Soil Conservation Service of N.S.W.

AN URBAN CAPABILITY STUDY AND SOIL CONSERVATION PLAN FOR THE DEVELOPMENT OF THE GLENFIELD AREA, WAGGA WAGGA

December, 1976

SOIL CONSERVATION SERVICE OF NEW SOUTH WALES

AN URBAN CAPABILITY STUDY AND A SOIL CONSERVATION PLAN FOR THE DEVELOPMENT OF THE GLENFIELD AREA - WAGGA WAGGA

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S.J. Lucas April 2014

Prepared for the Council of the
City of Wagga Wagga

*

DECEMBER, 1976.

THIS REPORT DESCRIBES THE CAPACITY OF THE STUDY AREA TO SUPPORT VARIOUS INTENSITIES OF URBAN USE IN TERMS OF THE INHERENT STABILITY OF THE LAND. IT IS NOT, OF ITSELF, A RECOMMENDATION FOR PARTICULAR FORMS OF DEVELOPMENT ON SPECIFIED AREAS.

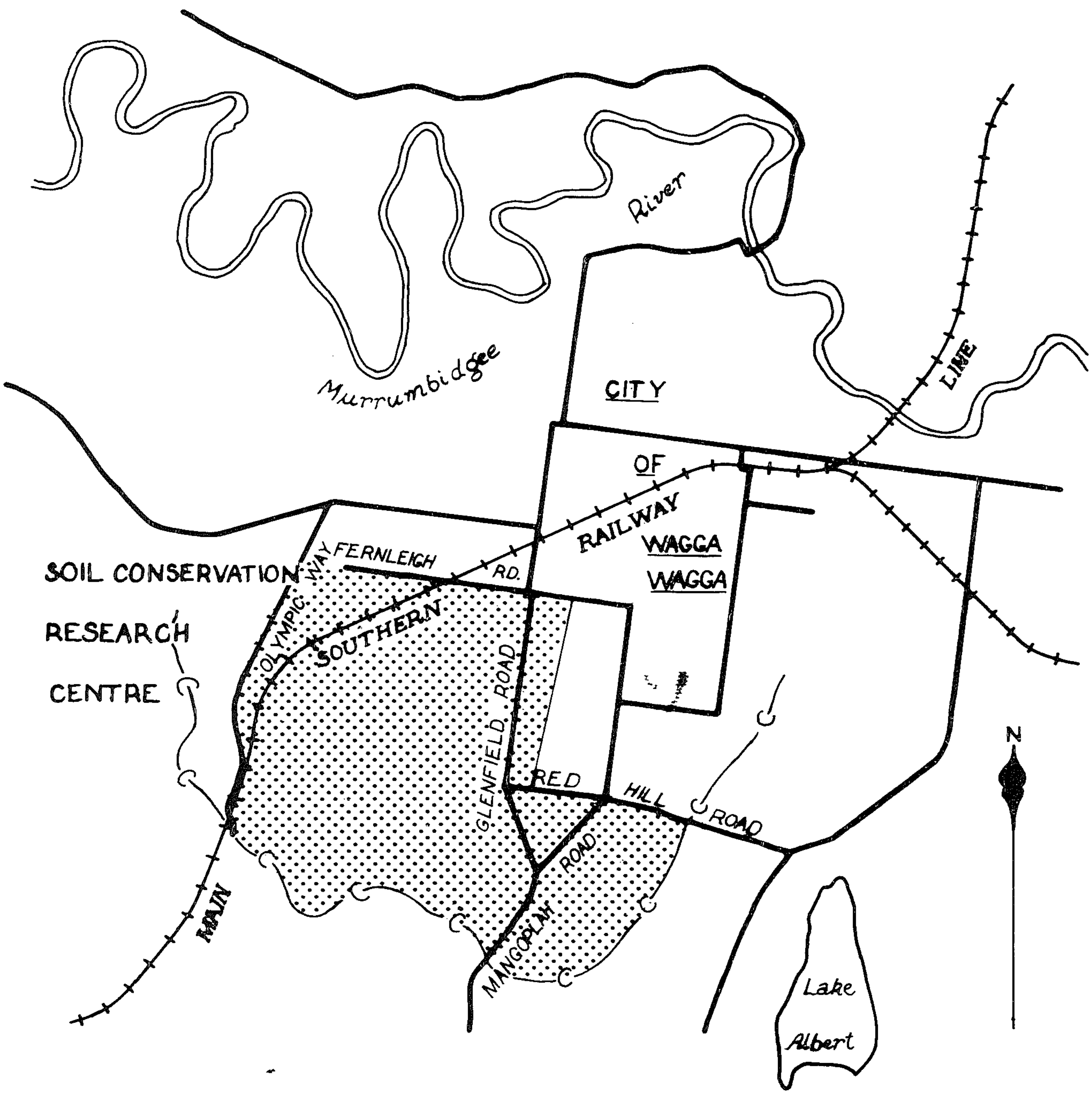
THE REPORT TAKES NO ACCOUNT OF OTHER TOWN PLANNING CONSIDERATIONS WHICH MUST INFLUENCE ANY FINAL DECISION. IT PROVIDES A USEFUL BASIS ONTO WHICH THESE MAY BE IMPOSED TO DERIVE A SUITABLE DEVELOPMENT PLAN.

CONTENTS

CONTENTS

LIST OF MAPS AND TABLES

LOCATION DIAGRAM



STUDY AREA ....

SUMMARY

The Glenfield development area comprises a catchment of 1200 hectares south of the city of Wagga Wagga. It extends southwards from the present urban areas of Mount Austin, Tolland and Ashmont to a well defined semi-circle of hills.

This report contains specific recommendations for development of the area. It is presented in three sections, Part A contains an inventory of the physical features of the environment, Part B describes the urban capability of the area and Part C makes recommendations for the development of drainage reserves incorporating detention basins and a soil conservation and land management programme.

Landform, Soils and Landscape Evaluation maps were prepared on 1:4000 base plans although in this report they are reduced in scale for convenience. Copies of the larger maps are available, on request, from the Soil Conservation Service.

The physical features of the landscape - soils, slope, terrain and drainage provided the basis for the Landscape Evaluation Map. The suitability of each landform for urban development was assessed in terms of landscape stability and an urban capability classification then determined.

A summary of this urban capability classification is given below;

Sub-Class A-0 : Low erosion/instability hazard. There are no major constraints to development. The slope gradients range from 2% to 5%. A yellow solodic soil occurs over most of the area. Suitable for extensive building complexes.

Sub-Class A-2 : Low erosion/instability hazard. Site drainage is a development constraint. Only two small areas of this sub-class occur. The slope gradient is 2% on a yellow solodic soil. Suitable for extensive building complexes.

Sub-Class A-2,3 : Low erosion/instability hazard. Site drainage and soils are development constraints. The slope gradient is 2%. Soils are a yellow solonetzic soil and a red brown earth. Special attention to drainage and foundation design is required. Suitable for extensive building complexes.

Sub-Class A-3 : Low erosion/instability hazard. Highly plastic soils are a development constraint. Slope gradients range between 2% and 5%. Soil is a red brown earth. Special attention to building foundation design is required. Suitable for extensive building complexes.

Sub-Class B-1 : Moderate erosion/instability hazard. Slopes gradients range from 5% to 15%. The main soil is a red podsolic soil. Slope is a development constraint, with seepage areas occurring on the upper slopes. Suitable for residential development.

Sub-Class B-1,3 : Moderate erosion/instability hazard. Slope and soil erodibility are development constraints. Slope gradients range between 5% and 10%. The colluvial soils are variable in texture and localized seepage areas occur. Erosion of exposed embankments would be a problem. Suitable for residential development.

Sub-Class C-1 : High erosion/instability hazard. Slope gradients range from 10% to 20% with predominately gravel soils. Slope is a development constraint. Rock will be encountered with excavation. Suitable for residential development.

Sub-Class C-1,2 : High erosion/instability hazard. Slope and poor site drainage are development constraints. This sub-class occurs in one small area of yellow solonetzic soil with slope gradients between 5% and 10%. Special attention to drainage is required to allow residential development.

<u>Sub-Class C-1,3</u> : High erosion/instability hazard. Slope and erodible soils are development constraints Deep colluvium soils occur on slope gradients that range between 15% and 20%. Seepage areas occur. Surface instability will be acute during development. Suitable for residential use if special attention is given to foundation design and sub-surface drainage.

<u>Sub-Class C-1,2,3</u> : High erosion/instability hazard. Slope, drainage and erodible soils are development constraints. Slope gradients range between 10% and 15% on colluvium soils with extensive seepage patches. Special attention is required to site drainage before residential development can proceed.

<u>Sub-Class D-1,2</u> : Very high erosion/instability hazard. Slope and drainage and development constraints. Soils comprise gravels overlying a red podsolic soil on slope gradients greater than 20%. Suitable for reserve or yard space.

<u>Sub-Class D-1,3</u> : Very high erosion/instability hazard. Slope and erodible soils are development constraints. Comprises the steep slopes and main ridges in the area. Slope gradients range from 20% to 50%. Soils are gravels or shallow soils with rock outcrops. Suitable for retention under native vegetation for a reserve.

<u>Sub-Class D-1,2,3</u> : Very high erosion/instability hazard. Slope, drainage and erodible soil are development constraints. Occupies the upper sections of natural drainage lines with slope gradients above 5% on yellow solodic soils. Suitable for development as drainage reserves.

<u>Sub-Class D-2,3,6</u> : Very high erosion/instability hazard. A high water table and erodible soil liable to flooding are development constraints. Slope gradients range between 1% to 2% on yellow solodic or yellow solonetzic soils and occupy the major drainage lines. Suitable for development as drainage reserves for the trunk drainage system. (Refer to <u>Part C</u> of this report).

Sub-Class E-1,3 : Extreme erosion/instability hazard. Slope and unstable soils are development constraints. Slope gradients range from 5% to 15% with yellow solonetzic soils associated with granites. Development of this sub-class is not recommended.

Severe gully and sheet erosion is occurring in most sub-catchments in the Glenfield area. The eroded material will continue to cause siltation, pollution, flooding and drainage problems in the lower catchment. Uncontrolled urban development will significantly add to this problem and will involve Council in a continual heavy maintenance cost. Erosion control at this early stage is an essential part of urban development. A soil conservation programme is shown to have a favourable cost benefit ratio to Council involving a very low additional headworks charge estimated at $6.00 per residential block.

Hydrological investigation of the trunk drainage system recommended the construction of detention basins and grassed drainage reserves (waterways) to control storm runoff in the area. Pipes laid beneath the grassed drainage reserves would carry runoff from small rainfall events. Larger flows would be contained in the grassed waterways.

The information in this report is a guide to development based on soil conservation principles. To ensure the recommendations are effectively carried out consultation with local officers of the Soil Conservation Service is essential during the planning and construction stages.

PART A

INVENTORY OF PHYSICAL FEATURES OF THE ENVIRONMENT

Environmental features that influence site stability and urban development capability of this land include:

- Climate and Vegetation
- Terrain and Slope
- Drainage and Soil Erosion
- Geology and Soils

Climate and Vegetation

The median annual rainfall of 575 mm is slightly winter dominant. Highest monthly median is 53 mm in October and the lowest 23 mm in February. Evaporation varies from 223 mm in January to 31 mm in July with an annual mean of 1342 mm.

Mean temperatures range from 24.0°C in January to 8.0°C in July and extreme values of 43.7°C and -3.4°C have been recorded. The climate is characterised by hot dry summers and cool moist winters.

High intensity storms are a feature of the rainfall pattern, and predispose the area to soil loss and sedimentation of drainage works. A graph of the Rainfall Intensity Frequency Duration applicable to the Glenfield area is attached as Appendix I.

The native vegetation adapted to these climatic conditions comprises a savannah woodland of White Box with Hill Red Gum on the ridges. Red grass and spear grasses are widespread together with winter annual grasses and clovers such as Wimmera rye grass, barley grass and subterranean clover.

Terrain and Slope

The Glenfield area is a broad gently sloping valley bounded by a semi-circle of hills in the east, south and west. Three small ridges extend in a northerly direction from these hills to form the main sub-catchments.

