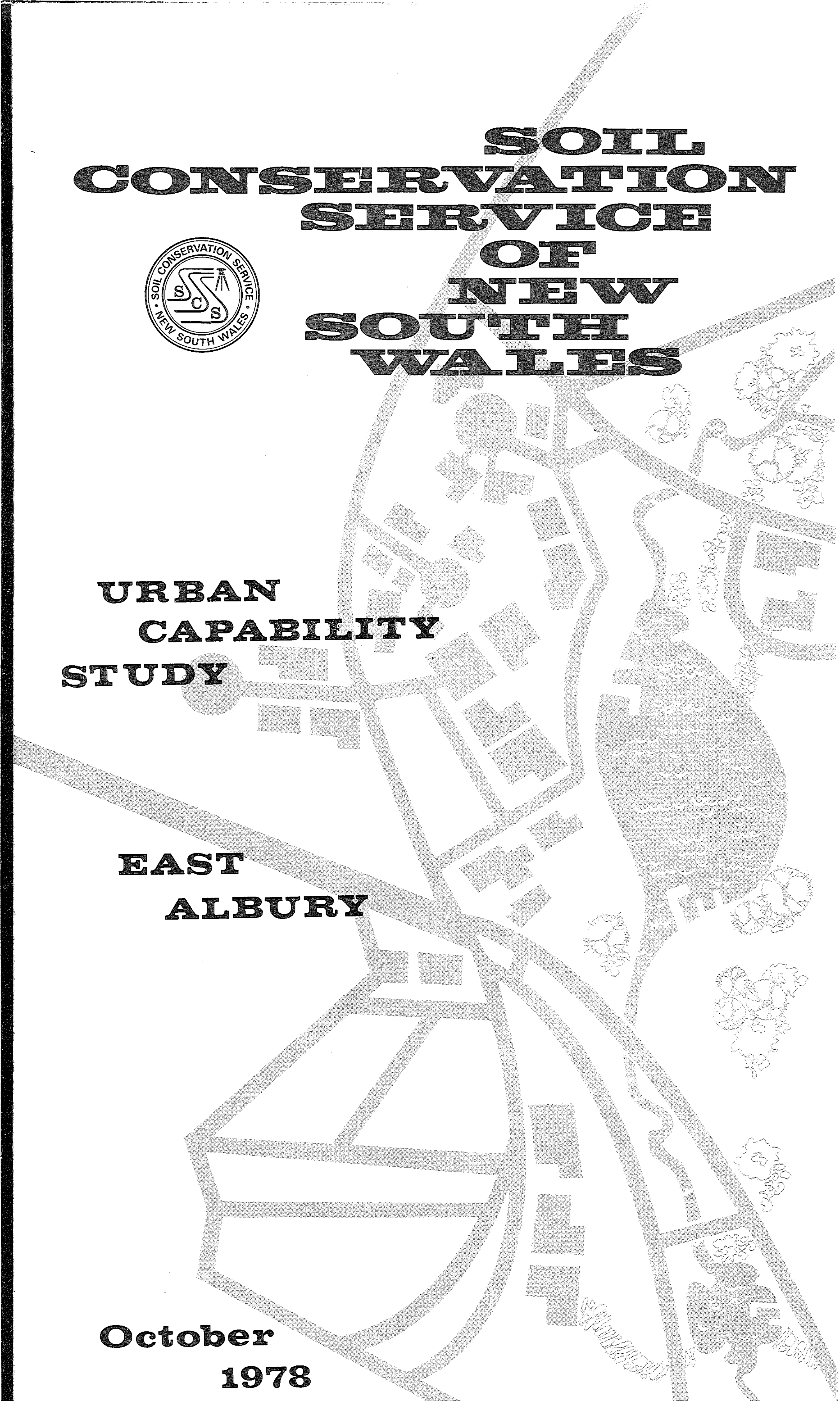
SOIL CONSERVATION SERVICE OF NEW SOUTH WALES



URBAN CAPABILITY STUDY

EAST ALBURY

October 1978

SOIL CONSERVATION SERVICE OF NEW SOUTH WALES

URBAN CAPABILITY STUDY

EAST ALBURY AREA, NEW SOUTH WALES

Report prepared for
Albury City Council

This report, and the original maps associated with it, have been scanned and stored on the custodian's intranet.
Original maps drafted at 1:2,500 were catalogued SCS 12674/A -Z.
These full size maps have been scanned and named
"UC_EastAlbury_theme". S.J. Lucas April 2014

Report compiled by:

I. A. Murray, Soil Conservationist

R. J. Crouch, Soil Conservationist

This report is a guide to development potential only in terms of erosion hazard and land stability. It indicates the capacity of the physical resources of the study area to sustain various intensities of urban use.

The maps are accurate at the scale at which they have been prepared and, as such, will assist in subdivision planning. It is important that information is not extracted from them at a scale larger than the scale of the originals.

Neither the maps nor the written report are a substitute for specific engineering and design investigations which may be required to more accurately define constraints in the location and design of roads, individual buildings, or recreation facilities.

The report does not constitute an overall recommendation for particular forms of use or development on specified areas, as no account has been taken of other town planning considerations. It forms a basis onto which these may be imposed to derive a development plan.

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SUMMARY

The study area occupies approximately 130 hectares on the eastern fringe of present Albury residential development.

It is comprised of two main terrain components, the steep eastern slopes of Eastern Hill and the broad, low slope areas of the old Murray River floodplain.

Soil boundaries are broadly related to landform. The Eastern Hill sideslopes have shallow stony soils as a result of erosion over a long period. The footslopes have deep sandy colluvial soils, consisting of material transported from above. The river terraces have a heavy clay soil, with poor internal drainage characteristics.

A portion of the first river terrace is subject to inundation by a 1 in 100 year flood.

From interpretation of landform, soils and surface drainage features, various urban capability classes have been defined.

Sub-Class A-0 Covers most of the second river terrace, its slopes to the first terrace and the gentle footslopes of Eastern Hill. This land will tolerate commercial, industrial, residential or recreational use.

Sub-Class A-3d This is the most extensive sub-class in the area, and comprises poorly drained land of low slope on the old river terraces. Periodic waterlogging and poor soil drainage will need to be accounted for during development. The development potential of this land is similar to that of sub-class A-0.

Sub-Class A-3e There is a small area of this sub-class which is largely developed already. It occurs on low slopes with highly erodible soils. Its development potential is similar to sub-class A-0, but more attention needs to be paid to preventing erosion of areas exposed during development.

Sub-Class B-5, 3e This land is situated on the footslopes of Eastern Hill, with gradients between 5 and 10 per cent. Two major constraints to development are the occurrence of run-on water and erodible soils. Commercial or industrial development is not recommended, but the land will accept residential subdivision.

Sub-Class C-1, 3e, 5 This land is located on the steeper footslopes. Slope, soils and run-on are constraints to development. Residential development is considered the highest capability of this land.

Sub-Classes D-1, 3e and D-1, 3e, 5 These lands have similar development constraints to those on Class C-1, 3e, 5, but steeper slope gradients in the 20 to 25 per cent range impose a greater level of hazard, so that commercial, industrial or residential development are not recommended. These lands are suitable for open space, or yard space for houses built on adjacent Class A or C land.

Sub-Class D-2 This land is subject to periodic inundation, and it is recommended it be developed as a drainage reserve. Alternatively, the proposed private stormwater drainage system for this area, may prevent inundation and allow commercial or residential development.

Sub-Class D-2, 3d Covers approximately one third of the first river terrace above the present floodplain, this area is inundated by floodwaters in a 1 in 100 year flood. Building is not recommended on this land. Recommended use is for parks, playing fields and passive recreation.

Sub-Class E-1, 3e This land is situated on slope gradients exceeding 30 per cent on highly erodible soils. It is recommended that this hillslope remain undisturbed.

INTRODUCTION

The study site is an area of 133 hectares on the eastern side of Eastern Hill. It includes most of the eastern half of this hill and part of two river terraces.

