	69	58	56	51	52
Moisture deficit/surplus (mm) C	(17)	(11)	(1)	25	41	41	59	50	31	20	8	2

Campbell Town	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Effective rainfall required (mm) A	55	48	37	26	17	12	15	21	27	36	41	52
Average Rainfall received (mm) B	39	36	36	44	45	43	48	48	48	56	47	54
Moisture deficit/surplus (mm) C	(16)	(12)	(2)	17	29	31	33	27	21	19	6	2

Moisture deficit/surplus is calculated as follows A-B =C
*Note: deficit figures bracketed

Source: Australian Bureau of Meteorology, unpublished data, collated from correspondence, (1995).

APPENDIX C. Capability Classes for Sites within the South Esk Area

Site ID	Map Easting	Map Northing	Dominant Soil Association/Series/Type	Land Capability Class
SE1	509050	5379950	Eastfield	5
SE2	500500	5378750	Eastfield	6
SE3	501225	5373450	Brumby-Panshanger	4
SE4	502200	5372800	Canola	4
SE5	503000	5370000	MEa and M2	6
SE6	504200	5374550	Newham	4
SE7	504550	5375375	Brickendon	4
SE8	506750	5377200	Newham - Brickendon	4
SE9	508050	5374200	Canola	5
SE10	508650	5368850	Canola - Glen	4
SE11	505800	5355800	M1	7+E
SE12	508050	5356425	Quamby - Blessington	7
SE13	506700	5360225	Quamby - Blessington	5
SE14	505950	5367600	MEa	6
SE15	506075	5370925	Millers	5
SE16	510555	5377675	Brumby - Tara	4
SE17	514800	5376325	Newham	4
SE18	514325	5373800	Woodstock	5
SE19	519225	5365875	Macquarie-Panshanger	4
SE20	522500	5353250	Bicton	4
SE21	521125	5355175	Bicton	5
SE22	535550	5369500	Woodstock-Panshanger	4
SE23	532250	5371100	Panshanger(Woodstock)	4
SE24	527850	5373500	Woodstock (Panshanger)	4
SE25	528250	5372775	Eastfield	6
SE26	524500	5372000	Macquarie & Brickendon	4
SE27	526150	5369500	Blessington-Panshanger	4
SE28	527425	5367925	Panshanger-Canola	5
SE29	522600	5371650	Panshanger-Eastfield	4+5
SE30	531450	5378850	Canola	5
SE31	524650	5368100	Canola-Panshanger	5
SE32	516925	5377450	Newham-Panshanger	4
SE33	529275	5364100	Panshanger	4
SE34	519925	5373750	Panshanger-Eastfield	4+5
SE35	530150	5362975	Bloomfield-Panshanger	4+6
SE36	530925	5362525	Panshanger-Bloomfield	5
SE37	533275	5361850	Panshanger-Bloomfield	4
SE38	530475	5360050	Canola-Panshanger	4
SE39	526875	5361350	Canola-Eastfield	5
SE40	526150	5355550	Blessington -Panshanger	4
SE41	526425	5350325	Canola	4
SE42	525850	5352100	Eastfield-Panshanger	4
SE43	526000	5352500	Lagoon	5