Slopes have been divided into the following gradient classes (Map 1)

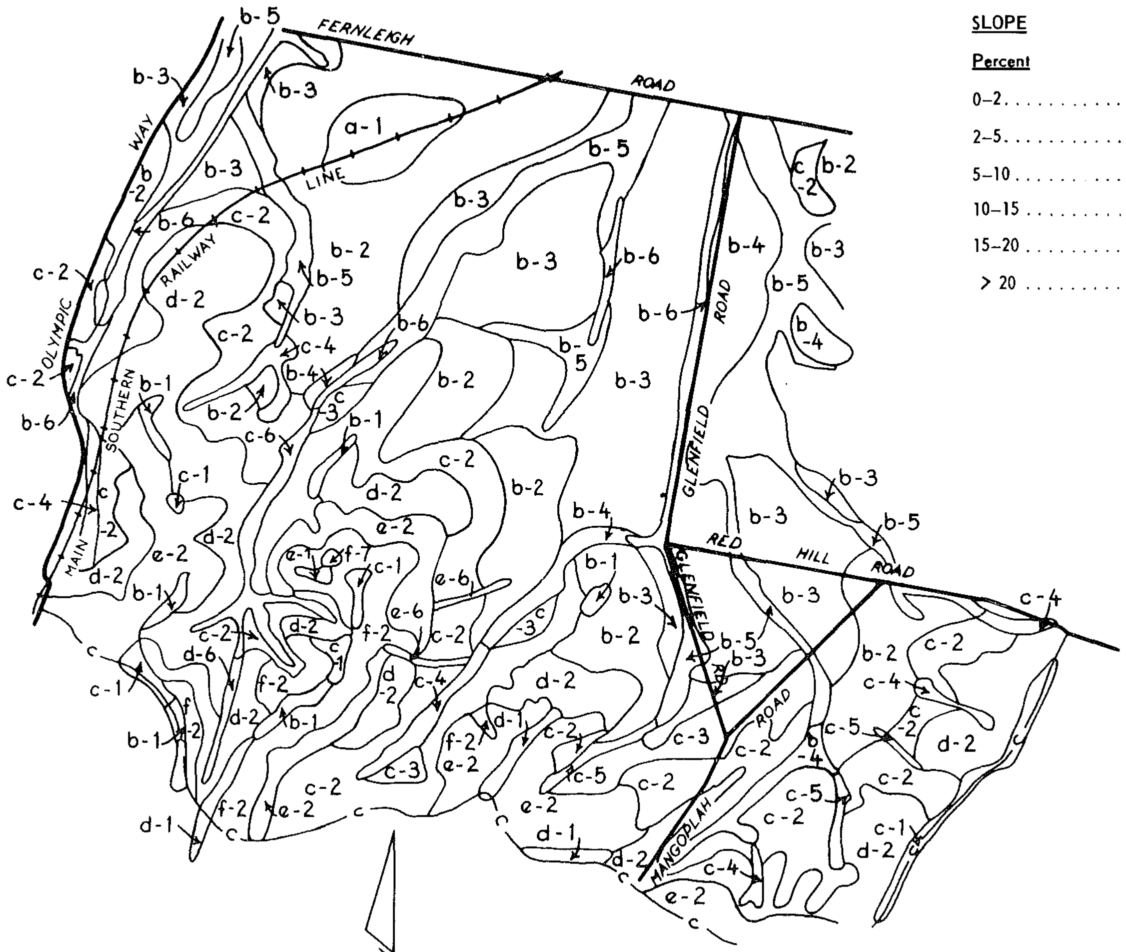
a.	0- 2%
b.	2- 5%
c.	5-10%
d.	10-15%
e.	15-20%
f.	above 20%

The predominant slope gradient is less than 10% and is suited to maximum urban development. Drainage problems can occur on slope gradients less than 2%. Slope gradients between 10% and 20% are best suited for residential purposes. Slope gradients in excess of 20% are considered unsuited for urban development due to the erosion hazard associated with the level of disturbance necessary for construction as well as a mass soil movement hazard.

Seven terrain components have been identified on the Landform map (Map 1)

1. Hillcrest and ridge
2. Sideslope
3. Footslope
4. Floodplain
5. Drainage plain - liable to overland water flow
6. Incised drainage channel - includes steep banks of channel
7. Disturbed terrain - includes gravel extraction sites

MAP 1.



SLOPE

Percent

0–2	a
2–5	b
5–10	c
10–15	d
15–20	e
> 20	f

TERRAIN

Hillcrest and ridge	1
Sideslope	2
Footslope	3
Floodplain	4
Drainage plain–liable to overland water flow	5
Incised drainage channel– includes steep banks of channel	6
Disturbed terrain	7
Catchment area boundary	— c —

Soil Conservation Service of N.S.W.

GLENFIELD SUBDIVISION

LANDFORM

SCALE

METRES 400 200 0 400 800 METRES

Drainage and Soil Erosion

The Glenfield area is drained by four small sub-catchments that converge near the junction of Glenfield and Fernleigh Roads. A fifth sub-catchment drains to the west between the main southern railway and the Olympic Way.

The five sub-catchments are located in rolling to steep hill country. All are presently in rural land use and apart from a small area of cropping all are grazed.

Serious gully erosion has occurred in the two western sub-catchments.

The condition of the three eastern catchments is generally satisfactory but erosion has developed where drainage lines have been intercepted by the Mangoplah and Glenfield Roads.

Drainage from the central catchments west of the Mangoplah Road is confined to an eroded channel beside the Glenfield Road.

Proposals for the improvement of these eroded drainage lines and their development as drainage reserves are made in Part C of this report.

Present Catchment Condition

The areas affected by soil erosion are shown on Map 5. This includes:

- 210 hectares affected by moderate sheet erosion. (Figure 1.)
- 74 hectares affected by severe sheet erosion that has removed most of the A soil horizon and contains numerous small rills and gullies. (Figure 2.)
- 11.8 kilometres of moderate gully erosion; gullies 1 - 2 metres deep. (Figure 3.)
- 8.1 kilometres of severe gully erosion; gullies greater than 2 metres deep. (Figure 4.)

Land degradation in the Glenfield area following agricultural and pastoral activities has created a catchment condition that presents a hazard to urban development.

This degradation will affect urban development in the following manner;

i Increased pollution and turbidity of runoff, which eventually enters the Murrumbidgee River.

ii Higher rates of runoff created by shallower, less absorptive soils.

iii Siltation of existing drainage facilities in developed industrial and residential areas which will increase the risk of local flooding.

iv Involve Council in a continuous maintenance cost on drainage facilities.

Sedimentation Rates

Sediment yield from two catchments on the ajoining Wagga Wagga Soil Conservation Research Centre has been measured over the past 24 years. One catchment is retained under natural conditions the other has had soil conservation treatment.

The records show an average annual sediment yield of 1970 kg/ha from 38 mm of runoff under natural conditions. By comparison, soil conservation treatment has reduced average annual sediment yield by 97% to 20 kg/ha.

Using this data the average annual sediment movement in the Glenfield area - a natural untreated catchment - is estimated at 2,400 tonnes. A major reduction in sediment output can be expected with soil conservation treatment.

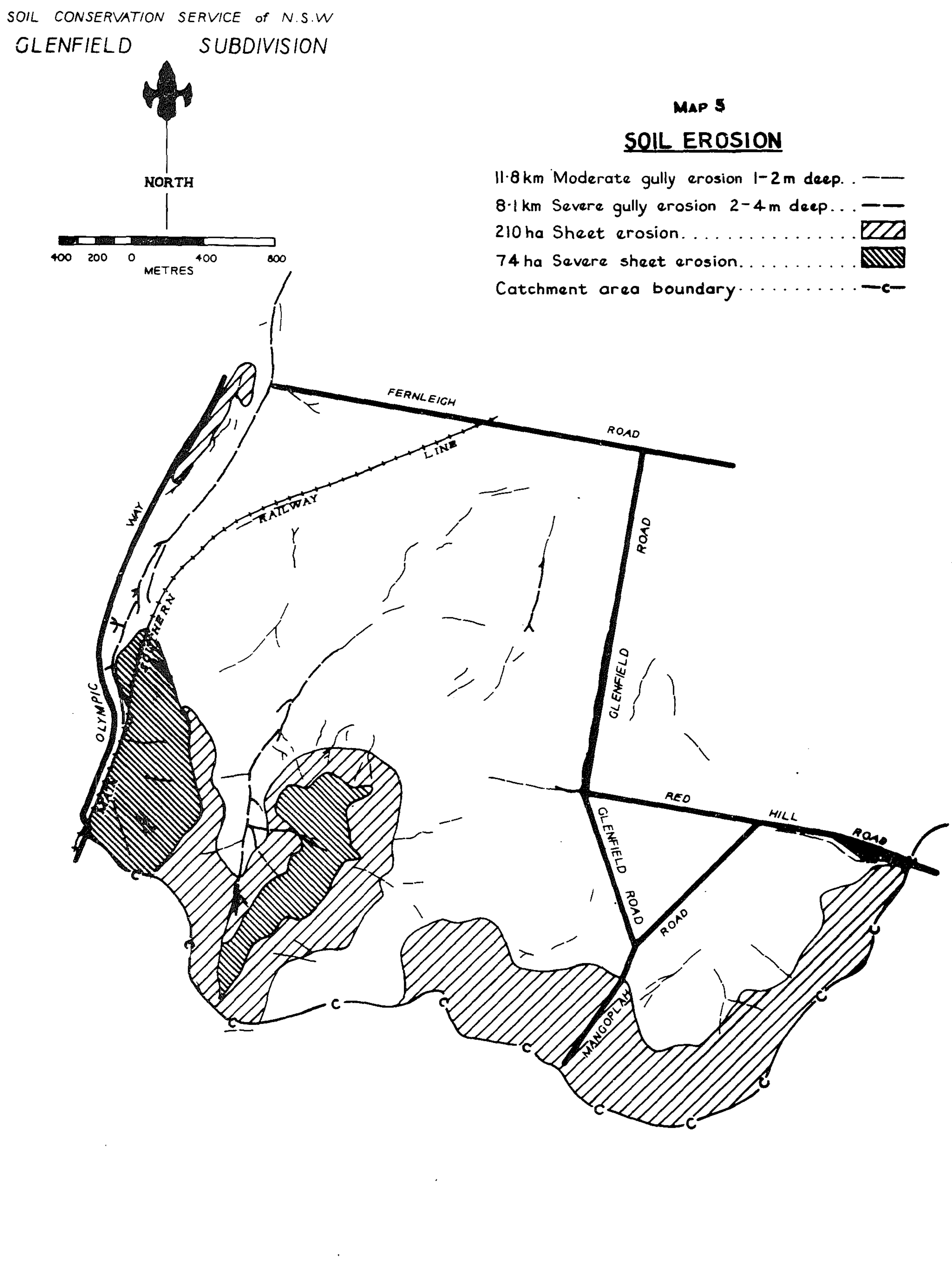

SOIL CONSERVATION SERVICE of N.S.W
GLENFIELD SUBDIVISION
NORTH
400 200 0 400 800
METRES
MAP 5
SOIL EROSION
11·8 km Moderate gully erosion 1–2 m deep
8·1 km Severe gully erosion 2–4 m deep
210 ha Sheet erosion
74 ha Severe sheet erosion
Catchment area boundary
FERNLEIGH ROAD
RAILWAY LINE
SOUTHERN
MAIN
OLYMPIC WAY
GLENFIELD ROAD
RED HILL ROAD
MANGOPLAH ROAD

Figure 1. Moderate sheet erosion has significantly reduced topsoil depth and limited the soils ability to absorb rainfall. The resultant high runoff has caused gully erosion to proceed towards the top of the hill where it is now spreading laterally.

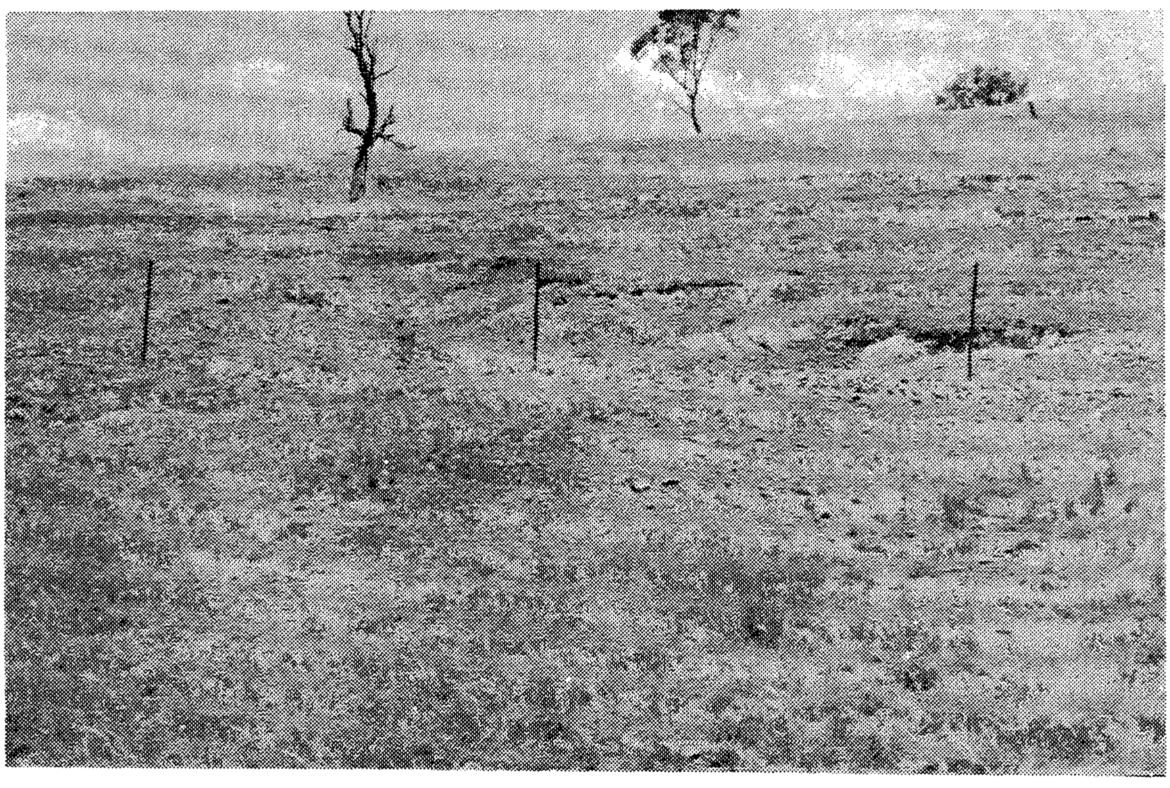


Figure 2. Severe sheet erosion has caused complete catchment degradation. Development on lower slopes will require protection, by diversion banks, from the large volume of runoff these areas generate.

Figure 3. Moderate gully erosion has affected approximately 11.8 km of drainage lines in the area. A soil conservation programme is required to control existing erosion and contain siltation before urban development takes place.

Figure 4. Severe gully erosion exists in the major drainage lines. This is a prime source of siltation now being observed and measured under rural conditions. Siltation will jeopardise proposed development and seriously reduce drainage capacities both in the Glenfield area and existing residential and industrial areas if not controlled.

A proposal for soil erosion control to reduce siltation and to improve catchment condition is given in Part C of this report.

Geology and Soils

The geology of the area consists of Ordovician sediments of shales, slates and schists which are exposed on the ridges. There is a single granitic outcrop in the south. The lower and gently undulating sections consist of Quaternary deposits and recent colluvial material.