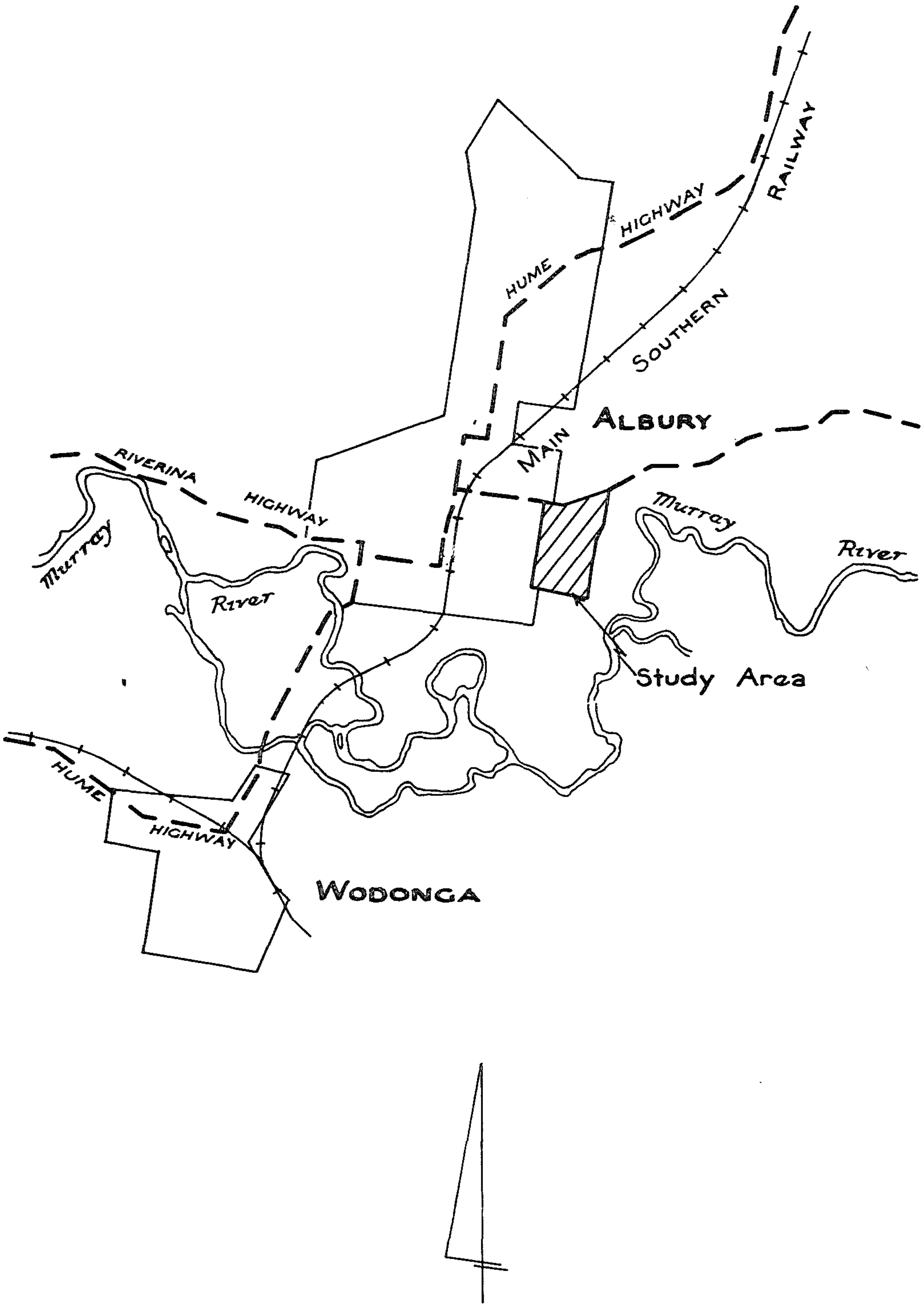
Development problems are anticipated on both the steep slopes of the hill and on sections of the river terrace which are subject to flooding.

Albury City Council requested the Soil Conservation Service to identify the problem areas and physical constraints to urban development, so that unstable lands could be avoided, and the requirements necessary to overcome any other site constraints.

This Urban Capability Study is based on a survey of the physical features of the site - soils, landform and drainage pattern. These features have been mapped on 1:2,500 scale base plans.

While originals of the landform, soils and urban capability maps have been prepared at the scale indicated above, copies included in this report are reduced in scale for convenience of presentation. The large scale copies are available, on request, from the Soil Conservation Service.

The information provided in this report is a guide to development, based on soil conservation principles. To ensure the effective implementation of the recommendations it contains, consultation with officers of the Soil Conservation Service should be made during both the planning and construction stages of development.



LOCALITY MAP

EAST ALBURY

URBAN CAPABILITY STUDY

PHYSICAL FEATURES

Environmental features that influence land stability and the urban capability of the East Albury area are:

1. Climate
2. Landform (slope, terrain and drainage)
3. Geology and Soils

1. Climate

The median annual rainfall for Albury is 694 mm and occurs mainly in winter. The median rainfall for June, July and August totals 214 mm, whereas for January, February and March, it is 95 mm (Table 1).

Rainfall reliability is highest from June to October, and lowest in February.

There is a 95 per cent probability that soil moisture conditions in January will be inadequate for plant growth. There is an 80 per cent chance that both January and February will be drought months, and a 70 per cent chance that there will be a 3 month drought from January to March.

During winter, higher rainfall and lower evaporation lead to extended periods of high soil moisture.

Summers are warm to hot and winters are cold.

The hottest month is February with a mean monthly maximum of 32.4^{o}C and the coldest is July, with a mean monthly minimum of 3.4^{o}C. (Table 2).

Frosts are expected from May to September, with an average frost free period of 249 days.

Local topography exerts a major influence on frost incidence and severity. The sideslopes and footslopes, on the eastern face of the Eastern Hill, experience milder frost conditions than the floodplain, to which cold air will drain.

TABLE I - SELECTED RAINFALL DATA - ALBURY

(a) Monthly Rainfall Variability

(Albury 1862-1969)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1st Quartile	10	6	12	21	32	47	42	50	37	36	19	17
Median	28	29	38	42	58	75	69	70	60	66	40	43
3rd Quartile	61	63	62	71	85	102	98	96	85	100	68	59
% Deviation	75	86	66	57	45	36	39	31	38	45	60	58
% chance no rain	2	5	3	3	2	0	0	0	0	0	3	1

(b) Seasonal Rainfall Variability

(Albury 1862-1969)	Summer	Autumn	Winter	Spring
1st Quartile	49	99	160	126
Median	80	145	223	174
3rd Quartile	127	203	274	223
% Deviation	43	37	25	28

TABLE 2 - SELECTED TEMPERATURE DATA - ALBURY

(a) Monthly Temperatures

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean Monthly Max. Temp.	32.2	32.4	29.1	23.1	18.3	14.1	13.6	15.8	19.6	23.2	27.4	30.8	23.3
Mean Monthly Min. Temp.	15.4	15.7	12.9	8.8	5.7	4.1	3.4	4.4	6.2	8.7	11.6	14.2	9.3
Mean Daily Temp	23.8	24.1	21.0	15.9	12.0	9.1	8.5	10.1	12.9	16.0	19.5	22.5	16.3

(b) Frost Incidence

Mean date of First Occurrence	Mean date of Last Occurrence	Average Frost Free Days
May 17th	September 9th	249

2. Landform

The following slope and terrain classes are indicated on the landform map.

Slope (first numeral)

1	0	-	1%
2	1	-	5%
3	5	-	10%
4	10	-	15%
5	15	-	20%
6	20	-	25%
7	25	-	30%
8		>	30%

Terrain (second numeral)

1	Hillcrest or ridge
2	Sideslope
3	Footslope
4	Floodplain
5	Water disposal area
6	Incised drainage channel
7	Disturbed terrain
8	Water body

The area has been divided into three topographic sections, the Eastern Hill with its steep sideslopes and gentler footslopes, the first river terrace above the present floodplain, and the second terrace, in the north-west corner.

A. Eastern Hill

The Eastern Hill lies in the central-west and south-west sector of the site. Sideslopes vary in gradient from 20 per cent to over 30 per cent. Soils are shallow and stony much of the soil having been transported down the slope.

The footslopes range in grade from 5 per cent to 20 per cent, and their soils consist largely of colluvial deposits transported from the hill above.