Site ID	Map Easting	Map Northing	Dominant Soil Association/Series/Type	Land Capability Class
	540400	5377300	Canola(west),Brumby(east)	4
SE45	539200	5374600	Brumby-Panshanger	4
SE46	539100	5374350	Breadalbane	4
SE47	537975	5375025	Eastfield-Panshanger	4
SE48	537025	5373400	Macquarie	4
SE49	536525	5372775	Panshanger-Eastfield	5
SE50	538375	5368425	Breadalbane	4
SE51	538325	5363325	Canola-Breadalbane	4
SE52	539275	5361100	Campbell Town-Breadalbane	4
SE53	540875	5355500	Campbell Town-Breadalbane	4
SE54	541500	5352625	Panshanger-Bloomfield	4
SE55	540900	5352650	Panshanger-Bloomfield	5
SE56	537325	5351125	Brumby-Panshanger	4
SE57	535500	5351100	MEA. Misc. soils re:Eastfield	6
SE58	535800	5355725	Glen-Canola	5
SE59	533700	5358275	Glen-Panshanger	5
SE60	524500	5364250	Woodstock	4
SE61	535675	5361525	Bloomfield	5
SE62	535975	5361400	Canola	4
SE63	537775	5360550	Campbell Town	4
SE64	503700	5379375	Woodstock	4
SE65	503400	5376850	Eastfield	5
SE66	501800	5371225	Brumby	4
SE67	510550	5372400	Brickendon	6
SE68	513925	5371500	Newham	4
SE69	516875	5369575	Brumby	4
SE70	520525	5363400	Eastfield	5+6
SE71	520325	5358725	Bicton	4
SE72	526275	5358825	Canola-Eastfield	4
SE73	526125	5365175	Canola	4
SE74	528300	5376500	Woodstock-Panshanger	4
SE75	527500	5375600	Panshanger-Woodstock	4
SE76	531375	5374725	Brumby-Panshanger	4
SE77	536425	5368225	Breadalbane	4
SE78	538300	5364475	Breadalbane	5
SE79	536900	5353025	Brumby-panshanger	4
SE80	533050	5361000	Panshanger/Bloomfield	4
SE81	539575	5358250	Campbell Town - Breadalbane	4
SE82	500275	5379375	Lagoon soil/ Panshanger	6
SE83	500125	5378525	Eastfield	5+6
SE84	500100	5379950	Canola	4+5
SE85	501375	5380500	Canola\Panshanger	7
SE86	502950	5379550	Eastfield	4
SE87	502775	5380275	Cressy	3
SE88	503550	5382575	Cressy	3
SE89	502075	5385025	Brumby	4

Site ID	Map Easting	Map Northing	Dominant Soil Association/Series/Type	Land Capability Class
SE90	504000	5385000	Kinburn	4
SE91	504875	5381875	Brickendon	4
SE92	506350	5378625	Brumby	4
SE93	500325	5384200	Woodstock	4
SE94	500875	5384900	Brumby	4
SE95	503600	5384525	Kinburn	4
SE96	505100	5383700	Cressy	3
SE97	500175	5388300	Cressy	3
SE98	503050	5387775	Cressy	3
SE99	506875	5405700	Canola	4
SE100	504850	5404850	Panshanger	4
SE101	504325	5404375	Brumby	4
SE102	502350	5403450	Brickendon	4
SE103	504675	5405550	Eastfield	5
SE104	534825	5405750	Not Known	4
SE105	540000	5404525	probably Brumby	4
SE106	539750	5404100	probably Eastfield	5
SE107	538950	5403300	Blessington	5
SE108	540000	5402300	Deddington (probably)	6
SE109	537850	5402750	Deddington	6
SE110	532975	5402875	Deddington	5
SE111	530825	5404525	Deddington	5
SE112	527900	5403800	Deddington or Eastfield	6
SE113	525525	5404175	Eastfield	5
SE114	523625	5404425	Breadalbane	4
SE115	520525	5405350	Relbia	4
SE116	521425	5404100	Relbia	4
SE117	521775	5402475	Breadalbane	5
SE118	523525	5403150	Breadalbane	4
SE119	530400	5403000	Arnon	5
SE120	529575	5402100	Arnon	5
SE121	528150	5400700	Relbia	4
SE122	521950	5400400	Relbia	5
SE123	525325	5401400	Relbia	5
SE124	501250	5398775	Woodstock	4
SE125	500375	5395875	Cressy	3
SE126	500150	5392500	Cressy	3
SE127	500425	5393875	Cressy	3
SE128	501825	5394110	Lagoon	4
SE129	504600	5394600	Lagoon	5
SE130	538725	5402150	Blessington	5
SE131	538800	5401725	Blessington	6
SE132	539425	5399075	Deddington	7
SE133	538900	5398100	Deddington	6
SE134	540775	5397250	Deddington	7
SE135	540550	5398175	Blessington	5