Soil variability is related to the diverse nature of the parent material and topographic situation. Soils range from red-brown earths and yellow solodic soils on the sediments, to lithosols and sandy soils on the ridges.

The soil survey undertaken for this study was carried out by detailed field reconnaissance, followed by classification and soil sampling for laboratory analysis.

Soils were classified using the Northcote Factual Key (Northcote 1974) with the Soil Conservation Service extended principal profile form (Charman 1975).

Details of the laboratory analysis of soil samples and a summary of soil properties are presented in Appendix II

Nine soils units have been defined in the Glenfield area and are shown on Map 2.

Boundaries between units range from abrupt - 2 to 3 metres - for the red podzolic soil unit to gradual - more than 50 metres - with the yellow solodic soil unit.

Unit boundaries have been defined and soil classified from examination of the top metre of the profile. Sampling, in selected locations, extended to two metres to assess variation in the underlying material and to collect samples for analysis.

Surface seepage patches were delineated by the occurrence of actively growing green areas during the summer and plant species present. The seepage areas mapped are approximate only, whilst some may not have been detected.

A summary of the soil features that effect urban capability assessment are: -

High soil erodibility, unit (B), unit (D), unit (E) and unit (I).

Seepage problems; unit (B), unit (E), unit (G) and unit (I).

Soils with a low wet strength and low plasticity, unit (B) and unit (F).

Map Units

(A) Yellow Solodic Soil (Dy 3.42 - 3/0/40)

This unit occupies a large part of the gently sloping land in the lower sections of the area.

It is composed primarily of a yellow solodic soil that on the higher areas is overlain by 50 cm of red moderately plastic clay.

The A_2 horizon is about 20 cm thick and is moderately bleached. It overlies a yellow to red clay B horizon. The profile has a neutral pH at the surface and becomes alkaline at depth (pH 8.5). Some calcium carbonate nodules are present. The soil is moderately erodible. Well grassed drainage reserves will be quite safe. However, denuded reserves and bare excavated channels will readily erode.

(B) Yellow Solonetzic Soil (Dy 3.42 - 3/0/65)

This unit is limited to the drainage lines near the hills. Trickle flows will usually keep the area continuously wet during winter. These soils are characterised by a deep bleached A_2 horizon which has a low wet strength.

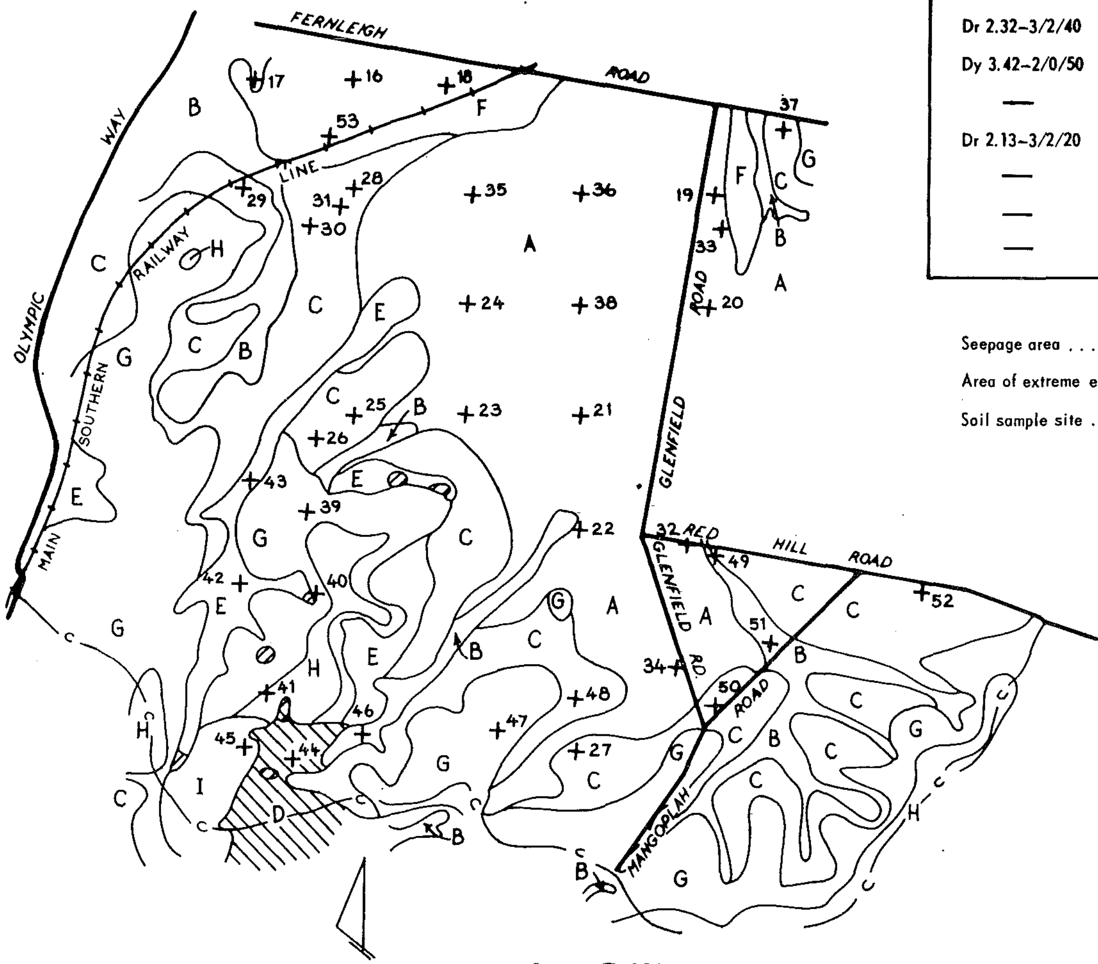
MAP 2.

NORTHCOTE CODE	GREAT SOIL GROUP	U.S.C.S.	KEY
Dy 3.42-3/0/40	Yellow solodic	CL	A
Dy 3.42-3/0/65	Yellow solonetzic	CL	B
Dr 2.32-3/2/40	Red podzolic	CL	C
Dy 3.42-2/0/50	Yellow solonetzic	SM	D
—	Deep colluvium	CL	E
Dr 2.13-3/2/20	Red-brown earth	CH	F
—	Gravel	GH	G
—	Schist and shale outcrops	—	H
—	Granite outcrops	—	I

Seepage area . . . .

Area of extreme erosion hazard . . . .

Soil sample site . . . . +36



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GLENFIELD SUBDIVISION

SOILS

SCALE

METRES 400 200 0 400 800 METRES

The soil is uniform throughout the unit and consists of a yellow gleyed moderately platic B horizon underlying the deep A_2 horizon. It has a neutral pH throughout and is of moderate to high erodibility.

The major constraint to development is the dispersible and highly erodible A_2 horizon which extends below the depth of the normal excavation for residential foundation. Deeper excavation for foundations may be required.

(C) Red Podzolic Soil (Dr 2.32 - 3/2/40)

Red podzolic soil has formed on the footslopes and low ridges which extend from higher areas.

The loam topsoil includes an A_2 horizon which varies in depth. The red earth medium clay subsoil overlies bedrock or deep yellow clay. The B horizon is of low to moderate plasticity well suited to residential development. The pH is neutral to slightly acid throughout.

This soil is only slightly erodible. It does, however, contain several seepage patches along its top boundary that will present a constraint to development.

(D) Yellow Solonetzic Soil Associated with Granite (Dy 3.42 - 2/0/50)

This unit is limited to one area of granitic colluvium on the southern catchment boundary. It can be readily separated from other similar soils in the area by its high dispersibility and high sand content (60%). Despite this high sand content the soil is relatively impermeable and promotes high runoff yields. Hence it presents an extreme erosion hazard to areas below.

The soil consists of sandy A_1 and A_2 horizons overlying a yellow mottled sandy clay B horizon that terminates in weathered granite. The pH is neutral throughout.

The high dispersibility gives the soil a high erodibility rating and low wet strength. Hence it will have a poor bearing strength when wet and will slump and erode readily in batters.

(E) Deep Colluvium

Unlike the other soil units, the deep colluvium unit is highly variable. It contains interbedded layers of sands, silts and clays and some gravels. A typical profile cannot be described.

The unit is highly erodible and contains numerous deep gullies. Due to its high variability and the presence of sand and gravel seams, along with patches of highly erodible soil any proposed development on this unit will require individual investigation.

(F) Red-Brown Earth (Dr 2.13 - 3/2/20)

The red-brown earth unit is limited to a ridge in the north-west corner of the area.

It consists entirely of a deep red soil with minimal A_2 horizon development overlying a yellow clay subsoil that increases in calcium carbonate content with depth.

This is the most plastic soil in the area and problems with house foundation movement have been experienced in the southern edge of Ashmont. This is the major constraint to development on this unit.

(G) Gravel

This unit is readily recognised by the high stone content of the surface soil. The soil underlying this layer varies from bedrock to a marginal red podzolic soil coinciding with the top edge of unit (C).

The soil rarely exceeds one metre in depth before hard rock is encountered. Therefore, foundations will largely be placed on rock but problems will be experienced with service installation excavations.

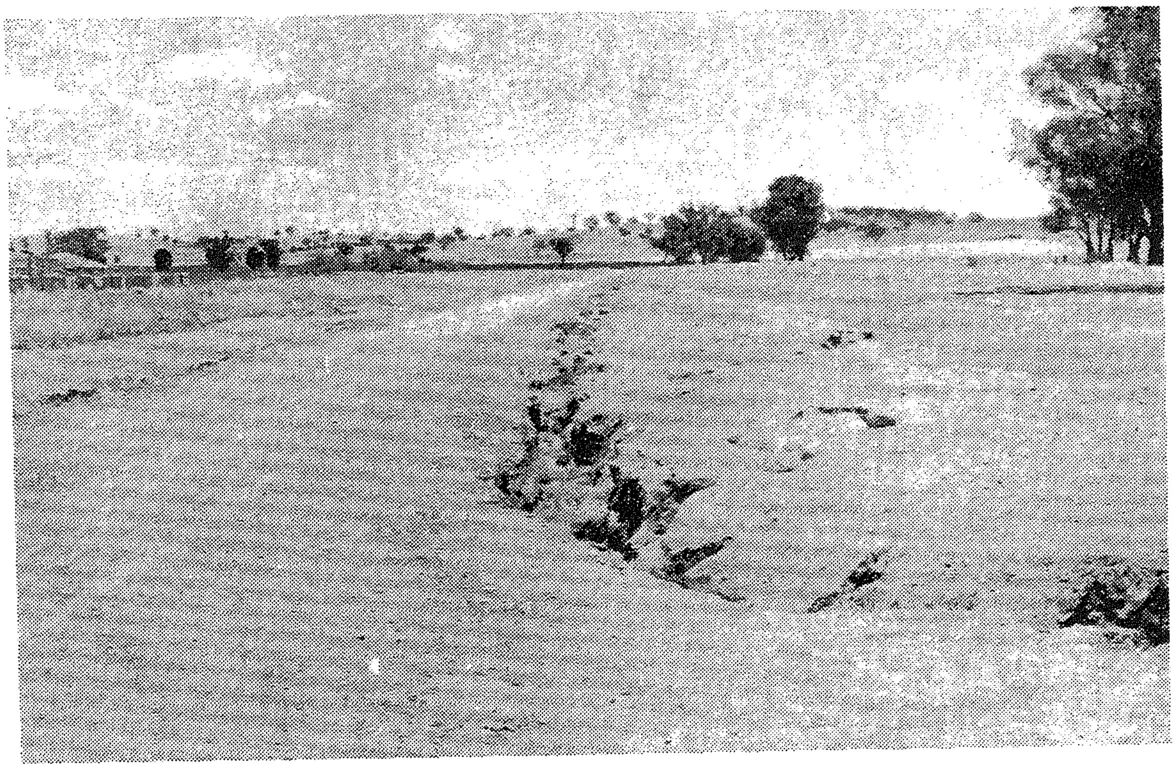


Figure 5. Erosion of yellow solodic soils will rapidly occur where roads or development sites are left exposed. The many tonnes of soil eroded from this table drain will contribute to drainage problems and flooding of existing residential and industrial areas in Wagga Wagga.

Figure 6. Sub-class D-2,3,6 contains the broad drainage plains on flatter slopes with yellow solonetzic soils. Uncontrolled development will lead to serious gullying in the short term and flooding, waterlogging and undermining of roads and service facilities in the long term. This gully erosion has developed from drainage works associated with current residential development.

Extensive seepage patches occur along the junction of this unit with the red podzolic soil. They will pose instability problems following development, especially for roads.

Major soil constraints to development are soil instability due to seepage and a shallow soil depth to bedrock.

(H) Schist and Shale Outcrops

This unit consists of very shallow soil with numerous outcrops of hard rock.

The soil consists mainly of a thin layer of gravel and loose stones with some patches of red podzolic soil occurring immediately above major rock outcrops on the slopes.

Due to its stone content, the unit is rated low to moderately erodible with extensive areas of hard rock being the major development constraint.

(I) Granite Outcrops

This unit is characterised by a large number of granitic boulders and outcrops. Soil development varies considerably from nil through a sandy yellow soil of minimal development to patches of red clay. However, the sandy soil covers most of the area.

This unit is highly erodible and is closely associated with unit (D).

Major constraints to development are extensive sheets and boulders of hard rock, high soil erodibility and seepage patches.

---------oOo---------

The Landscape Evaluation map of the Glenfield area has been prepared from an interpretation of the interaction of the physical features. (Map 3).

The assessed potential for urban development is based on five major classes of erosion/instability hazard. These are defined as:

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 that restrict development potential. Numbers used to define these restricting features are:

0. No physical constraints limiting development
1. Slope constraint
2. Drainage constraint
3. Soil constraint
6. Flooding constraint

The combination of two or more numerals indicates physical features which interact to restrict development potential. For example the numerals 3,6 would refer to a particular soil property and flooding liability as major constraints affecting development.