LANDFORM

SLOPE (first numeral)

Percent	Code
0-1	1
1-5	2
5-10	3
10-15	4
15-20	5
20-25	6
25-30	7
>30	8

TERRAIN (second numeral)

Component	Code
Hillcrest or ridge	1
Sideslope	2
Footslope	3
Floodplain	4
Water disposal area	5

--- Boundary of 1 in 100 year flood

B. First River Terrace

This terrace comprises the largest part of the site. It occurs on sediments above the existing Murray River floodplain. Part of it is, however, subject to inundation by the 1 in 100 year flood.

Slope gradients are low, ranging from 0 to 1 per cent.

C. Second River Terrace

This is a small area of high terrace in the north of the site. There are gentle slopes of 1 to 5 per cent gradient between this and the first terrace.

The low slope gradients on the two terraces lead to poor surface drainage. Internal drainage is also poor due to the clayey nature of the soils. These two factors are responsible for prolonged wetness of large areas during winter.

3. Geology and Soils

(a) Geology

Eastern Hill is comprised primarily of high grade metasediments of quartz-mica schists, with a small area of volcanic rocks along its north-east edge.

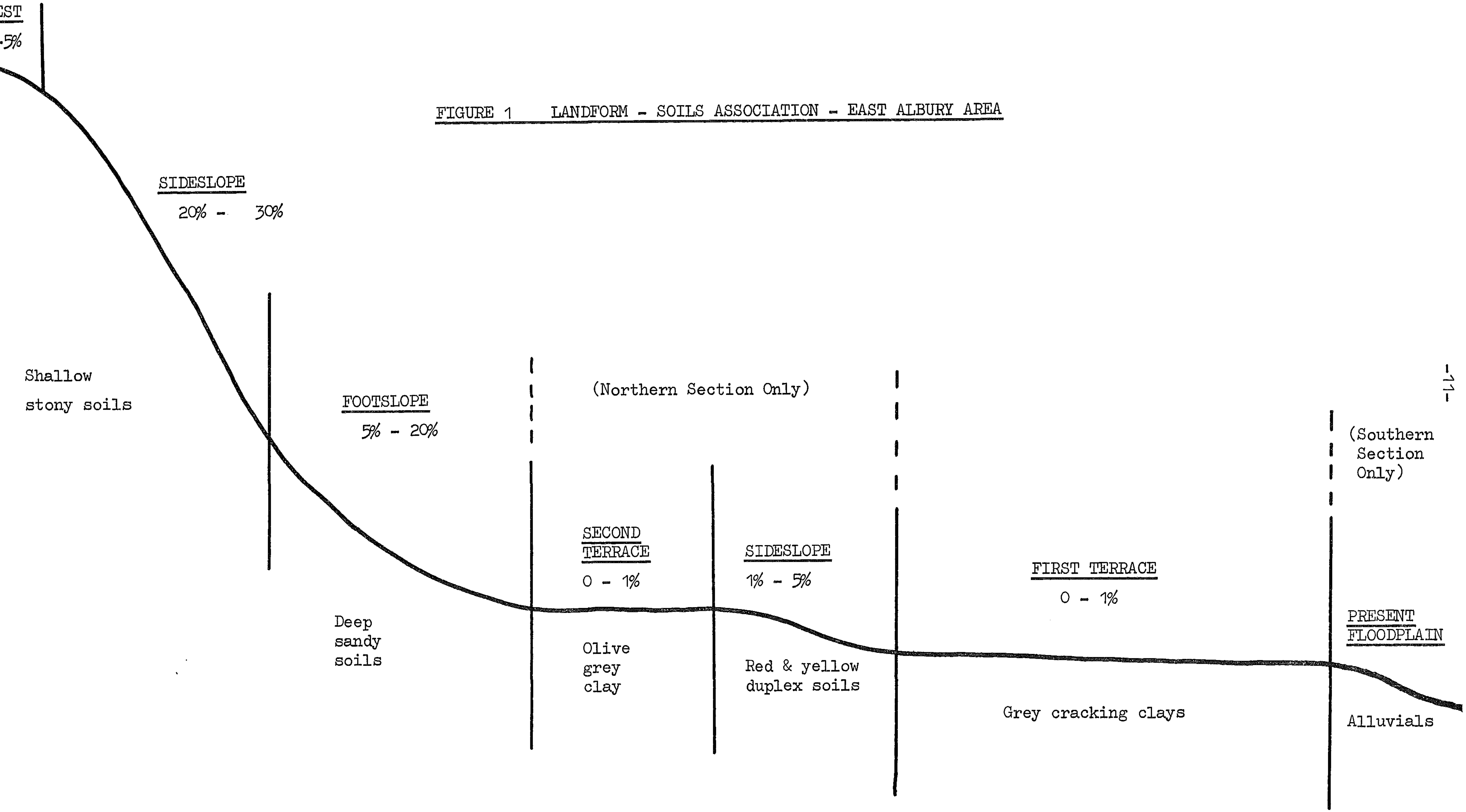
The central and eastern parts of the subdivision consist of sediments deposited on the high terraces above the Murray River.

(b) Soils

The soils reflect their parent material and situation. For example, shallow rocky soils occur on Eastern Hill, with deep sandy soils on colluvial slopes. These contrast markedly with the grey clay soils of the first river terrace and the low ridges of red and yellow soils of the second river terrace (Figure 1).

Soils were surveyed by field reconnaissance and mapped on a 1:2500 base plan. They were classified using the Factual Key (Northcote 1971) and Soil Conservation Service addendum.

FIGURE 1 LANDFORM - SOILS ASSOCIATION - EAST ALBURY AREA



Soil samples were taken from selected sites for laboratory analyses.

Soil descriptions and the results of laboratory tests are presented in Table 3 and Appendix III.

Description of Soil Map Units

Five map units have been defined, and they are described below:

Map Unit A (Uc 2.12 - 1/0/30)

This unit consists of a shallow stony soil on the upper slopes and crest of Eastern Hill. The land is very steep with slope gradients generally exceeding 30 per cent.

The soil consists of weathered rock fragments surrounded by finer soil material. The fine material is darkened by organic matter in the top 20 cm. Below this it is bleached. The bleached soil either lies directly on rock or grades into a minimal red clay B horizon around rock fragments. The whole profile rarely exceeds 50 cm depth.

Rock outcrops occur frequently.

The soil in this unit is highly erodible and, in the deeper areas, may be subject to mass movement.

Constraints to urban development are the high soil erodibility and shallow depth to bedrock.

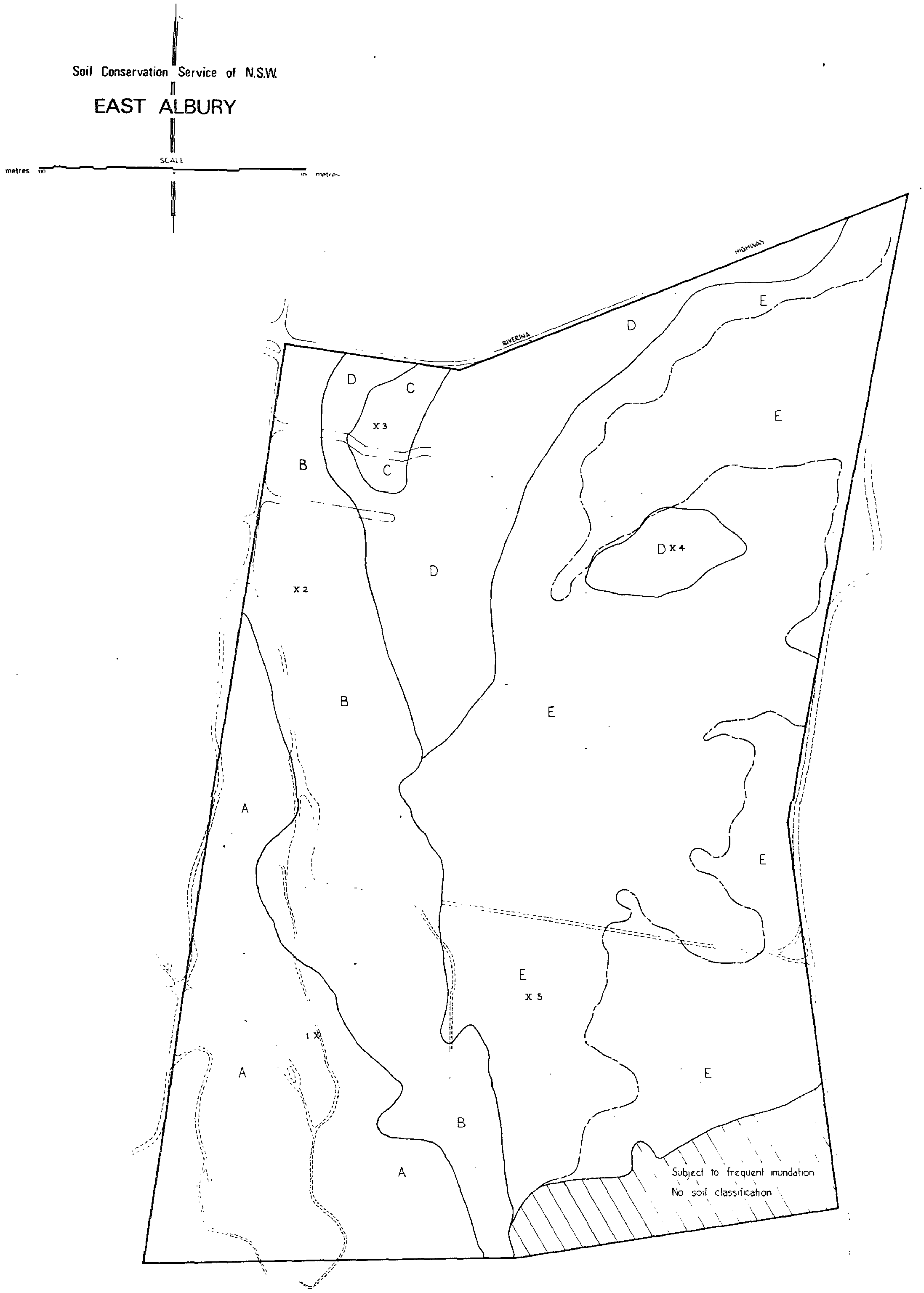
Map Unit B (Uc 2.12 - 1/0/80)