Site ID	Map Easting	Map Northing	Dominant Soil Association/Series/Type	Land Capability Class
SE136	537475	5398025	Canola over stones.	5
SE137	541100	5391000	Nile?/Brumby	5
SE138	536775	5395525	Canola	4
SE139	534100	5393575	Canola?	4
SE140	531950	5393475	Deddington	5
SE141	527075	5391850	Brumby	4
SE142	508475	5381200	Brickendon	4
SE143	512625	5382725	Newham	4
SE144	508750	5402300	Eastfield	6
SE145	527475	5395300	Woodstock	4
SE146	525125	5394850	Brickendon	4
SE147	526900	5393925	Woodstock/Brickendon	5
SE148	529625	5396650	Eastfield	6
SE149	527550	5397475	Lateritic Eastfield	5
SE150	525850	5397125	Woodstock?	4
SE151	525175	5398125	Canola	4
SE152	521925	5395550	Brickendon	4
SE153	523500	5391700	Panshanger	4
SE154	526450	5390275	Nile	4
SE155	508200	5402175	Brickendon	4
SE156	509175	5401325	Eastfield	5
SE157	512200	5397200	Panshanger sand over Brickendon	4
SE158	511775	5399525	Eastfield	5
SE159	511775	5398900	Eastfield	5
SE160	511025	5397250	Sandy Brickendon association	4
SE161	509425	5382450	Brickendon	4
SE162	511800	5381900	Panshanger	4
SE163	519875	5383725	Woodstock	4
SE164	527450	5389025	Canola?	4
SE165	528175	5388500	Nile	4
SE166	530200	5389675	Eastfield	6
SE167	532250	5390850	Eastfield	6
SE168	533100	5391275	Canola?	4
SE169	534600	5387950	Woodstock	5
SE170	533600	5388375	Nile and Canola.	5
SE171	533725	5392725	Deddington	6
SE172	528750	5386350	Brumby?	4
SE173	529875	5384775	Brumby?	4
SE174	508175	5403750	Eastfield	5
SE175	520025	5388600	Brickendon	4
SE176	521875	5385175	Brickendon	4
SE177	525725	5381100	Brickendon	4
SE178	527625	5379000	Brickendon	4
SE179	532500	5379200	Panshanger	4
SE180	531700	5378900	Breadalbane	5
SE181	541225	5376475	Eastfield	5+6

Site ID	Map Easting	Map Northing	Dominant Soil Association/Series/Type	Land Capability Class
SE182	540400	5376875	Brumby	4
SE183	540050	5376800	Canola	5
SE184	541175	5379600	Nile / (Brumby)	4
SE185	538700	5379300	Woodstock	5
SE186	512175	5404225	Eastfield	5
SE187	513950	5404800	Relbia	4
SE188	516025	5401350	Breadalbane	4
SE189	516550	5398125	Arnon	4+5
SE190	513850	5400200	Arnon	5
SE191	522475	5391550	Canola	4
SE192	526675	5385700	Brumby	3
SE193	527200	5387100	Nile	4
SE194	524300	5390125	Canola	4
SE195	525425	5390725	Brumby	4
SE196	522625	5393250	Brumby	4
SE197	521800	5392750	Canola	4
SE198	522925	5383275	Brickendon?	4
SE199	523425	5382650	Woodstock	4
SE200	521200	5383750	Woodstock	5
SE201	517400	5403950	Breadalbane assoc.	4
SE202	519300	5404225	Relbia	4
SE203	519000	5404500	Canola	4
SE204	518975	5402600	Breadalbane	5
SE205	517425	5405475	Woodstock	5
SE206	523650	5390525	Sandy alluvial soil	5
SE207	522325	5388000	Brumby	4
SE208	521700	5389350	Brumby	4
SE209	522850	5386125	Panshanger	4
SE210	524950	5385175	Canola	5
SE211	524550	5385200	Canola association	4
SE212	515700	5403925	Breadalbane(Evandale clay)	4
SE213	516550	5405575	Relbia	4
SE214	520600	5402825	Breadalbane assoc.	4
SE215	519775	5398425	Breadalbane assoc.	4
SE216	515600	5398000	Panshanger sand	4
SE217	518300	5396300	Brickendon	4
SE218	519525	5394150	Brumby	4
SE219	519050	5394925	Brickendon	5
SE220	514725	5395275	Brickendon	4
SE221	513850	5392700	Canola	4
SE222	514875	5393900	Newham/Brumby/Panshanger	4
SE223	508800	5395425	Kinburn	4
SE224	509400	5388625	Cressy	3
SE225	508525	5389200	Cressy	3
SE226	507925	5390850	Brickendon	4
SE227	512475	5393550	Brickendon Assoc.	4