The capability defined for each sub-class refers to the most suitable urban use which areas within 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, aesthetics or factors relating to ecology and the environment. Development planned to minimise erosion hazard is however generally consistent with an aesthetically pleasing landscape and savings in 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 shopping malls, industrial centres, or other structures which require large scale clearing and levelling for broad areas of floor space and parking bays. Residential development infers a level of construction which provides roads, drainage and services to cater for 600 square metre housing blocks. Low density residential development infers construction to cater for 4000 to 8000 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 necessarily imply the capacity of that site to support multi-storey units or other major structures. Before such works are undertaken, a detailed analysis of the engineering characteristics of the soil, in particular bearing capacity and shear strength, is necessary.

In the following text general guidelines for erosion and sediment control during urban development are given. Specific advice relating to these techniques - such as seed and fertiliser mixtures and rates, cultivation measures, siting of sediment retaining basins and batter slopes - should be sought from the local Soil Conservation office prior to subdivision work commencing. This detail can be provided for inclusion in specifications if required.

General Guidelines for Soil Erosion and Sediment Control during Urban Development.

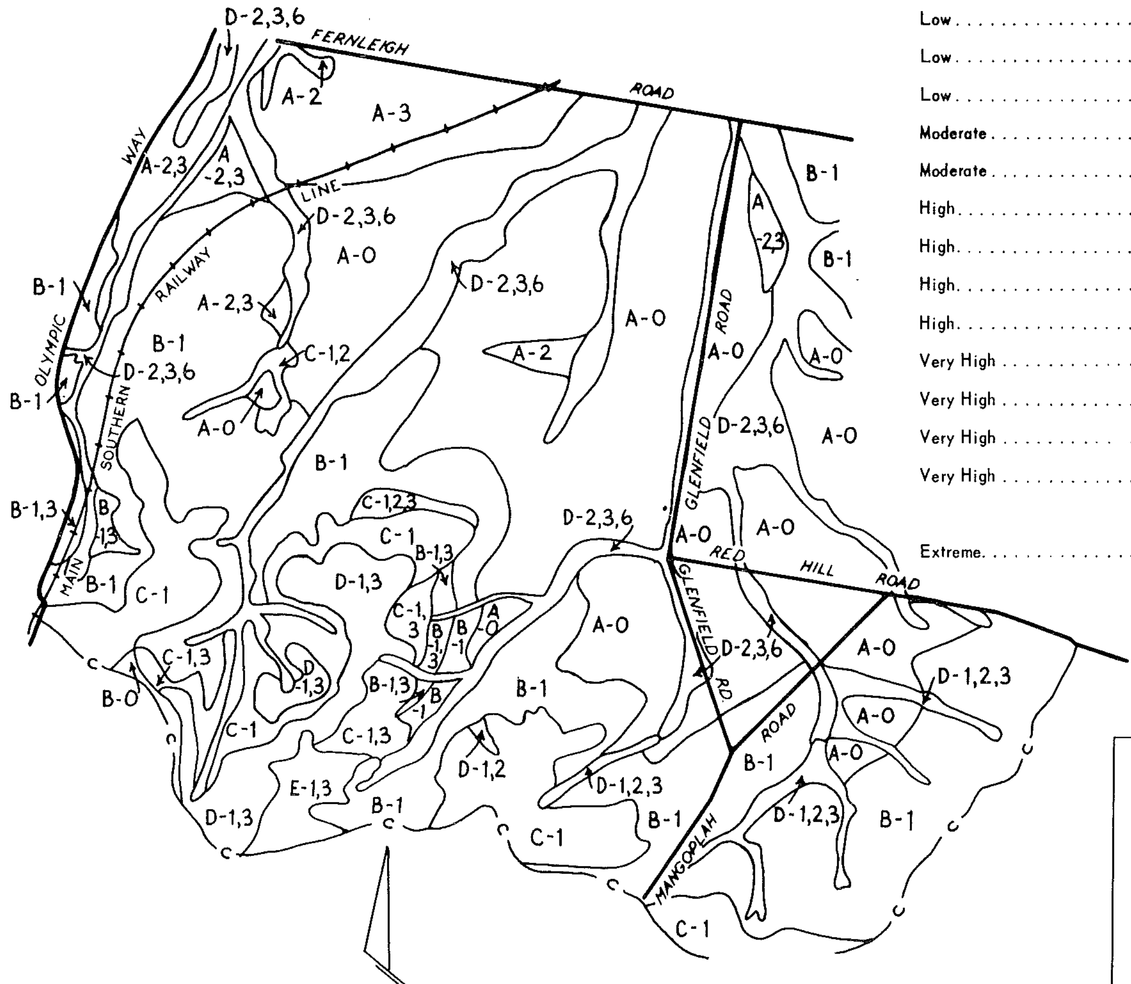
These guidelines are aimed at the control of erosion and siltation during development. They are an integral part of the capability plan and adherence to them is recommended for successful implementation of the plan.

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

MAP 3.

EROSION/INSTABILITY HAZARD	MAJOR LIMITATIONS	CAPABILITY	CLASS
Low	Nil	*E.B.C.	A – 0
Low	Drainage	E.B.C.	A – 2
Low	Drainage/Erodible soils	E.B.C.	A –2,3
Low	Soils of high plasticity	E.B.C.	A –3
Moderate	Slope	Residential	B – 1
Moderate	Slope/Erodible soils	Residential	B – 1,3
High	Slope	Residential	C – 1
High	Slope/Drainage	Residential	C –1,2
High	Slope/Erodible soils	Residential	C –1,3
High	Slope/Drainage/Soils	Residential	C–1,2,3
Very High	Slope/Drainage	Reserve	D–1,2
Very High	Slope/Shallow erodible soils	Reserve	D –1,3
Very High	Slope/Drainage/Soils	Reserve	D–1,2,3
Very High	Major Drainage Lines Drainage/Erodible soils/ Flooding	Drainage Reserve	D–2,3,6
Extreme	Slope– very unstable soil	No development	E–1,3

*Extensive Building Complexes



The classes and associated capabilities described on this map are a measure of the capacity of land within the study area to support different intensities of urban use, based only on the inherent stability of that land. The map does not constitute a recommendation for the particular forms of development indicated on the various areas.

Soil Conservation Service of N.S.W.

GLENFIELD SUBDIVISION

LANDSCAPE EVALUATION FOR URBAN USE

SCALE

METRES 400 200 0 400 800 METRES

(b) Disturbance of vegetation and topsoil should be kept to the minimum practicable. This provision is 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.

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

(e) Where appropriate, exposed areas such as construction sites should 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) Where possible, development should be designed to minimise modification of the natural landscape.

(i) Cut and fill and general grading operations should be restricted to the minimum essential for development.

(ii) On steep slopes, roadways should, where possible, be aligned just off the contour. While such an alignment may require increased cut and fill, it provides improved control over surface drainage.

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

(h) Vehicular traffic should be controlled during subdivision development, confining access, where possible, to proposed or existing road alignments. Temporary culverts or causeways should be provided across major drainage lines.

(i) Temporary tracks used during development should be graded to a crown and provided with effective surface drainage to prevent runoff eroding adjacent land.

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

(k) Borrow areas should not be located on steep slopes or on highly erodible soils. Topsoil from borrow areas should be stockpiled, and erosion control earthworks provided to protect them from upslope runoff.

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

(m) Cut and fill batters should be formed to a safe slope. On stable soils this will usually be no steeper than 1 in 2. On unstable soils it may be as low as 1 in 4. Early stabilisation of the exposed soil of cut and fill batters is essential :

   (i) Suitable seed mixtures include cereal rye, Wimmera rye grass and Woogenellup subterranean clover. These should be sown at a heavy rate with a liberal dressing of fertiliser.
   Specific recommendations on mixutres and application rates will be provided, on request, by the local Soil Conservation office.

(ii) Establishment of vegetation on batters is 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) Hydro-seeding is an alternative, effective, batter stabilisation technique. A mixture of seed, fertiliser, wood or paper pulp, and water is sprayed onto the batter through a specially designed applicator, which may be hired from the Soil Conservation Service.

(v) Vegetation is best established in autumn. If seed is sown in spring, provision for watering may be required during summer.

(vi) Once vegetation is established on batters, regular topdressing with fertiliser is necessary.

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

(n) Following roadway construction and the installation of services, all disturbed ground which is not about to be paved or built on should be vegetated:

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

(ii) Topsoil should not be respread while it is very wet or very dry

(iii) Grasses and legumes should be sown into a prepared seed bed. The range of species which may be considered for general revegetation work includes phalaris, perennial and Wimmera rye grasses, couch, creeping and browntop bent grasses, Kentucky blue grass, white clover, Seaton Park subterranean clover, and, in moist situations, paspalum and kikuyu grasses. Clover seed should be inoculated with Rhizobia and lime pelleted prior to sowing.

Autumn sowings will generally be the most successful for all species except kikuyu, which should be sown or planted in spring-summer. If spring sowing is necessary, irrigation may be required during the summer to ensure successful plant establishement.

(iv) All vegetation sites should receive an adequate dressing of fertiliser at sowing to assist vigorous establishment and growth. Specific recommendations on seed and fertiliser mixtures and application rates will be provided, on request, by the local Soil Conservation office.

(o) Correct maintenance of all areas which are to remain under a permanent vegetative cover will ensure a persistent and uniform sward. Regular topdressing with fertiliser is necessary in the early years of establishment, while mowing will control weeds and promote a vigorous turf.

Urban Capability Classification - Glenfield Area.

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

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This sub-class contains the gently sloping land forming the footslopes that adjoin the drainage plain.. Slope gradients range up to 5%. (Figure 7)

Soils are predominatly yellow solodic soils having a moderate erodibility and profile drainage.

The footslopes are subject to runoff from areas of sideslope above. Control of this overland flow with temporary diversions to prevent surface erosion and siltation on construction sites may be required. These temporary diversions usually have a life expectancy of one year or less and the failure hazard is low. Runoff should be directed into drainage reserves in sub-class D-1,2,3 or D-2,3,6.

(i) This sub-class can tolerate the maximum site disturbance of any land in the area. It is suitable for extensive building shopping or educational complexes involving large scale ground disturbance and levelling without serious erosion occuring. To minimise the area of site disturbance and access in adverse weather conditions, it is recommended that the paved parking areas be built as the first stage of development. This will facilitate the handling of materials, avoid costly delays and minimise erosion and siltation damage. Where this form of land development occurs attention should be given to provisions (a), (c), (e), (f), (m), and (o) of the general guidelines for soil erosion and sediment control during urban development.

(ii) If residential development takes place, the erosion hazard will not be significant provided the general guidelines are followed.

(iii) Few problems will be associated with the use of this area as open space, although the development of such facilities as ovals will require care with cut and fill to ensure batters are stable and well vegetated, and can be readily maintained.

Sub-Class A-2 : Low Hazard - Drainage Constraint - Suitable for Extensive Building Complexes

Two small areas are identified, one approximately at the centre, the other in the north western corner of the area. Both receive drainage from surrounding slopes and have a high seasonal water table.

These sites have a similar capability to sub-class A-0 if attention is given to overcoming the drainage constraint.

Construction on these lands will require initial attention to the provision of drainage facilities, temporary and permanent, as well as underground drainage facilities to overcome soil erosion of exposed areas.

Provisions (a), (c), (e), (g), (m), (n) and (o) of the general guidelines will apply to this land class.

Sub-Class A-2,3 : Low Hazard - Drainage, and Plastic Soil Constraints - Suitable for Extensive Building Complexes

This sub-class is located on the lower footslopes adjacent to the drainage plain. Slope gradients are approximately 2%. The yellow solonetzic soils associated with the drainage lines are usually saturated during the winter. An area classified as A-2,3 occuring in the north eastern section of the area has a red-brown earth soil which is highly plastic and foundation design will

Figure 7. Sub-class A-0 land is suitable for commercial or residential development. Provision of adequate drainage reserves is an essential part of urban development of this area.

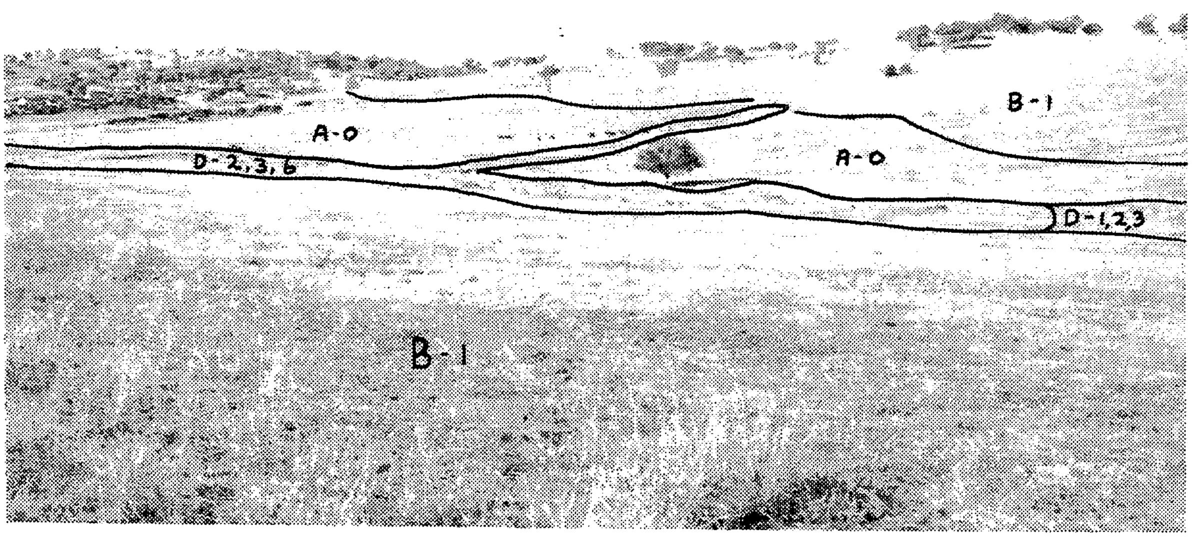

Figure 8. The central drainage line is classified as sub-class D-2,3,6 and D-1,2,3 to be retained as a drainage reserve. The lower gentle slopes up to 5% gradient comprise sub-class A-0 which has a capability to support extensive building complexes. The upper slope gradients range from 5% to 15% at the skyline and are included in sub-class B-1 being suitable for residential development.

require special attention.