Map Unit B delineates the recent slope deposits immediately below map unit A. It includes a relatively deep sandy soil occupying concave slopes, and depositional fans at the foot of Eastern Hill.

The soil is usually deep (2m) and sandy. It consists of a shallow topsoil and a deep A_2 horizon that grades into a layered sandy subsoil. Due to its situation, it contains some large (1 - 2 m diameter) boulders. Pockets of clay are also present, usually associated with seepage areas.

Soil Conservation Service of N.S.W.

EAST ALBURY



SOILS

MAPPING UNIT	NORTHCOTE CODING	TEXTURE OF B HORIZON	PROFILE DRAINAGE	LINEAR SHRINKAGE	PLASTICITY INDEX	QUALITY OF TOPSOIL	ERODIBILITY	SPECIAL SITE FEATURES
A	Uc 2·12 1/ 0/30	—	Good	O	NP	Low	High	Shallow soil < 50cm
B	Uc 2·12 1/O/ 80	Sand.	Good	O	NP	Low	Very High	Very high erosion hazard
C	Ug 3·3 5/ 2/ 15	Heavy Clay	Poor	6	9	Moderate	Moderate	Some sections inundated periodically Poor profile drainage.
D	Dy 3·23 2/O/30	Medium Clay	Moderate	6	12	Moderate	Moderate	Nil
E	Ug 3·2 5/1/15	Heavy Clay	Poor	7	14	Moderate	Moderate	Some areas inundated periodically Poor profile drainage

Boundary of 1 in 100 year flood

Soil sampling site X 2

The soil is highly erodible and has eroded to bedrock in some drainage lines. Evidence of mass movement is present. These two characteristics present constraints to urban development.

Map Unit C (Ug 3.3 - 5/2/15)

This unit is limited to an area of internal drainage on the high terrace in the north of the subdivision.

The soil consists of an olive/grey clay with a shallow silty clay topsoil. The pH of the soil varies from 6.5 on the surface to 8 at 150 cm.

Clay plasticity and shrink/swell potential are moderate.

The only significant development problems likely on this unit are those resulting from its periodic waterlogging, a particular problem during winter.

Map Unit D (Dy 3.23 - 2/0/30

The soil in this unit is similar to that predominating over the well drained undulating slopes of the Thurgoona area.

It is a stable soil, consisting of a fine sandy loam topsoil separated from the B horizon by a slightly dispersible, bleached A_2 horizon. The B horizon of medium clay may be either red, yellow/red mottled, or yellow. The yellow B horizon occurs most frequently.

The clay in the B horizon is moderately plastic and of moderate shrink/swell potential.

The pH is acid (6) at the surface, neutral at 100 cm and alkaline (8.5) at 150 cm. Soil erodibility is moderate.

There are no significant development problems anticipated on this unit.

Map Unit E (Ug 3.2 - 5/1/15)

Map unit E consists of the grey clay soils of the first river terrace above the present floodplain. They are young soils in which the clay content may decrease down the profile.

The typical soil consists of a silty clay loam A horizon with fine crumb structure overlying a sporadically bleached silty clay A_2 horizon.

The B horizon is made up of coarse blocky grey clay.

This soil is moderately plastic and has moderate shrink/swell potential.

The only anticipated soil problems for urban development result from poor profile drainage, and inundation of sections of the unit by local runoff water. Some areas in this unit are below the 1 in 100 year flood level of the Murray River.

SUMMARY OF SOIL PROPERTIES - EAST ALBURY AREA

TABLE 3

MAP UNIT	A	B	C	D	E
Northcote Coding	Uc 2.12	Uc 2.12	Ug 3.3	Dy 3.23	Ug 3.2
Texture of B Horizon	-	sand	Heavy clay	Medium clay	Heavy clay
Profile Drainage	Good	Good	Poor	Moderate	Poor
Linear Shrinkage	Low	Low	Moderate	Moderate	Moderate
Liquid Limit	Low	Low	Moderate	Low	Moderate
Plasticity Index	Low	Low	Moderate	Moderate	Moderate
Suitability for Ponds	Low	Low	Good	Good	Good
Topsoil Quality	Low	Low	Moderate	Moderate	Moderate
Erodibility	High	Very High	Moderate	Moderate	Moderate
Special Site Features	Shallow soil 50 cm	Very high erosion hazard	Some sections inundated periodically. Poor profile drainage	Nil	Some areas inundated periodically. Poor profile drainage.

URBAN CAPABILITY

The urban capability map was developed following an assessment of the physical features of the site. The area was divided into a number of classes according to landscape stability and the assessed potential for urban development.

Five major classes of erosion/instability hazard are defined on the urban capability map.

Class A	-	low
Class B	-	moderate
Class C	-	high
Class D	-	very high
Class E	-	extreme

Within these classes, a number of sub-classes are defined, relating to the dominant physical features which restrict development potential. Numbers used to define these constraints are:

1	-	slope
2	-	flooding/drainage
3	-	soil characteristic
5	-	topographic feature (e.g. run-on)

Letters attached to subscript 3 indicate the nature of particular soil constraints:

d	-	impeded profile drainage
e	-	erodibility

The physical constraints to development for each sub-class are also itemised in the legend of the urban capability map.

The capability suggested for each sub-class refers to the most intensive urban use which areas in that sub-class will tolerate without the occurrence of serious erosion and siltation in the short term, and possible instability and drainage problems in the long term. In assessing this capability no account is taken of development costs, social implications, aesethetics or other factors relating to ecology and the environment.

The capability map can be used for planning at a conceptual level. This will take account of potential erosion hazard, and be generally consistent with preservation of an aesethetically pleasing landscape and minimisation of long term repair and maintenance costs.

Capabilities as defined relate to the degree of surface disturbance involved in the various categories of urban development. Extensive Building Complexes refers to the development of commercial complexes such as offices, accommodation units or other structures which require large scale clearing and levelling for broad areas of floor space and for parking bays. Residential development infers a level of construction which provides for roads, drainage and services to cater for 600 square metre housing blocks. The development of Reserves may require shaping and modification of the ground surface and vegetative improvement, but no building and minimal roadway construction is envisaged.

The definition of site capability for residential development or for extensive building complexes does not exempt developers from normal site analysis procedures in foundation design and in engineering analyses of proposed road alignments. Nor does it imply the capacity of that site to support multi-storey units or other major structures. Before structural works of such magnitude are undertaken a detailed analysis of engineering characteristics of the soil, such as bearing capacity and shear strength, may be necessary on the specific development site.