Site ID	Map Easting	Map Northing	Dominant Soil Association/Series/Type	Land Capability Class
SE228	515325	5391900	Brumby Assoc.	4
SE229	517600	5392725	Newham	4
SE230	517575	5393525	Newham Assoc.	4
SE231	512225	5388425	Brickendon	4
SE232	512125	5387525	Brickendon Assoc.	4
SE233	514600	5385925	Brickendon	4
SE234	513875	5384925	Newham Assoc.	4
SE235	512200	5383500	Panshanger	4
SE236	509250	5385450	Brumby	4
SE237	534425	5380525	Brumby Assoc.	4
SE238	534800	5382725	Eastfield	5+6
SE239	533950	5382275	Woodstock	4
SE240	533125	5381300	Blessington Assoc.	4
SE241	532550	5380825	Brumby?	4
SE242	531175	5383200	Panshanger	4
SE243	524525	5382600	Brickendon Assoc.	4
SE244	511325	5384900	Canola	4
SE245	510125	5382825	Panshanger	4
SE246	509100	5383700	Brumby	4
SE247	508975	5382900	Brickendon Assoc.	4
SE248	519500	5380100	Deddington	6
SE249	519875	5380550	Eastfield	5
SE250	519225	5382800	Woodstock	5
SE251	520675	5396850	Brumby	4
SE252	506400	5395125	Cressy	3
SE253	507575	5392875	Cressy	3+4
SE254	523050	5378500	Woodstock	5
SE255	522775	5379900	Woodstock	5
SE256	522300	5379850	Woodstock	5
SE257	521600	5381350	Woodstock	5
SE258	522475	5381275	Woodstock	5
SE259	524275	5380100	Woodstock	5
SE260	523750	5380700	Woodstock	5+6
SE261	523975	5381000	Woodstock	5
SE262	529575	5380800	Canola	6
SE263	517900	5390600	Brickendon	4
SE264	517500	5390775	Brickendon	4
SE265	517075	5390925	Brickendon Assoc.	4
SE266	516875	5391925	Brumby	4
SE267	519400	5392550	Brumby	4
SE268	520300	5395275	Brumby	4
SE269	523950	5399425	Canola/Woodstock?	4
SE270	524300	5398975	Relbia	4
SE271	523600	5399975	Breadalbane	4
SE272	522875	5399850	Relbia	4
SE273	522775	5398600	Brickendon	4

Site ID	Map Easting	Map Northing	Dominant Soil Association/Series/Type	Land Capability Class
SE274	504100	5400450	Cressy	4
SE275	500975	5398975	Woodstock	5
SE276	503550	5399375	Woodstock	4
SE277	504475	5399975	Cressy	3+4
SE278	505475	5399625	Eastfield	5
SE279	505125	5400475	Cressy Assoc	4
SE280	505950	5400975	Brickendon	5
SE281	507125	5401250	Canola	5
SE282	512950	5391325	Brumby	4
SE283	514450	5388450	Brickendon	4
SE284	515900	5387475	Brickendon Assoc.	4
SE285	516300	5383700	Newham	4
SE286	530050	5386575	Newham?	4
SE287	532425	5386800	Canola Assoc.	5
SE288	534625	5386825	Nuka?	4
SE289	537825	5386325	Deddington	6
SE290	530775	5384550	Panshanger	5
SE291	538100	5381150	Eastfield	4
SE292	539300	5381200	Woodstock	5
SE293	539550	5379200	Breadalbane	5
SE294	536900	5378650	Woodstock	5
SE295	512500	5381850	Panshanger	4
SE296	512550	5381650	Brumby	5
SE297	512850	5380925	Brumby +Panshanger	4
SE298	512525	5380850	Brumby +Panshanger	5
SE299	513525	5380325	Newham +Panshanger	4
SE300	514750	5380275	Eastfield	5
SE301	519300	5387900	Brickendon	4
SE302	520725	5384875	Woodstock	6
SE303	521075	5385900	Brickendon	5+6
SE304	518625	5387325	Brickendon	6