The capability of this sub-class is similar to A-O if constraints are overcome.

Construction on these sites will require initial installation of temporary and permanent drainage facilities. Subsurface drainage will also be desirable for any development proposal.

Provisions (a), (c), (e), (g), (m), (n), and (o) of the general guidelines will apply to the development of land in this sub-class.

Sub-Class A-3 : Low Hazard - Highly Plastic Soils Constraint - Suitable for Extensive Building Complexes

This sub-class is located on a low ridge in the north west corner of the study area, having slope gradients up to 5%. Soils are red-brown earths with highly plastic clays which have caused house foundation movement in the southern edge of the suburb of Ashmont.

To overcome this instability problem building foundations will require individual design. A building covenant for foundation design in this subclass to reduce property damage may be required.

This land is suitable for extensive building complexes involving large scale ground disturbance. Particular attention should be paid to provisions (a), (c), (e), (m) and (o) of the general guidelines.

The capability of this sub-class is similar to sub-class A-O.

Sub-Class B-1 : Moderate Hazard - Slope Constraint-Suitable for Residential Development

In this sub-class are undulating hillslopes with slope gradients ranging from 5% to 15% that form the middle slopes of the main hill features in the area. (Figure 12)

The principal soil is a red podzolic soil which is suited to urban use having a low erodibility. Seepage areas may occur on the upper slopes at the boundary with hill crest gravel soils. This would cause a development hazard.

Uncontrolled development of sub-class B-1 land will lead to sheet and rill erosion, minor gullying, and erosion of cut and fill batters.

(i) Commercial or industrial development requiring large scale levelling is not recommended. The extent and depth of cut and fill which such development would require on the steeper slopes would generate an erosion hazard and may lead to high levels of siltation during construction. If however, such development is undertaken emphasis should be placed on permanent or temporary diversions, stabilisation of cut and fill batters and the effective compaction of fill. Particular attention should be paid to provisions (a), (b), (c), (d), (e), (f), (g), (h), (m) and (n), contained in the general guidelines.

(ii) These areas will tolerate residential development without generating a severe erosion hazard. In the event of such development particular attention should be paid to provisions (a), (b), (d), (f), (j), (m) and (n) of the general guidelines.

(iii) Few problems are associated with passive recreation on land in this sub-class provided a dense vegetative cover is maintained. The development of active recreation facilities such as ovals, requiring large scale cut and fill, will be subject to similar restrictions as set out in (i) above.

Figure 12. This photograph demonstrates the application of the urban capability classification and the relationship between erosion instability hazard, slope gradient and soil type.

Sub-class A-0	Low hazard, slope 5% stable red podsolic soil.
Sub-class B-1	Moderate hazard, slope 10% stable red podsolic soil.
Sub-class B-1,3	Moderate hazard, slope 10% erodible colluvium soil.
Sub-class C-1,3	High hazard, slope 20% erodible colluvium soil.
Sub-class D-1,3	Very high hazard, slope 20% erodible gravel soil.

Sub-Class B-1,3 : Moderate Hazard - Slope and Soil Constraints - Suitable for Residential Development

This sub-class includes slope gradients between 5% and 10% and is defined principally by the location of deep colluvial soils. These soils are very variable having been washed from the steeper slopes above and deposited in interbedded layers of clay, sand and gravel. They are highly erodible and may cause seepage problems in cut embankments. Due to their variable nature these soils may have poor coherence and individual site investigation for foundation design is required. (Figure 12)

Serious sheet and rill erosion will occur during development without erosion control measures. The erosion hazard will be minimal if attention is paid to provisions (c), (e), (f), (g), (j), (m) and (n) of the general guidelines.

Sub-Class C-1 : High Hazard - Slope Constraint - Suitable for Residential Use

This sub-class contains upper hill slopes and crests having slope gradients from 10% to 20%. The soils are predominately gravel soils containing weathered fragments of quartz, schist and shale. Soils depth is usually less than one metre and excavation for foundations or provision of services would be carried into the underlying rock. Due to the steep gradients and low soil permeability high rates of runoff which have the potential to cause rill and sheet erosion, are generated from these areas.

(i) Development of extensive commercial or industrial complexes is not recommended on these slopes for the same reasons which preclude similar development in sub-class B-1. The hazards of such development are even greater in this sub-class.

(ii) These lands are suitable for residential development without imposing a serious erosion hazard, and attention should be paid to the following provisions of the general guidelines; (a), (b), (c), (d), (f), (h), (j), (l), (m), and (n).

(iii) Passive recreation in this sub-class presents no problems, although a good vegetative cover should be maintained. Active recreation is not recommended where it will require substantial cut and fill to provide expanses of level ground.

Sub-Class C-1,2 : High Hazard - Slope and Drainage Constraints - Suitable for Residential Development

This sub-class is confined to one small section in the north western part of the area. Slope gradients range from 5% to 10% and the main constraint is created by a physiographic location in a small drainage plain subject to minor flooding and a high seasonal water table. Soil is a yellow solonetzic soil with a deep A2 horizon of poor wet strength and low bearing capacity. Foundation design should take account of this limitation.

Construction on this land should be proceeded by installation of surface and interblock subsurface drainage facilities to carry surface water and reduce erosion of exposed areas.

The capability of land in this sub-class is similar to sub-class C-1 once drainage facilities are provided.

Sub-Class C-1,3 : High Hazard - Slope and Erodible Soil Constraints - Suitable for Residential Development

This sub-class is located on deep colluvium soil, unit (E), in the centre of the area. Another small area occurs in the south-west corner. Slope gradients range from 15% to 20%.

The major development constraint is a high erosion hazard created by the combination of deep colluvium soils and steep slope. Seepage patches will be encountered if development is undertaken.

Potential erosion problems include serious rilling and gullying and soil slip on cut batters. Silt from this area may cause maintenance problems and reduction of capacity of drainage facilities constructed below.

(i) These areas are considered unsuitable for development of extensive building complexes, entailing large scale cut, fill and levelling operations.

(ii) Residential development is considered the highest capability of land in this sub-class. Due to the extreme soil variability specific attention should be paid to foundation design and subsurface drainage on each individual housing block.
Development of these areas can be achieved without generating a severe soil erosion problem by paying particular attention to provisions (a), (b), (d), (e), (f), (m), (n) of the general guidelines.

(iii) Extensive site levelling for active recreation facilities is not recommended. Development for passive recreation purposes does not present problems of site instability.

Sub-Class C-1,2,3 : High Hazard - Slope, Drainage and Erodible Soil Constraints - Suitable for Residential Development

This sub-class is confined to one small area north of Red Hill road in the centre of the area. This area contains extensive seepage patches on a colluvium soil unit with slope gradients ranging from 10% to 15%. (Figure 14)

Development of extensive building complexes or active recreation areas requiring extensive cut and fill is not recommended.

Residential development will require specific attention to foundation design and provision of both surface and subsurface interblock drainage facilities to overcome the extensive subsurface seepage. Cut and fill batters should be constructed on the lowest gradients practicable as soil slip will be experienced on steeper batters.

Similar provisions of the general guidelines to those recommended for sub-class C-1,3 are required for residential development.

Sub-Class D-1,2 : Very High Hazard - Slope and Drainage Constraints - Suitable for Reserve

This sub-class with slope gradients greater than 20% is confined to a small area in the south. Soils comprise gravels overlying a red podzolic soil. Seepage patches occur at the junction of these soils.

Development of this area will create a very high erosion hazard due to the steep terrain and seepage.

This land is best suited to passive recreation or yard space. Minor modification of the ground surface for maintenance and to control gully erosion would be required and specific advice will be available from the Soil Conservation Service on request.

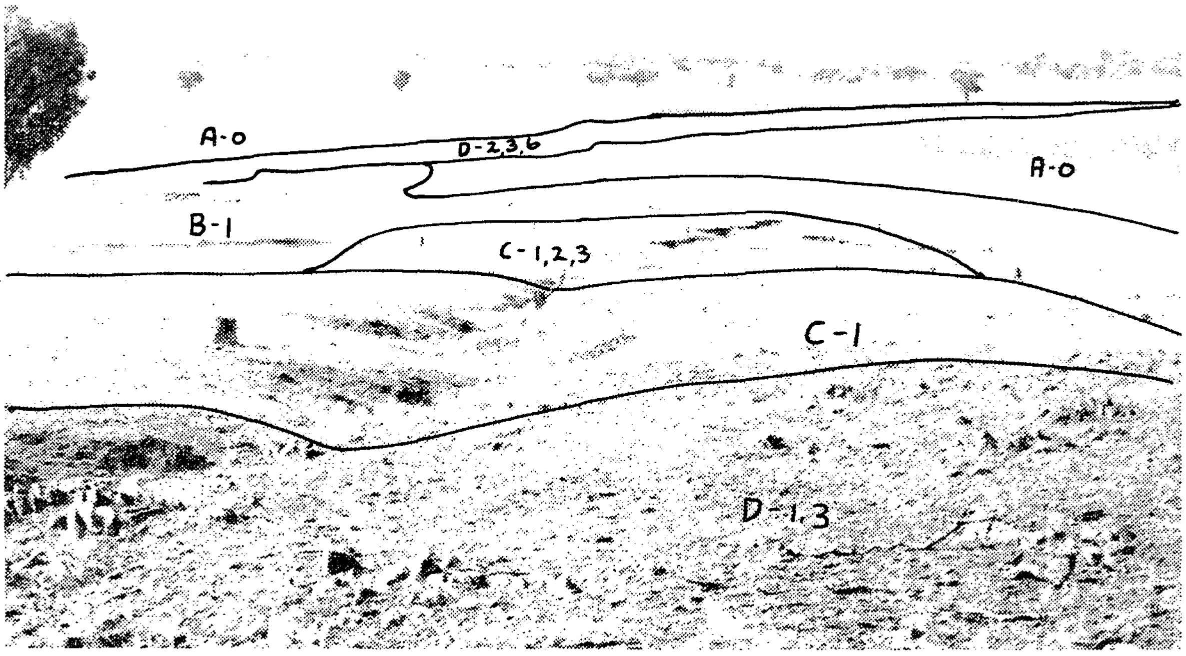

Figure 13. Sub-class D-1,3 contains the steep rocky land in the foreground. Sub-class C-1 is suitable for residential development. Sub-class C-1,2,3 contains extensive seepage patches. A low density residential use is recommended.

Figure 14. Detail of land in sub-class C-1,2,3 shown in Figure 13. This land has a high erosion hazard due to the combination of deep colluvium soil, slope gradients between 10% and 15% and extensive seepage areas.

Figure 15. Gravel soils on the steep slopes in the foreground are liable to mass movement if disturbed. This area is classed as sub-class D-1,3 suitable for reserve. The gentler slope to the right is sub-class C-1,3 which is suitable for residential development provided runoff from the steep slope above is controlled and the deep colluvium soil, that may contain seepage patches, is subsurface drained.

Figure 16. Sub-class E-1,3 contains an extremely erodible soil of low wet strength. This is the most unstable unit in the area. No form of development is recommended. This gully erosion of a stock track has deposited a large volume of sediment.

Sub-Class D-1,3 : Very High Hazard - Slope and Erodible Soil Constraints - Suitable for Reserve

The steep slopes of the main ridges and crests are included in this sub-class. Slope gradients range from 20% to 50%. Two soil units occur, they are the very shallow soils in numerous outcrops of hard rock, and gravel soils with high stone content. The latter are liable to be unstable due to seepage, and one small land slip has occurred on a slope gradient greater than 30%. (Figure 15)

Due to the shallow nature of these soils, high rates of runoff can be expected and the planning of drainage reserves through residential development should take this factor into account. Detention basins in the upper catchment will reduce the effect of these high runoff rates, provide some erosion control and allow development of a stable waterway system.

This area is not recommended for urban development due to the high erosion and instability hazard arising from land slip and extensive seepage patches.

It is recommended the area remain undisturbed and retained under a good vegetative cover for passive recreation.

Sub-Class D-1,2,3 : Very High Hazard. Slope, Drainage and Erodible Soil Constraints - Suitable for Reserve

The upper sections of the major drainage lines with slope gradients above 5% have been included in this sub-class. The yellow solodic soils are not subject to a high seasonal water table to the extent of similar soils lower down. Land in this sub-class is not liable to prolonged overland flow as is land in sub-class D-2,3,6. However, these areas will receive large volumes of runoff from adjacent slopes which together with an erodible soil type will cause continual instability problems if developed.

It is recommended this unit be used as open yard space or maintained as a drainage reserve.

Recommendations for the establishment of the drainage reserve are contained in Part C of this report.

Sub-Class D-2,3,6 : Very High Hazard - Seasonal High Water Table, Erodible Soil, Flooding Liability Constraints - Suitable for Drainage Reserve

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Slope gradients within this sub-class range between 1% to 2%. Soil is primarily a yellow solodic soil which is moderately erodible. In some places the soil has been covered with sediment deposited from erosion of upstream slopes. This sediment has low cohesion and is readily erodible once disturbed. (Figure 6.) Yellow solonetzic soils occur in the drainage lines near to the hills. These soils are usually saturated during winter, have a deep A_2 horizon, a moderately plastic B horizon, and are moderately to highly erodible.