Assessment of capability is objective and based on physical criteria alone. Thus the classification of various areas as suitable for development of extensive building complexes, for housing, or for reserves is an assessment of the capacity of those areas to sustain a particular level of disturbance. It is not a recommendation that such a form of development be adopted.

In Appendix I a list of general guidelines is provided which will assist control of erosion and sedimentation during development.

URBAN CAPABILITY

CLASS	EROSION/ INSTABILITY HAZARD	MAJOR LIMITATIONS	CAPABILITY
A-0	Low	Nil	*EBC
A-3d	Low	Internal Drainage	EBC
A-3e	Low	Soil Erodibility	EBC
B-3e.5	Moderate	Runon and Erodibility	Residential
C-1.3e.5	High	Slope/Erodibility and Runon	Residential
D-1.3e.5	Very High	Slope/Erodibility and Runon	Recreation Reserve
D-2.3d	Very High	Flooding and Internal Drainage	Recreation Reserve
D-2	Very High	Drainage	Drainage Reserve
E-1	Extreme	Slope Constraint	No Development

*EBC Extensive Building Complex

Class A-0: Low Hazard - No Major Constraints - Suitable for Extensive Building Complexes

This sub-class comprises the second river terrace, the sideslopes to the first terrace, and the footslopes of Eastern Hill. Slope gradients range up to 5 per cent.

Unit D soils extend over this area. They are stable red or yellow duplex soils, with a fine sandy loam topsoil, and no internal drainage problems are expected.

The land in sub-class A-0 can tolerate the maximum site disturbance associated with urban or recreational development. It may be used for extensive building, shopping or educational complexes involving large scale ground disturbance and levelling without a serious erosion hazard being generated. Where this form of land development occurs, particular attention should be paid to provisions in the guidelines in Appendix I.

Land in this class may also be used for residential subdivision or for recreation.

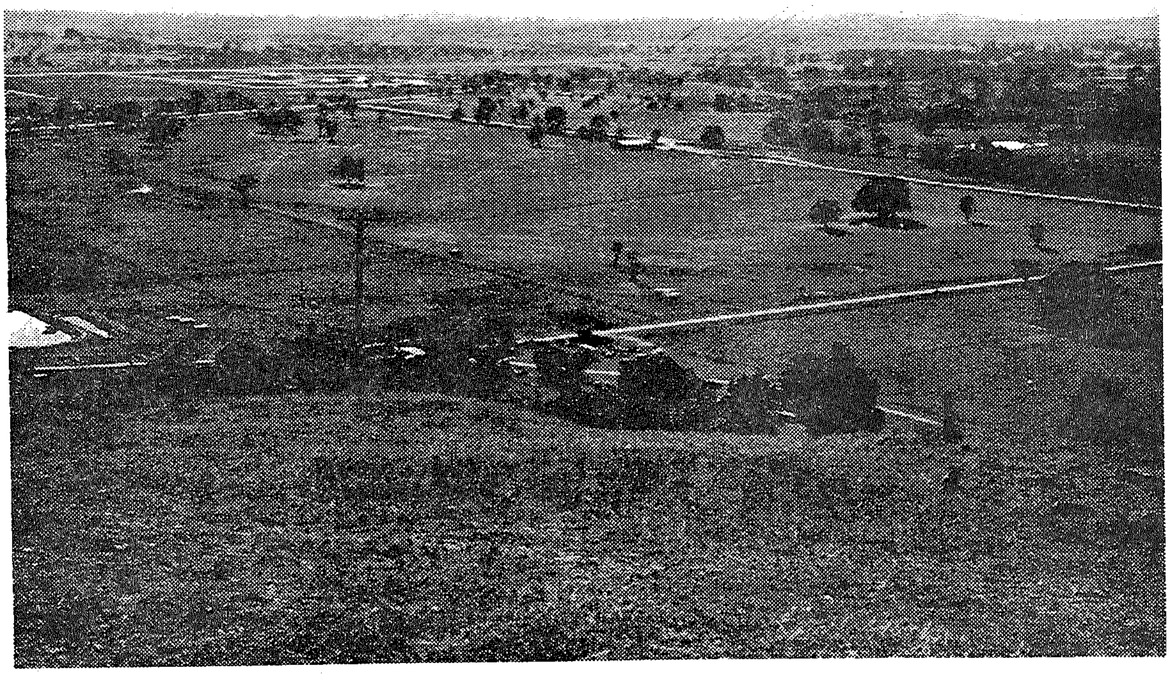
Sub-Class A-3d: Low Hazard - Soil Drainage Constraint - Suitable for Extensive Building Complexes

This sub-class comprises the major portion of the first river terrace and a small area on the second terrace.

Unit C soils occur on the second river terrace and unit E soils on the first terrace. They have similar physical properties. Their plasticity and shrink/swell potential are moderate. They are both heavy clays with poor profile drainage.

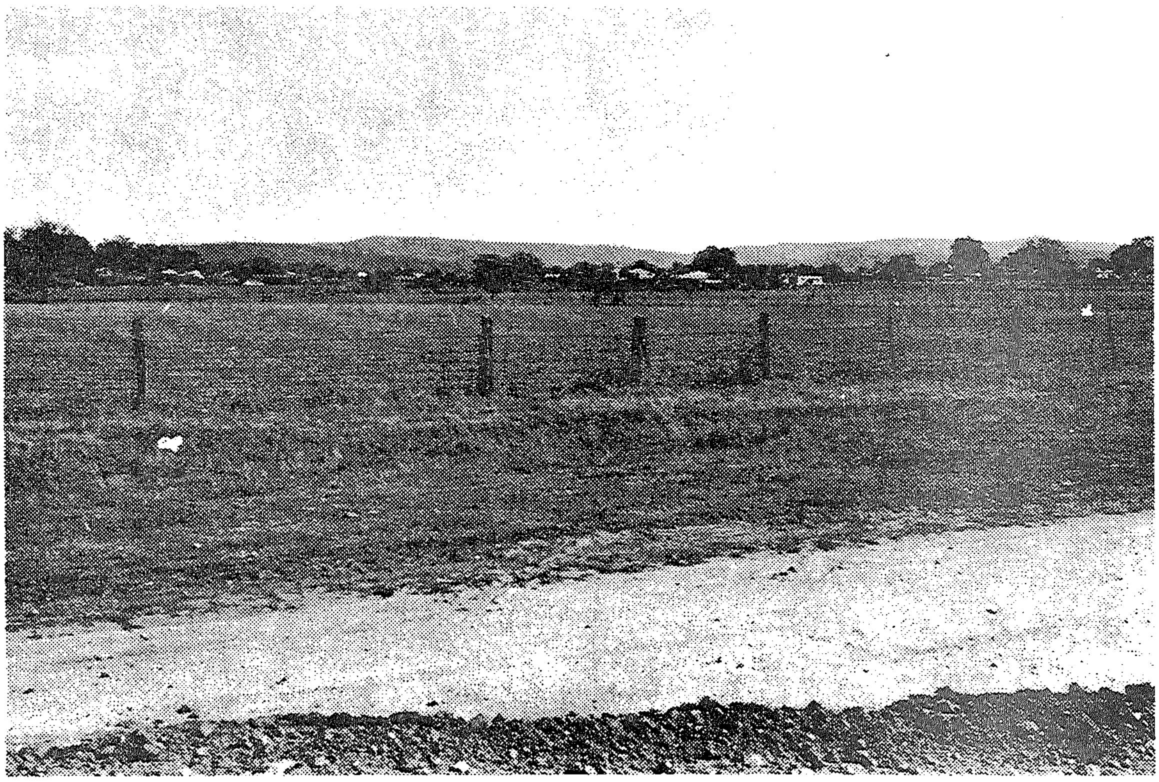
Periodic waterlogging occurs particularly in winter. Low percolation rates will make these areas unsuitable for installation of septic tanks and associated absorption fields. The problem of impeded soil drainage should be drawn to the attention of developers, as it may influence the design of roads and building foundations.

Land in this class may be used for industrial/commercial development, residential subdivision and recreation without serious erosion occurring. To minimise erosion hazard, attention should be paid to the guidelines in Appendix I.