Uncontrolled development of land in this sub-class will lead to serious gullying in the short term, and flooding, waterlogging and undermining of development works in the long term.

(i) Development of extensive building complexes or houses is not recommended on these lands because of the hazards indicated above.

(ii) To minimise erosion and long term instability the most suitable use for areas delineated by D-1,2,3 and D-2,3,6 is drainage reserves. These reserves can be developed to carry all storm water from the catchments above. Recommendations for their development are contained in Part C of this report.

Ideally drainage reserves in the Glenfield area should be constructed and stabilised at least 18 months before sub-division works commence. As most drainage lines are eroded their early development and stabilisation should receive highest priority.

Construction of grassed drainage reserves should be planned to allow two growing seasons prior to extensive residential development. Provisions (h) and (o) of the general guidelines should receive particular attention.

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

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This sub-class contains yellow solonetzic soil which is highly erodible and dispersible. In addition the soil has a low wet strength and will slump and erode readily from batters. Slope gradients range from 5% to 20%. (Figure 16)

The soil is relatively impermeable and promotes high rates of runoff. Gully erosion rapidly develops once the surface is disturbed.

The removal of vegetation and surface disturbance generally will accentuate the landslip hazard. Any such slope movement will not only affect the immediate area but may also, through transport of debris downslope, affect development works at lower elevations.

Because of this extreme erosion and instability hazard development of this sub-class is not recommended.

PART C.

DEVELOPMENT OF DRAINAGE RESERVES AND DETENTION BASINS

SOIL CONSERVATION PROGRAMME

DEVELOPMENT OF DRAINAGE RESERVES AND DETENTION BASINS

Introduction

This part of the report provides recommendations for the development of trunk drainage reserves and detention basins together with proposals for soil conservation treatment of eroded lands.

Site investigations have shown that uncontrolled urban development in the Glenfield area would adversely affect existing residential and commercial development in Dobney Avenue and Pearson Street in the following manner;

* Existing drainage facilities would be severely overtaxed with increased runoff from new urban areas.

* The culvert under the main southern railway line is inadequate and would cause localised flooding on the upstream side.

* Heavy silt loads from areas being converted from a rural to an urban land use will severely reduce capacities of channels and culverts and greatly add to Councils' maintenance costs.

* Most sediment would eventually be deposited in the temporary flood pondage behind the main levee bank of the Murrumbidgee River. Once the capacity of this pondage has been reduced by siltation, flooding of new industrial areas could occur from local runoff.

Consequently, the following items are a necessary part of the urban development of the Glenfield area:

* Development of drainage reserves incorporating detention basins

* A soil conservation programme.

The Urban Drainage System

Conventional trunk drainage systems are normally designed for a 5 to 10 year flood frequency and are usually piped underground. Where this becomes too expensive due to increased discharges concrete lined channels are constructed. However, the defined flow paths and lower roughness coefficients shorten flow times which increase the discharge and the cost of the system throughout its entire length. Consequently, a compromise is normally made between cost and the storm return period. This often leads to the sytem being overtaxed for particularly heavy storms.

An alternative method, recommended for the Glenfield area, is to contain the 3 year flow in a concrete pipe and provide a formed natural grass waterway to cope with discharges from storms of greater return period. The combination of an underground pipe and grassed waterway has proved an efficient method of storm runoff disposal in urban areas. By separating the low flows in a pipe the grassed waterway can be maintained in a better condition to carry heavy storm flows with minimum erosion damage and at a small maintenance cost. In addition, the grassed drainage reserve provides recreational and pedestrain access. (Figure 9.)

The drainage reserves referred to here relate to sub-classes D-1,2,3 and D-2,3,6 of the urban capability assessment.

Detention basins in the trunk drainage system can reduce flood discharges to levels similar to or less than those occurring prior to urbanisation. This discharge reduction will significantly reduce soil erosion and siltation.

MAP 4

HYDROLOGICAL INVESTIGATION
DRAINAGE RESERVES AND DETENTION BASINS

SOIL CONSERVATION SERVICE of N.S.W
GLENFIELD SUBDIVISION

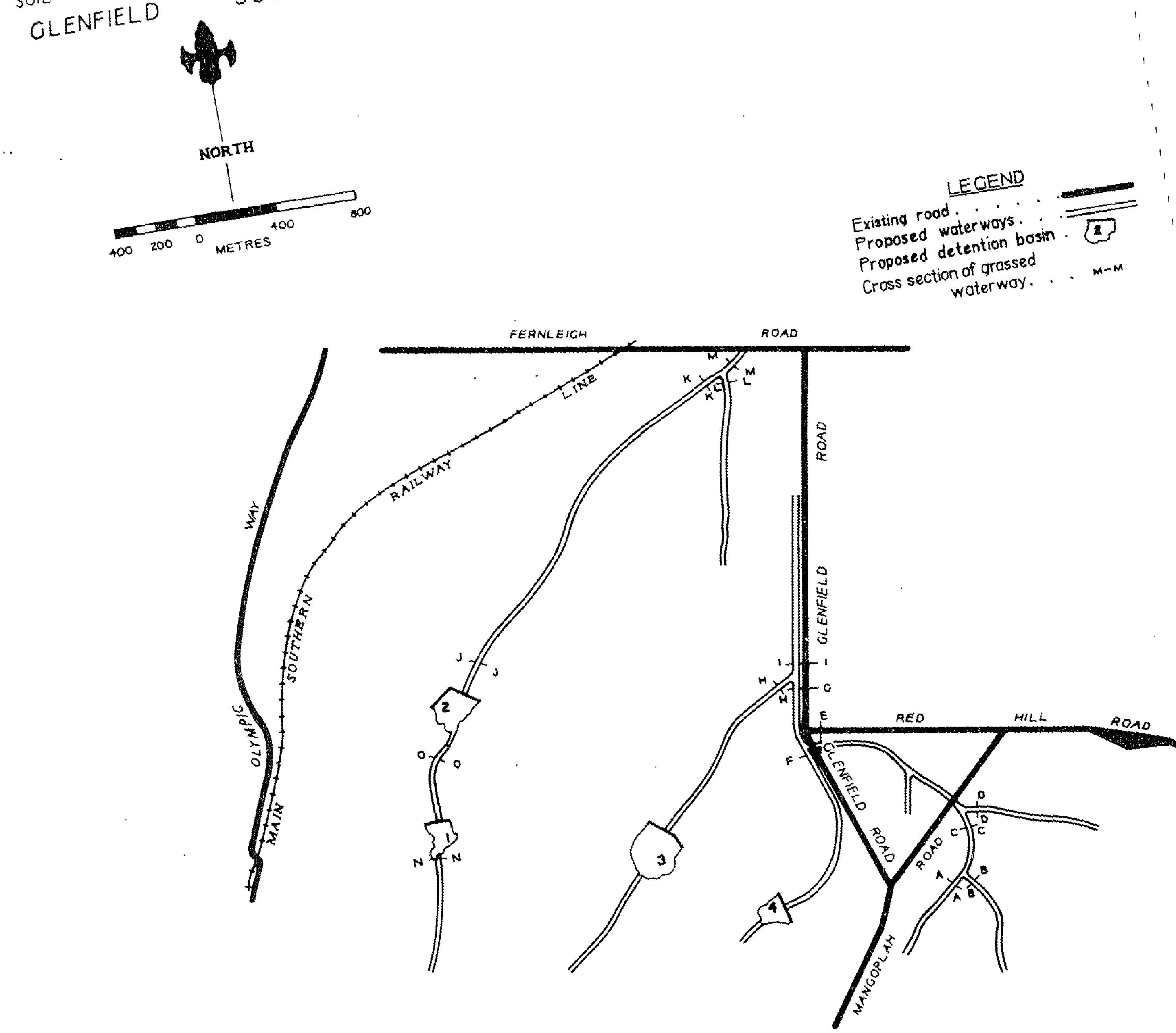


Figure 9. Development of drainage reserve sub-class D-2,3,6 in an urban area. The combination of an underground pipe and grassed waterway is an efficient method of storm water disposal and provides a recreational area for a large number of residents.

Design Factors for the Glenfield Trunk Drainage System

Map 4 shows the location of the proposed grass drainage reserves and the sites of the proposed detention basins.

The Rational Method of flood estimation was used to determine flood discharges for the design return periods. This method was adopted since local design values have been derived from a similar adjacent catchment at the Wagga Wagga Research Centre. (Adamson 1975)

Runoff coefficients were based on those derived by the statistical method of French et al (1974) for the Wagga Wagga Research Centre catchment. These were adjusted for urbanisation effects using data from several urban Melbourne catchments. (Aitken 1975)

A design return period of 3 years should be selected for the pipes to be laid below the grassed drainage reserves while reserve widths should be determined for a 100 year return period.

The 3 year return period will be sufficient to carry the majority of storm events and allow the grassed channels to become stabilised.

The maximum velocity of runoff to be carried in the grassed waterway is 2 metres per second. This velocity is determined by soil characteristics and would cause least scouring of the channel once vegetation was established.

Peak runoff in excess of the 1 in 100 year return period is usually not considered for the design of grassed channels, since in catchments of this size design for greater return periods is considered uneconomic and too conservative. Nevertheless, residential development is not recommended directly alongside the floodways where flooding from a storm with a greater return period may occur.

Where major roads cross the waterways longer design return periods may be needed for culvert design.

A separate report will be provided concerning the hydrological details and specifications of the grassed drainage reserves.

Application of Detention Basins to Urban Drainage

Detention basins are large storages designed to impound runoff and control its discharge through a regulating pipe. An emergency spillway is always provided for events when storm runoff exceeds storage capacity. (Figure 10 and Figure 11)

Where suitable sites exist, detention basins can be used to delay runoff and reduce the increased peak discharges brought about by urbanisation. They will also act as a sediment trap.

Detention basins will reduce drainage costs since pipe diameters downstream can be designed using a 1 in 1 year discharge rather than a 1 in 3 year. Storm runoff discharges greater than the pipe capacity are detained within the basin and metered through the regulating pipe. Surplus runoff is discharged over the emergency spillway to enter the grassed drainage reserve.

In summary the following return periods are used for the design of the pipes:

Above the detention basin - 3 year return period.
Below the detention basin - 1 year return period.
The 1 year return period is continued below the detention basin until the next lateral inflow occurs, it then reverts to a 3 year return period.

Four detention basins are proposed for the Glenfield area details of which are given in Map 4 and in Table 1.

Cost of Detention Basins

Table 2 provides cost estimate details for construction of the proposed detention basins.

TABLE 1 SUMMARY OF SPECIFICATIONS FOR PROPOSED DETENTION BASINS - GLENFIELD AREA - WAGGA WAGGA CITY

BASIN NO.	CATCHMENT AREA ha	100 Yr INFLOW m^3/sec	TIME TO PEAK mins	ROUTED OUTFLOW m^3/sec	TIME TO PEAK AFTER ROUTING mins	STORAGE BELOW SPILL m^3	SPILLWAY WIDTH m	SPILLWAY DEPTH OF FLOW m
1	58	11.5	25	7.2	54	20,000	17	0.45
2	94	8.9	58	4.0	78	22,400	17	0.30
3	81	12.5	34	7.8	72	22,100	17	0.45
4	30	8.6	16	6.2	30	4,300	17	0.35

TABLE 2.

ESTIMATED COSTS OF DETENTION BASINS - GLENFIELD AREA, WAGGA WAGGA CITY

Item	Unit	Rate $	Quantity	Amount $
Detention Basins				
Volume in walls	m^3	1.00	27,950	27,950
Pipe outlets	m	50.00	230	12,500
Concrete	m^3	225.00	10	2,250
Trash Screens	-	-	4	650
Grassing	ha	250.00	2	500
TOTAL				$43,850

A comparision between the construction cost of a conventional trunk drainage system and grassed drainage reserves with detention basins for a catchment at Albury, showed that the conventional system was 20% more expensive. (S.M.E.C. 1976). The Albury catchment is comparable in topographic features to the Glenfield catchment and similar construction cost advantages can be expected.

FIGURE 10 DETENTION BASIN DETAILS

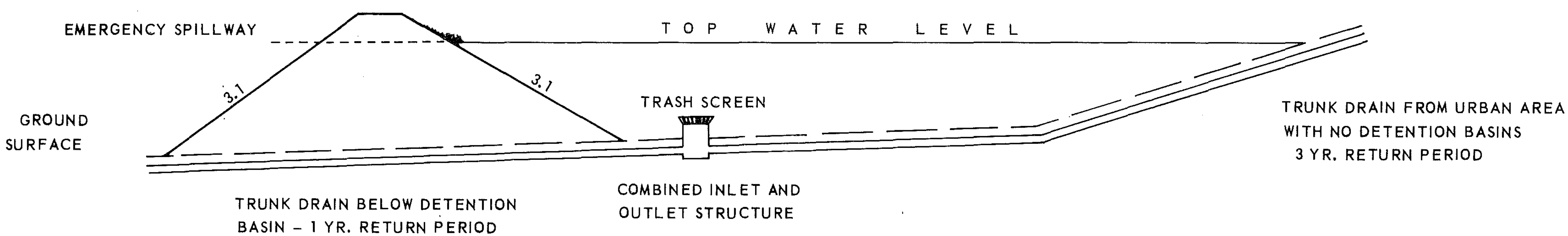
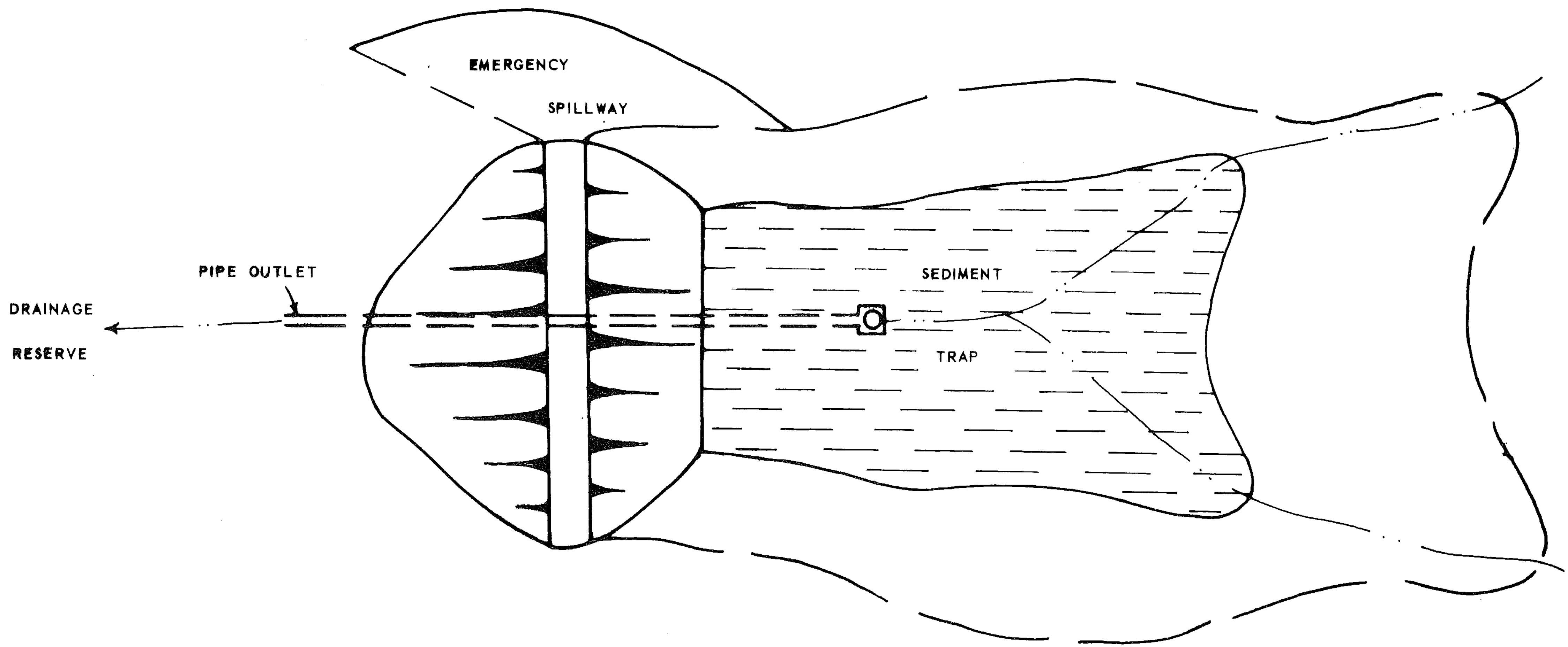


FIGURE 11 DETENTION BASIN DETAILS - PLAN VIEW



SOIL CONSERVATION PROGRAMME

Effects of Urban Development

Experience in Australia and overseas has shown a dramatic increase in sediment output from catchments changing from a rural to an urban land use. Although urbanisation may be spread over a five year period, the increase in sediment yield is in the order of 400 times the rural rate.

Sedimentation generally follows a two stage pattern with a large increase during the construction phase as the result of vegetation removal by earthmoving machinery.

This is followed by steady reduction as the area stabilises with the establishment of drainage facilities, paved roads and lawns. The general change in sediment output is shown in Figure 17.

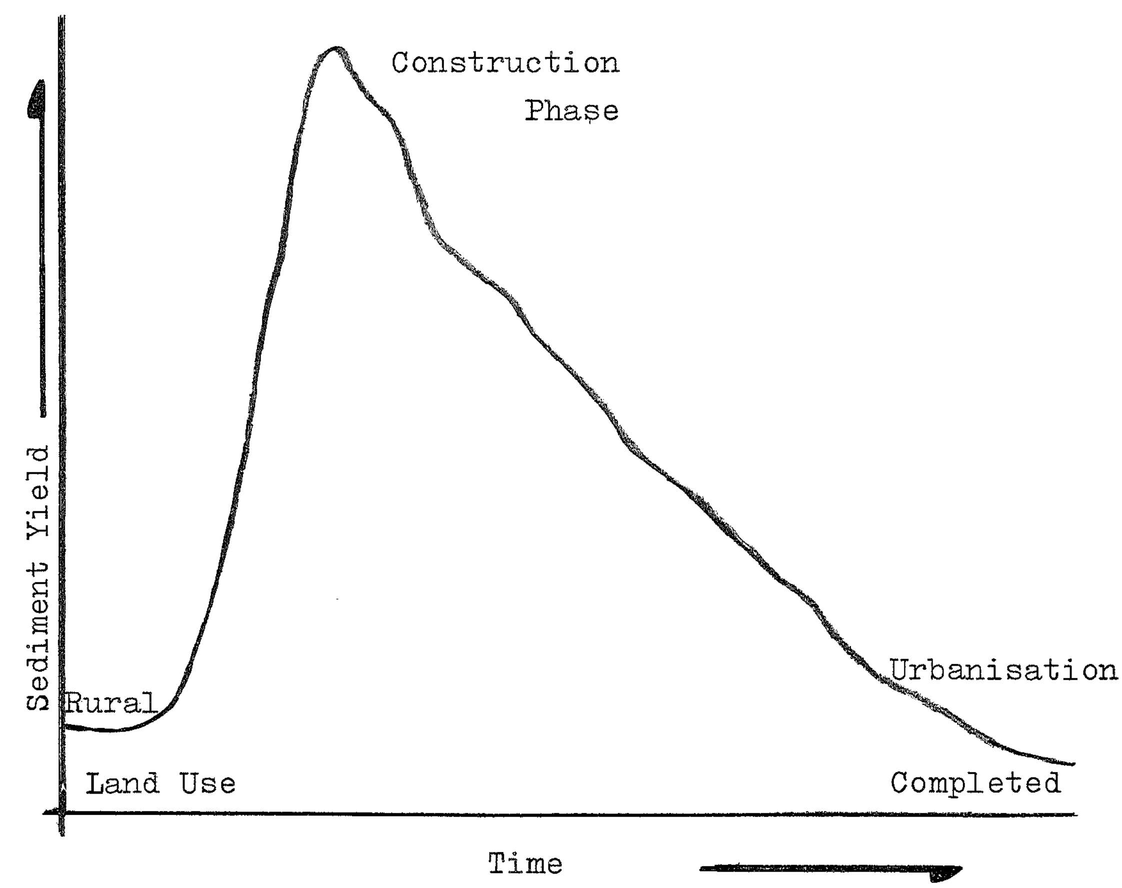


FIGURE 17. A Generalised Relationship Between Sediment Yield and Time for a Catchment Changing from Rural to Urban Land Use.

Sedimentation can be reduced in the construction phase by adequate planning and the adoption of recommendations contained in the general guidelines in Part B of this report.

Soil Conservation and Land Management Programme

In Part A of this report, annual average sediment yield from a local rural catchment was recorded at 1970 kg/ha. With urban development this is expected to increase 400 times during the construction phase. Assuming only 25% of the total Glenfield area is in this construction phase in any one period, the potential sediment output is estimated to be in the order of 2400 tonnes per year.

Reduction of sediment yield is essential for the long term stability of development. Small subdivisions should not be considered in isolation from their physiographic relationship to the entire catchment. Early control of existing erosion will ensure long term stability and community benefit.

It is recommended a soil conservation programme be adopted as an integral component of the planning process for the urban development of the Glenfield area.

This programme would include the design and construction of soil conservation earthworks such as absorption banks, graded banks, contour ripping and sediment detention basins. These works would control runoff, increase moisture absorption, reduce sedimentation and the erosive velocity of runoff across the gentler slopes and developing areas below. Once runoff is controlled eroded gullies can be filled and shaped for development as grassed drainage reserves in the expanding urban area.

The programme would complement the runoff detention basins proposed earlier in this report by increasing moisture infiltration and the time of concentration of runoff from storm events. Rapid siltation of these basins would also be avoided.

In addition, the soil conservation banks will protect construction sites from runoff from higher land. This is recommended for development of lands having high erosion hazard - such as Class C land. When construction is finished and alternate site drainage systems are installed the soil conservation banks can be progressively eliminated. Banks constructed on Class D and E land where commercial or residential development is not recommended would provide permanent protection.

A programme of rural land management of the catchment is also required to ensure the continued stability of treated lands. This programme would aim at controlled grazing, fencing of critical areas, such as gully fill of main drainage lines, for revegetation and pasture improvement. This programme would require close liason with landholders in the area.

Cost of the Soil Conservation and Land Management Programme

The cost of soil conservation treatment of eroded lands shown on Map 5 in Part A of this report has been estimated on the current Soil Conservation Service plant hire charges.

The estimates are provided in Table 3.

Earlier in this report sediment yield, from uncontrolled development on only 25% of the area, was estimated at 2,400 tonnes per year. Assuming 75% of this amount is deposited in drainage channels and the flood pondage behind the Murrumbidgee levee, sediment will accumulate at a rate of 1,800 tonnes per annum.

The average annual cost to Council to remove this sediment is estimated to be $10,800 based on a rate of $6.00 per tonne for removal with backhoe, dragline and trucks.

TABLE 3

ESTIMATED COSTS OF SOIL CONSERVATION AND LAND MANAGEMENT TREATMENT - GLENFIELD AREA - WAGGA CITY

Broad area treatment of sheet eroded lands with graded and absorption banks, contour ripping and levelling of severely eroded lands.	284 ha	$ 32,800
Gully fill and shaping of moderate and severe gully eroded areas.	19,900 metres	$ 29,200
Land Management practices including fencing, and revegetation of critical areas.		$ 8,000
Total Cost		$ 70,000

The cost/benefit to Council in the adoption of a soil conservation programme is calculated on a present value basis of maintenance costs at $10,800 per annum at an interest rate of 6% over a 20 year period when the catchment is anticipated to be 80% urbanised.

$10,800 x 11.4699 (present value of annuity) = $123,875

$$\text{Cost/Benefit ratio} = \frac{\$123,875}{\$70,000} = 1.77$$

The cost/benefit ratio is based wholly on annual maintenance cost against the total cost of the soil conservation programme. Other benefits include protection of new urban areas, reduction in volume and time of concentration of storm runoff and increased aesthetic and recreation value.

The adoption of the soil conservation programme would result in an estimated charge of $6.00 for each 600 square metre residential block. This charge is based on the assumption that residential, commercial and industrial land would be only 60% of the total area of 1200 ha.