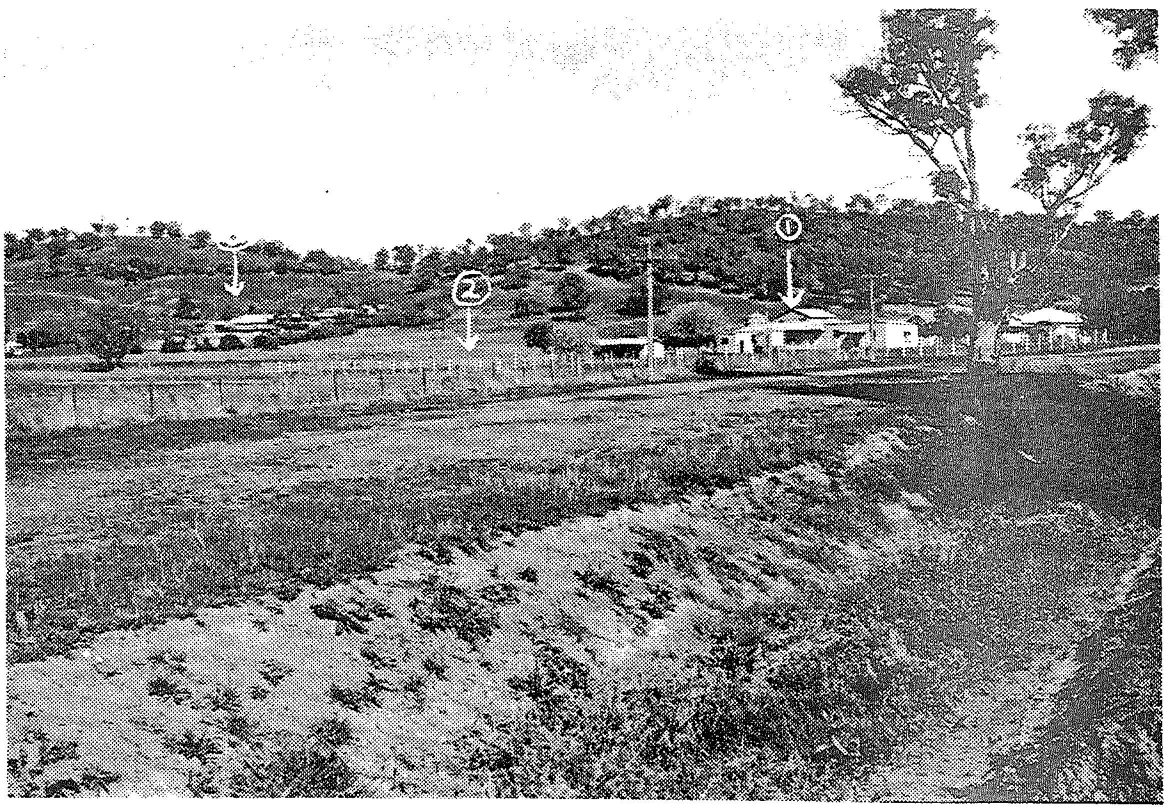


Taken from the top of Eastern Hill, and looking north-east, this photo shows the extent of the first terrace above the present floodplain. The dotted line shows the boundary of the study area.

In the foreground is land classed as B-5, 3e. It has a low slope gradient but a highly erodible soil, and is subject to run-on. It is suitable for residential development.



Sub-Class A-3d land, suitable for commercial or industrial development.



Open drain along the northern boundary of the study area. Arrow 1 shows buildings on the second river terrace, Arrow 2 the B-5, 3e footslopes, and Arrow 3 the steep sideslopes in sub-class E-1.

Sub-Class A-3e: Low Hazard - Soil Erodibility Constraint - Suitable for Extensive Building Complexes

There are two small areas of this sub-class.

One, on the footslopes of Eastern Hill, is almost fully developed as a residential subdivision, and no further development is likely.

The other area is on top of Eastern Hill and is largely occupied by a communications mast and buildings, a small carpark, and associated public facilities. The soil on this area is shallow and erodible.

Land in this sub-class may be used for industrial/commercial development, residential subdivision or recreation without serious erosion occurring, provided attention is paid to the guidelines in Appendix I.

Sub-Class B-5, 3e: Moderate Hazard - Run-on and Soil Erodibility Constraints - Suitable for Residential Development

Situated on the footslopes of Eastern Hill, this land has slope gradients between 5 and 10 per cent.

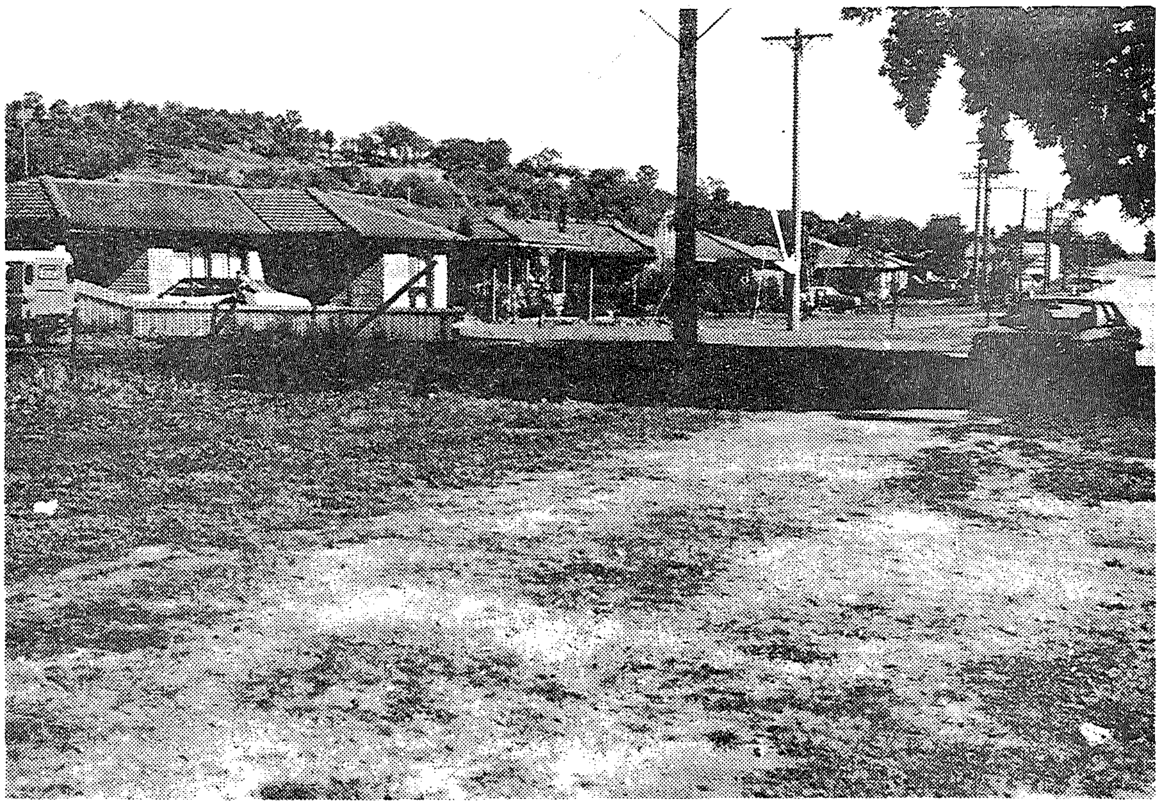
Unit B soils occur which consist of deposited material transported from the steep sideslopes above. It is a relatively deep, sandy soil and very erodible. The topsoil is shallow and of poor quality.

Two major physical constraints to development are exposure of the area to run-on and high soil erodibility.

These footslopes are subject to surface flows from the sideslopes above. The sideslopes, with their shallow soils and steep grades, yield large quantities runoff and, during high intensity rain, this runoff will pose a threat to residential development below. A drainage system to divert these flows and so protect development on this land is desirable.

The very high soil erodibility means there will be a significant erosion hazard during development, both when vegetative cover is removed and when subsoil is exposed following removal of topsoil.

Commercial or industrial development requiring large scale levelling is not recommended. The extent and depth of cut



Existing residential development in the study area. It is located on the second terrace, and on footslopes of Eastern Hill. The arrow marks the base of the footslope, i.e. the edge of the terrace.