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PART D

APPENDIX

APPENDIX 1

Rainfall Intensity Frequency Duration Curve
Wagga Research Centre

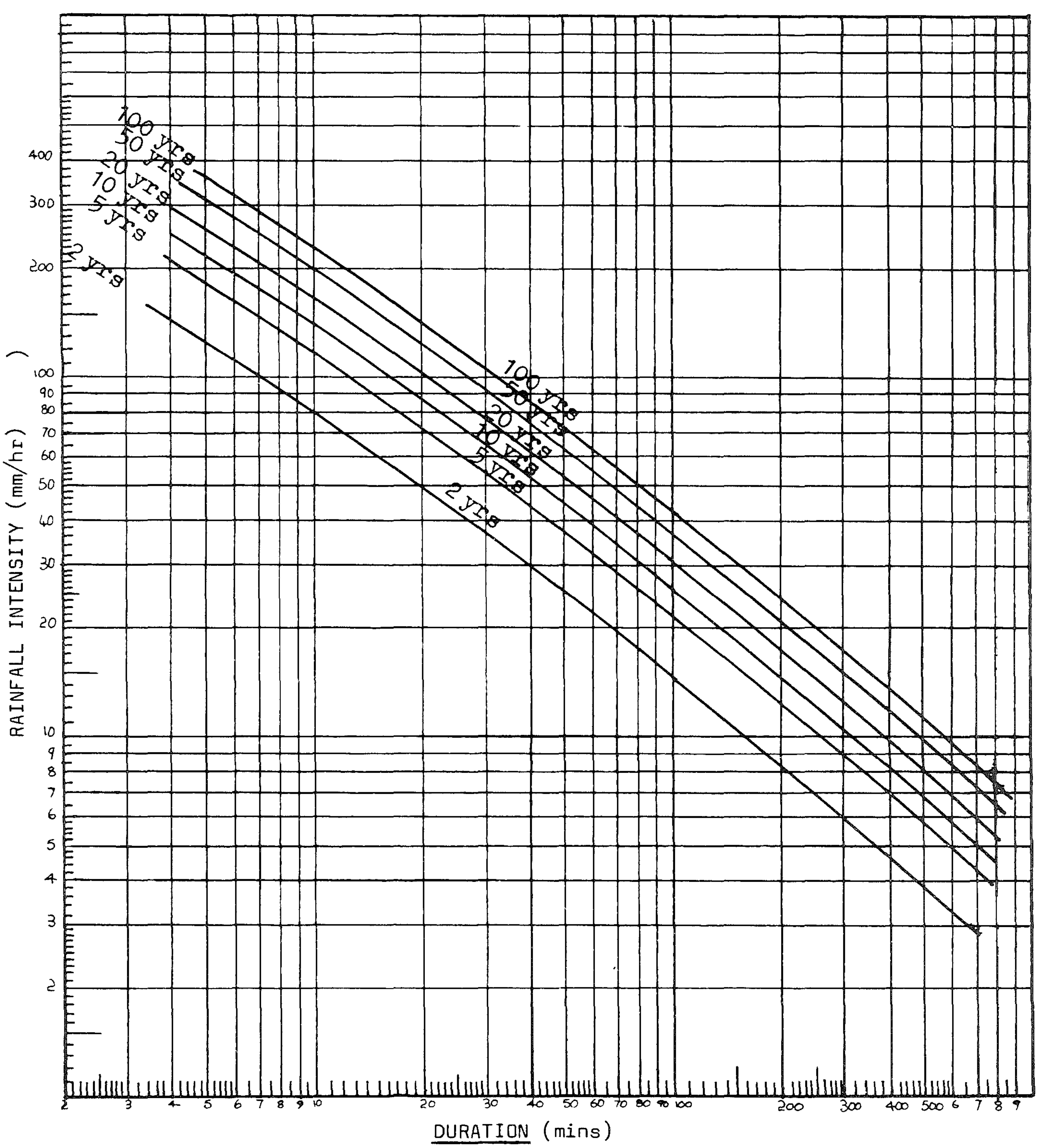

TABLE 4 LABORATORY ANALYSES OF SOIL - GLENFIELD AREA - WAGGA WAGGA CITY

No.	DEPTH (cm)	C	Si	F.Sa	C.Sa	G	St.	LL	PI	USCS	D.I.	S/S	E.C.T.	S.P.T.
16	10-75	82	4	10	1	1	2	59	34	CH	11	26	3	M
	75-180	48	4	11	1	17	19	54	32	CH	2.6	19	3	H
17	25-180	55	16	20	2	5	2	44	26	CL	4.4	27	1	H
18	35-75	58	10	14	5	4	9	51	29	CH	7.2	26	3	H
19	35-120	41	10	33	16	0	0	33	17	CL	7.3	18	3	ND
	120-150	32	2	44	18	3	2	25	14	CL	5.67	14	3	ND
20	0-150	70	10	17	3	0	0	46	26	CL	7.4	28	3	L
21	35-80	50	15	24	6	4	1	39	23	CL	5.8	16	3	L
	80-150	33	25	36	5	0	0	33	16	CL	4.4	7	1	H
22	0-100	33	6	51	9	0	0	26	13.7	SC	9.5	13	3	H
23	30-80	40	15	33	9	2	1	34	21	CL	8	12	-	-
24	15-50	42	15	36	5	0	1	32	16	CL	8.3	19	3	H
	50-80	44	15	33	6	0	2	33	19	CL	13	18	3	H
25	20-50	42	9	32	9	0	8	33	14	CL	8.3	17	3	H
	50-150	57	10	29	4.3	0	0	42	24	CL	15.5	13	3	H
26	30-70	42	25	14	16	0	4	37	19	CL	3.13	13	3	H
27	30-100	47	17	30	5	0	1	37	22	CL	9	16	3	ND

TABLE 4 LABORATORY ANALYSES OF SOIL - GLENFIELD AREA - WAGGA WAGGA CITY

No.	DEPTH (cm)	C	Si	F.Sa	C.Sa	G	St.	LL	PI	USCS	D.I.	S/S	E.C.T.	S.P.T.
16	10-75	82	4	10	1	1	2	59	34	CH	11	26	3	M
	75-180	48	4	11	1	17	19	54	32	CH	2.6	19	3	H
17	25-180	55	16	20	2	5	2	44	26	CL	4.4	27	1	H
18	35-75	58	10	14	5	4	9	51	29	CH	7.2	26	3	H
19	35-120	41	10	33	16	0	0	33	17	CL	7.3	18	3	ND
	120-150	32	2	44	18	3	2	25	14	CL	5.67	14	3	ND
20	0-150	70	10	17	3	0	0	46	26	CL	7.4	28	3	L
21	35-80	50	15	24	6	4	1	39	23	CL	5.8	16	3	L
	80-150	33	25	36	5	0	0	33	16	CL	4.4	7	1	H
22	0-100	33	6	51	9	0	0	26	13.7	SC	9.5	13	3	H
23	30-80	40	15	33	9	2	1	34	21	CL	8	12	-	-
24	15-50	42	15	36	5	0	1	32	16	CL	8.3	19	3	H
	50-80	44	15	33	6	0	2	33	19	CL	13	18	3	H
25	20-50	42	9	32	9	0	8	33	14	CL	8.3	17	3	H
	50-150	57	10	29	4.3	0	0	42	24	CL	15.5	13	3	H
26	30-70	42	25	14	16	0	4	37	19	CL	3.13	13	3	H
27	30-100	47	17	30	5	0	1	37	22	CL	9	16	3	ND

TABLE 4 (cont'd) (iii)

No.	DEPTH (cm)	C	Si	F.Sa	C.SA	G	St.	LL	PI	USCS	D.I.	S/S	E.C.T.	S.P.T.
37	20-70	42	4	48	4	4	0	38	19	CL	12.0	12	3	L
	70-130	55	9	29	3	4	0	54	22	CH	7.8	21	1	H
	130-180	24	24	39	7	0	3	35	16	CL	8.0	8		
38	30-60	26	19	36	14	6	0	22	7	CL	3.4	6	3	H
	60-150	33	20	41	6	0	0	27	8	CL	5.0	6	3	H
39	0-35	5	18	6	14	19	38	23	23	SM	3.0	-	3	H
	35-60	52	14	26	8	0	0	44	NP	CL	3.7	21		
40	0-30	15	18	29	22	6	10	29	-	SC	3.0	-	3	H
	40-50	40	13	31	15	6	0	35	12	CL	4.2	16	3	H
	50-130	9	13	36	23	19	0	27	NP	SM	3.0	17		
41	0-30	9	7	37	39	8	0	30	NP	SM	2.0	-		
	50-60	36	9	15	36	5	0	40	22	CL	4.6		2	H
42	0-50	12	15	56	15	2	0	NL	NP	SC	2.0	5	3	H
	50-100	32	15	38	11	3	0	31	16	CL	6.3	16	2	H
43	40-80	16	18	45	14	5	2	19	NP	SC	1.57	-	2	H
	80-100	30	15	30	21	4	0	37	19	CL	3.1	14		
44	20-35	3	11	45	37	4	0	-	-	SM	2.0	-	3	H
	35-70	26	9	37	24	4	0	39	25	SC	3.0	9		
45	15-45	53	5	24	14	3	0	56	30	CH	5.8	24		

TABLE 4 (cont'd)

No.	DEPTH (cm)	C	Si	F.Sa	C.Sa	G	St.	LL	PI	USCS	D.I.	S/S	E.C.T.	S.P.T.
46	15-45	9	24	47	15	4	0	NL	NP	SM	1.33	–	2	H
	45-160	43	14	28	6	7	0	42	26	CL	2.4	8	2	H
	160-180	23	8	42	27	0	0	26	12	CL	1.7	5		
47	0-30	7	16	19	17	15	22	24	1	SM	2.2	5		
	30-60	10	20	20	23	10	17	24	NP	SM	2.2	6		
48	15-30	48	14	24	3	9	0	57	35	CH	15.0	33		
	90-100	42	18	28	5	5	0	39	19	CL	13.5	12	3	ND
	100-120	30	21	21	10	17	0	29	9	CL	4.6	19	2	H
49	0-90	27	14	37	13	3	5	32	11	CL	4.25	20	3	H
	90-120	35	11	36	12	5	0	37	23	CL	4.0	25	2	H
	120-180	40	19	33	5	2	0	36	19	CL	2.77	9	1	H
50	0-30	12	23	55	8	0	0	NL	NP	NL	9.0	8	3	H
	30-45	11	21	51	14	1	1	NL	NP	NL	4.5	6	3	H
	45-80	47	13	21	2	16	1	52	26	CH	7.8	15	3	H
	80-120	28	10	20	2	32	8	50	26	CH	2.1	8	1	H
51	0-30	22	29	38	4	6	1	27	10	CL	8	11	3	S
	30-55	18	25	51	5	–	–	22	6	CL-NL	6	11	3	H
	55-120	29	11	30	1	23	5	35	17	CL	11.5	11	4	ND
	120-150	18	8	18	7	22	27	41	20	CL	2.6	21	1	H
52	20-50	40	21	33	3	2	1	33	15	CL	23	15	4	ND
	50-100	21	17	28	5	21	8	22	8	CL	3.0	6	3	H
	100-200	8	11	11	1	54	14	30	8	SC	5	12	3	H
53	0-25	26	18	39	11	4	1	30	10	CL	18	15	3	H
	25-120	28	29	32	5	6	0	42	23	CL	13.5	11	3	H
	120-140	56	13	24	2	3	1	49	25	CL	11	20	3	H

TABLE 5 PROPERTIES OF MAJOR SOILS IN THE GLENFIELD AREA

MAPPING UNIT	A			B			C		D	
Northcote Coding	Dy 3.42			Dy 3.42			Dr 2.32		Dy 3.42	
Great Soil Group	Yellow Solodic			Yellow Solonetzic			Red Podzolic		Yellow Solonetzic	
Underlying Material	Yellow clay			Yellow clay			Yellow clay		Granite	
Depth to bedrock (cm)	-			-			Variable		70	
Profile Drainage	Moderate			Poor			Moderate		Poor	
Texture of B Horizon	Medium clay			Medium clay			Medium clay		Sandy clay	
Sample depth (cm)	15-45	45-100	100-180	15-45	45-160	160-180	20-75	75-180	20-35	35-70
Liquid Limit (%)	23	44	41	NL	42	26	19	29	NL	39
Plastic Limit (%)	11	26	21	NP	26	12	14	16	NP	25
Plasticity Index (%)	12	18	20	-	16	14	5	13	-	14
U.S.C.S.	CL	CL	CL	SM	CL	CL	SC	CL	SC	SM
Optimum Moisture (%)	17	17	17	14	17	17	15	17	15	14
Volume Expansion (%)	2	19	12	Sh	8	5	8	18	Sh	9
Dispersal Index	2.3	4.5	2.3	1.3	2.4	1.7	2.2	4.2	2.0	3.0
pH	7	7	7	6.5	6	7.5	7	7.5	6	7.5
Erodibility	Moderate			Moderate-High			Low-Moderate		Extreme	
Suitability for ponds	Good			Good			Good		Poor	
Topsoil quality	Moderate			Moderate			Good		Poor	
Ease of Revegetation	Low			Low			Moderate		Low	
Special Features	-			Seepage			Seepage		Seepage	

TABLE 5 (Continued) PROPERTIES OF MAJOR SOILS IN THE GLENFIELD AREA

MAPPING UNIT	E	F		G	H	I
Northcote Coding	Highly	Dr 2.13		-	Schist	Granitic
Great Soil Group	Variable	Red-brown earth		Gravel	Rock Outcrops	Rock Outcrops
Underlying Material	Colluvium	Yellow Clay		Schist	Schist	Granite
Depth to bedrock (cm)	-	-		100	50	50
Profile Drainage	Variable	Good		Moderate	Good	Good
Texture of B Horizon	-	Heavy clay				
Sample depth (cm)		10-75	75-180			
Liquid Limit (%)		59	54			
Plastic Limit (%)		25	22			
Plasticity Index (%)		34	32			
U.S.C.S.		CH	CH			
Optimum Moisture (%)		26	26			
Volume Expansion (%)		26	19			
Dispersal Index		11	2.6			
pH		8	8.5			
Erodibility	High	Low		High-Medium	Medium	High
Suitability for ponds	Variable	Good		Poor	Poor	Poor
Topsoil quality	Moderate	Good		Poor	Poor	Poor
Ease of Vegetation	Low	Good		Low	Low	Low
Special Features	Variability	High V.E.		Seepage/Rock	Rock	Rock

APPENDIX II

EXPLANATION OF PROPERTIES ASSESSED FOR TABLE 5.

Northcote Coding

From Northcote, K.H. (1974) "A Factual Key for the Recognition of Australian Soils." Rellim Publications. S.A.

Great Soil Group

From Charman, P.E.V. (1975) A chart for the Indentification of Great Soil Groups in New South Wales.

Underlying Material

Country rock if encountered before 180 cm or soil type extending below 180 cm.

Depth of Bedrock

If encountered before 180 cm. Also indicates minimum depth of soil.

Profile Drainage

Estimated from site characteristics and soil appearance. Possible values : Poor, Moderate, Good.

Texture B. Horizon

Field Assessment.

Liquid Limit

The moisture content at which the soil passes from the liquid to the plastic state.

Plastic Limit

The lowest moisture content at which the soil is plastic.

Plasticity Index

The difference between the Liquid and Plastic limits.

U.S.C.S.

The Unified Soil Classification System from which engineering data can be estimated.

ML - Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity.

CL - Inorganic clays of low to medium plasticity gravelly clays, sandy clays, silty clays, lean clays.

CH - Inorganic clays of high plasticity and expanding clays.

SC - Clayey sands, poorly graded sand - clay mixtures.

GC - Clayey gravels, poorly graded gravel - sand - clay mixtures.

Optimum Moisture

For compaction.

Volume Expansion

Keen Rackowski method as used by the Soil Conservation Service.

5	- very low
5-10	- low
10-20	- moderate
20-40	- high
40	- very high

Dispersal Index (D.I.)

Dispersal Index test as used by the Soil Conservation Service.

1-2	highly dispersible
2-3	moderately dispersible
3	slightly dispersible

Dispersibility is a measure of soil structural stability to wetting, and so is important in the determination of erodibili and permeability. It is assessed on both Rtichie's

Dispersal Index outlined above and by the Emerson Crumb Test (1967).

Erodibility

As assessed in the field. Possible values : Low, Moderate, High, Extreme.

Suitability for Ponds

Determination based on grading analysis, dispersibility, Unified Soil Coding, and an assessment of the water-holding characteristic of the soil. Intended as a guide to suitability for runoff detention basins.

Possible values : Good, Moderate, Poor.

Topsoil Quality

Relates to fertility as assessed in the field.

Possible values : Good, Moderate, Poor.

Ease of Revegetation of Disturbed Subsoil

Low - Special site treatment required.
Moderate - Special fertiliser treatment requirement.
Good - Achieved with normal sowing techniques.