Gentle footslopes defined as sub-class A-0. The reed growth in the middle distance marks the drainage plain classed as D-2.

and fill which such development would require on the steeper slopes may lead to high levels of siltation during construction. If, however, such development is undertaken, temporary or permanent water diversion structures should be built, cut and fill batters stabilised and all fill adequately compacted. Particular attention should be paid to the guidelines in Appendix I.

These areas will tolerate residential development without generating a severe erosion hazard, provided close attention is paid to the provisions of Appendix I.

Few problems are associated with passive recreation on this land, provided good vegetative cover is maintained. The development of active recreation facilities such as ovals requiring large scale cut and fill, will however, be subject to similar restrictions to those set out above.

Sub-Class C-1, 3e, 5: High Hazard - Slope, Soil Erodibility and Run-on Constraints - Suitable for Residential Development

This sub-class is located on the steeper footslopes - 15 to 20 per cent gradient - of Eastern Hill.

Soils are the highly erodible unit B soils consisting mainly of material transported and deposited from the hill above. Severe soil erosion will occur if uncontrolled development takes place.

This land not considered suitable for development of extensive building complexes requiring large scale cut, fill and levelling.

Residential development is considered the highest capability of this land. Steep gradient, high soil erodibility and the run-on from slopes above all generate a high erosion hazard, and particular attention should be paid to controlling surface water movement, as well as implementing the relevant recommendations from Appendix I.

Use for passive recreation will not present serious site stability problems.

Sub-Class D-1, 3e, 5 &
Sub-Class D-1, 3e: Very High Hazard - Slope, Erodibility and Run-on Constraints - Suitable for Reserve

These sub-classes occur on the lower sideslopes of the east face of Eastern Hill and on the upper sideslopes of the west face of Eastern Hill, respectively.

Slope gradients which vary from 20 to 25 per cent impose a restriction on cut and fill operations, and will place a very high erosion hazard on development where this entails disturbance of the soil surface.

The soil is highly erodible and needs undisturbed vegetative cover to prevent severe erosion.

The run-off from steep slopes above will also create a significant erosion hazard.

These lands are best suited to passive recreation, or they may be used as yard space for houses built on Class A and C land. A good vegetative cover and effective surface drainage should be maintained.

Sub-Class D-2, 3d: Very High Hazard - Flooding and Soil Drainage Constraints - Suitable for Recreation

Approximately one third of the area of the first river terrace comprises this sub-class. It has a very high hazard rating because it is inundated by floodwaters of the Murray River in a 1 in 100 year flood. The extent of this flooding is mapped as the boundary of the sub-class.

In addition to the flooding constraint, the soils have very poor profile drainage. Areas without adequate surface drainage, will be subject to waterlogging.

Industrial or residential land use is not recommended. If any development extends onto the flood-prone area, there is a major risk of structural damage as well as inundation and waterlogging.

Measures used to control flooding and allow development, such as levee banks, substantial filling, or the straightening and widening of channels, will reduce the natural storage capacity of the floodplain. This will result in increased water elevation upstream of the area, and higher channel velocities immediately downstream. Accelerated erosion of the bed and banks of the stream may occur as a result.

Access roads on the flood prone land should be elevated to allow adequate site drainage. Flood channel crossings should be designed to allow unrestricted passage of floodwaters.

Looking to the west from the first river terrace, showing the Murray Brothers Pig Farm. In the distance is Eastern Hill.

The arrow marks the boundary between the old floodplain (first river terrace) and the present floodplain.

To retain land stability, the most suitable urban use of this land is for parks, playing fields, or passive recreation.

Sub-Class D-2: Very High Hazard - Drainage Constraint - Suitable for Reserve

This is a narrow drainage plain situated at the base of Eastern Hill. It carries short sharp runoff flows following storms and longer flows following prolonged rain.

There are no major soil constraints, and gradients are below 5 per cent. The principal hazards to development are flooding and waterlogging.

Development could safely proceed if runoff from the slopes above was diverted by a road or bank into stormwater pipes. These pipes would, however, need to be large enough to protect any development from extreme flows, and installation costs would be high.

A preferred method of handling the runoff would be the establishment of a drainage reserve along D-2 land. Such a reserve should be a broad parabolic or trapezoidal grassed waterway. This would provide an open space corridor which would also be useful for recreation. A concrete invert should be installed in the floor of the reserve or a small pipe beneath it to carry trickle flows.

Details on establishment of grassed drainage reserves appear in Appendix II.

More detailed investigation would be required at the site planning stage to establish the reserve widths necessary to carry selected design flows (preferably of a 1 in 100 year return period or greater).

Sub-Class E-1, 3e: Extreme Hazard - Slope and Soil Erodibility Constraints - Not Recommended for Development

This area comprises the steepest section of the east face of Eastern Hill.

It is located on unit A soils which are highly erodible. In addition, the steep slope gradients impose an extreme erosion hazard.

Any increase in loading by building construction, or in slope angle by cut operations will lead to surface instability and there may be a possibility of mass movement. Severe surface erosion of the shallow soils can be expected and runoff will deposit silt on the footslopes below causing damage to any development there.

The footslopes are largely comprised of deposited material transported downslope in past accelerated erosion phases.

It is recommended that these hillslopes remain undisturbed. Trees should not be removed and a good grass cover should be maintained to assist surface stability.

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APPENDIX I

Guidelines for Sediment and Erosion Control

A range of general recommendations aimed at the control of erosion and siltation during development applies to the total site. These recommendations are an integral part of the capability plan and adherence to them is essential for successful implementation of the plan.

(a) Development should be scheduled to minimise the area disturbed at any one time and to limit the period of surface exposure.

(b) Disturbance of vegetation and topsoil should be kept to the minimum practicable. This provision is most critical on steep slopes.

(c) Where development necessitates removal of topsoil, this soil should be stockpiled for later respreading. The stockpiles should not be deposited in drainage lines.

If the topsoil is to be stored for six months or longer, vegetation should be established on the stockpiles to protect them against erosion.

(d) Areas that remain bare for lengthy periods during subdivision development should be afforded temporary protection by cover cropping with a suitable fast growing species (Japanese millet in spring-summer, cereal rye in autumn-winter) or by treatment with a surface mulch of straw or a chemical stabilizer.

(e) Where appropriate, exposed areas such as construction sites may be protected by locating temporary banks and ditches upslope to contain and divert runoff. Simple drainage works will remove local water from construction sites.

(f) On hillslopes particular care is required with cut and fill and general grading operations, whether for roadways or building sites.

Such operations should be restricted to a practical minimum. Deep cuts and excessive fill should be avoided as far as possible.

(g) Where possible, development should be designed to minimise alteration of the natural landscape. In this context cut and fill and general grading operations should be limited to the minimum necessary for development.

(h) All permanent drainage works should be provided as early as possible during subdivision construction.

(i) Vehicular traffic should be controlled during subdivision development confining access, where possible, to proposed or existing road alignments.

(j) Permanent roads and parking bays should be paved as early as possible after their formation.

(k) Areas of fill should be thoroughly compacted before any construction takes place on them.

(l) Cut and fill batters should be formed to a safe slope. Where vegetative - rather than structural stabilization is proposed, early revegetation of exposed batters is essential.

(i) Species which might be considered for seed mixtures may include cereal rye, Victorian perennial rye grass, white clover, subterranean clover and red clover.

Specific recommendations on mixtures and sowing rates will be provided, on request, by the Soil Conservationist, Albury.

(ii) Establishment of vegetation on batters is greatly assisted by spreading topsoil over the surface.

(iii) Batters may be treated with a chemical or an organic mulch following sowing. This provides a measure of stability at an early stage.

(iv) Hydroseeding is an alternative batter stabilization technique. A mixture of seed, fertilizer, wood or paper pulp and water is sprayed onto the batter through a specially designed applicator. This is a simple and effective technique for vegetating batters.

(v) Once vegetation is established on batters, regular topdressing with fertilizer encourages the persistence of a vigorous sward.

(vi) Establishment of vegetation is most assured of success if species are sown in autumn. If seed is sown in spring, provision for watering may be required in the summer.

(vii) Batters may be protected from upslope runoff by locating catch drains immediately above them. When the batters are more than six metres high berm drains should be located at intervals down the batter face to prevent the accumulation of erosive concentrations of local runoff.

(m) Following roadway construction and the installation of services, all disturbed ground which is not about to be paved or built upon should be revegetated.

(i) The surface should be scarified prior to topsoil return.

(ii) Topsoil structure will be damaged if it is very wet or very dry when respread.

(iii) Grasses and legumes should be sown into a prepared seed bed. Autumn sowing will generally be the most successful. If Spring sowing is necessary, irrigation may be required during summer to ensure successful establishment.

(iv) All revegetation sites should receive an adequate dressing of fertilizer at sowing to assist vigorous plant establishment and growth.

(n) Correct maintenance of all areas which are to remain under a permanent vegetative cover will ensure a persistent and uniform sward.

Regular topdressing with fertilizer is necessary in the early years of establishment, while mowing will control weeds and promote a vigorous turf.

APPENDIX II

Establishment of Drainage Reserves

The recommendations that follow are guidelines to the establishment of vegetated reserves as the major stormwater arteries of the site, indicated as sub-class D-2 on the urban capability map.

For maximum effectiveness, these reserves should be shaped as broad parabolic or trapezoidal waterways. Where the land is gullied, this requires breaking down the gully sides and some filling. On the open slopes, where well defined channels do not exist, minor excavation or the construction of banks on either side of the reserves may be required to contain flows.

The width of the reserves should be sufficient to carry flows at a velocity not exceeding 2.5 metres per second. Flows of greater velocity scour vegetated channels and structural lining is then required.

Reserves of the width shown on the urban capability map should cater for most flood flows (one hundred year return period, and in some areas greater than this) from within the site and, where the flow lines extends beyond it, from the external catchment. These widths have been determined on the assumption that these external catchments will also ultimately be developed.

The reserves should be stabilized by revegetating them or by oversowing where existing cover is not adequate. Suitable plant species include, kikuyu, paspalum, Palestine strawberry clover and Seaton Park subterranean clover.

A cover crop of oats should be sown in autumn and the above species oversown in spring. A dressing of fertilizer should be applied and the oats slashed to form a mulch after the oversowing.

Follow-up applications of fertilizer and slashing are necessary until a dense sward is established. This should be continued on a maintenance basis.

If significant flows are anticipated in the reserves before vegetation is established, temporary stability may be achieved by applying a surface binding agent such as jute mesh and bitumen, straw and bitumen, or another suitable chemical or organic mulch.

This is particularly important if autumn sowing of oats, as recommended above, is not possible. In these circumstances, provision should also be made for watering during establishment.

Wherever possible, however, all drainage reserves on the site should be formed and stabilised before any major development works commence.

It is also desirable to install structural drainage works to carry continuous trickle flows down the reserves. These flows may cut an incised path in the reserves, while rushes and other water-loving species proliferate in wet flow lines.

A concrete V-invert in the floor of reserves or a concrete pipe installed beneath them will carry trickle flows. If a pipe is installed, drop inlets should be provided at regular intervals.

Where roadways cross drainage reserves, causeways or culverts should be provided to permit free passage of stormwater. Rock grouting, hay and wire netting, jute mesh and bitumen, or structural energy dissipators may be required below their outlets to alleviate erosion hazard. Similar provision may be required to control erosion on areas where stormwater pipes discharge into reserves.

APPENDIX III

LABORATORY ANALYSES OF SOILS - EAST ALBURY AREA

SAMPLING SITE	Particle Size Analysis							L.L. %	P.I.	USCS	D.I.	L/S %	Emerson Aggregate Test
	Depth (cm)	% Clay	% Silt	%Fine Sand	%Coarse Sand	% Gravel	% Stones						
Map Unit A	15-30	8	14	24	8	39	7	NP	NP	ML	1.7	0	1
Map Unit B	15-70	12	4	44	34	6	0	NP	NP	ML	1.9	0	1
Map Unit C	25-80	61	20	17	2	0	0	46	5	ML	8.5	6	2
	80-200	60	21	13	2	4	0	50	9	ML	5.0	9	2
Map Unit D	30-110	51	14	28	7	0	0	38	14	ML	4.5	7	2
	110-150	50	13	26	8	0	2	27	12	ML	4.0	9	2
Map Unit E	10-100	54	19	14	2	11	0	47	14	ML	4.0	7	7 or 8

NOTE (1) The laboratory results above are representative samples only. Average properties, as outlined in Table 3, are based on wider sampling in Albury regional surveys - Crouch and Junor (1976), Junor (1977) and Anon (1976)

(2) N.P. denotes "non-plastic", and indicates that the soils do not exhibit the property of plasticity.

APPENDIX IV

GLOSSARY OF TERMS

Atterberg Limits

The Atterberg Limits are based on the concept that a fine-grained soil can exist in any of three states depending on its water content. Thus, on the addition of water, a soil may proceed from the solid state through to the plastic and finally liquid states. The water contents at the boundaries between adjacent states are termed the plastic limit and the liquid limit (see Lambe and Whitman 1969, p. 33).

Plastic Limit (P.L.)

The plastic limit of a soil is the moisture content at which the soil passes from the solid state to the plastic state. A description of the plastic limit test is given in Black (ed.), (1965).

Liquid Limit (L.L.)

The liquid limit is the moisture content at which the soil passes from the plastic to the liquid state. A full description of the liquid limit test is given in Black (ed.), (1965).

Plasticity Index (P.I.)

The plasticity index of a soil is the difference between the plastic and liquid limits. Toughness and dry strength are proportional to the plasticity index (Black (ed.), (1965).

Dispersal Index (D.I.)

The Dispersal Index of a soil is the ratio between the total amount of very fine particles of approximately clay size, determined by chemical and mechanical dispersion, and the amount of very fine particles obtained by mechanical dispersion only. Highly dispersible soils have low dispersal indices because their very fine particles are already in a dispersed state and the ratio approaches one. Slightly dispersible soils have high dispersal indices.

The test has been shown to reflect field behaviour of soils in that dispersible soils are often highly erodible and subject to tunnelling, both *in situ* and when used in earthworks.

A full description of the Dispersal Index test and the background to it is given in Charman (ed.), (1978).

Emerson Aggregate Test

The Emerson Aggregate Test (E.A.T.) classifies soil aggregates according to their coherence in water. The interaction of clay size particles in soil aggregates with water may largely determine the structural stability of a soil.

The Emerson classes 1, 2, 3 and 4-6 generally represent aggregates from soils which are highly, moderately, slightly and non-dispersible respectively.

A full description of the test is given by Emerson (1967).

Erosion Hazard

The erosion hazard is a qualitative assessment of the potential for erosion to occur with consideration given to the whole soil unit, its erodibility and topographic situation. The erosion hazard of an area is also related to the proposed use of the land.

Linear Shrinkage (L.S.)

The linear shrinkage is the decrease in one dimension of a soil sample when oven dried (at 105°C for 24 hours) from the moisture content at the liquid limit, expressed as a percentage of the original dimension.

The linear shrinkage test is fully described in the Australian Standard A89-(1966).

Northcote Grouping

The Northcote Grouping represents the characterization of a soil profile according to a system for the recognition of soils in the field described by Northcote (1971).

The Soil Conservation Service of New South Wales addendum to this grouping comprises three additional digits representing the surface texture, surface soil structure and depth of the A horizon in centimetres respectively of the soil profile described. Texture classes range from 1 to 6 (sand to heavy clay). Structure classes range from 0 to 3 (structureless to strongly developed structure). These properties are defined in Charman, 1978.

Particle Size Analysis

Particle size analysis is the laboratory procedure for the determination of particle size distribution in a soil sample. The hydrometer method used for this report is given by Day in Black (ed.), (1965).

Soil Erodibility

The erodibility of soil material is an inherent property of that material. It is directly related to those basic properties which make the material susceptible to detachment by erosive forces and which prevent the soil absorbing rain, thus causing runoff. The erodibility of a given soil in the field is also controlled by soil profile characteristics. The qualitative categories for soil erodibility adopted by the Soil Conservation Service of New South Wales are low, moderate, high, very high and extreme.

Unified Soil Classification System (USCS)

The USCS is a classification system which has been correlated with certain engineering properties of soils such as optimum moisture content, permeability, compressibility and shear strength.

A full description of the system is given by Casagrande (1948) and by Lambe and Whitman (1969).

'ML' refers to inorganic silts and very fine sand, and silty or clayey fine sands of low plasticity.

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