City of Whittlesea land capability analysis for rural areas

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FURTHER INFORMATION

The information contained in this publication and the associated maps is presented at 1:40 000 scale. It is suitable only for regional planning purposes, rather than local or specific site investigation.

The precision of mapped boundaries is affected by the scale of the map. Any enlargement of the map will result in distortion of the information and is unlikely to improve its accuracy. The authors strongly advise that further detailed investigation be carried out prior to any new development proceeding.

The complete set of maps which accompany this report can be viewed at the City of Whittlesea municipal offices, they are not provided with this publication.

Please note that this study has been prepared by the Centre for Land Protection Research for the City of Whittlesea. The Centre for Land Protection Research is a business unit of the Department of Natural Resources and Environment. However, the Department reserves the right to comment freely on any strategic plans or planning scheme amendments prepared as a result of this study.

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Bibliography
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CITY OF WHITTLESEA LAND CAPABILITY ANALYSIS FOR RURAL AREAS

January 1999

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1 INTRODUCTION

The City of Whittlesea is located on the urban/rural fringe north of Melbourne. The rural lands in the City of Whittlesea are under considerable pressure due to subdivision. This is of primary concern due to the environmental, infrastructure and service implications of these developments, particularly when they are sited in inappropriate locations. There are also differing expectations concerning development within the community, this has resulted in confusion as to development entitlements, environmental outcomes and appropriate land management practices.

The City of Whittlesea has shown considerable foresight in identifying the need for natural resource information to support land use planning and the decision making process. All development should be based on a sound knowledge of the natural resource base, in conjunction with environmental constraints and social and economic information. This study has resulted in the preparation of a land capability mapping and environmental overlays, both of which are considered to be valuable and accepted planning tools.

Land capability information is derived from an understanding of the nature of the land, the condition of the land, and the likely impacts of a particular land use. Although not always definitive due to the many management systems that can be imposed for any particular land use, land capability information will provide planners with an indication of the likely performance of land under a particular land use or land management system. Therefore, this information can be used to determine appropriate local policies, zones, overlays, provisions, and planning permit conditions.

The information from this study will be used by the City of Whittlesea to distinguish areas which are appropriate for the development of low density residential development (0.4-2.0 ha) or rural living (5.0-8.0 ha). In addition, environmental overlays will further define areas that should be excluded from future, more intensive development, due to the potential loss of biodiversity.

1.1 Objectives of the Study

1. To map and describe the freehold land of the City of Whittlesea. The City will be mapped at 1:40 000 scale. This will involve identifying land units (including soil types and topography), and other features relevant to the capability of the land.

2. To prepare land capability analyses based on standardised rating tables for low density residential development and rural living.

3. To identify and map known sites of environmental significance, river and stream buffers, and habitat corridors.

4. To incorporate mapping from the NEROC report.

5. To provide the City with a digital copy of the land capability information gathered.

6. To incorporate this land resource information into the City of Whittlesea Geographic Information System.

2. METHODOLOGY AND CONSTRAINTS

The City has a wide range of land types that support various forms of land use. To facilitate the sustainable residential development, this study will undertake land capability assessment to determine the long term sustainability of low density residential development (0.4-2.0 ha) and rural living (5.0-8.0 ha).

Environmental protection will also be considered to ensure that residential development will not result in a net loss in biodiversity, or cause land and water degradation. This will be achieved through the preparation of environmental overlays.

The provision of natural resource information for the City of Whittlesea has been achieved using a range of existing land resource information. This land resource information has been presented at a scale of 1:40 000 for planning purposes. This information will have limitations with regards to the precision of mapped boundaries, survey intensity, and the quantity and quality of data collected. Therefore this information is suitable for broadscale planning rather than detailed site selection.

2.1 Land capability assessment for low density and rural living development

When developing land for low density residential development and rural living, provisions must be made for waste water disposal, year round property access, and a water supply. Therefore, when assessing land capability, these land use activities (septic tanks, gravel roads, and farm dams for water supply) must be considered.

For the City of Whittlesea study, it has been assumed that low density residential subdivisions (0.4-2.0 ha) will have insufficient catchment area to support a network of farm dams. Therefore, farm dams are not assessed as part of the capability assessment for low density residential development. It is assumed that water tanks will be utilised for low density residential subdivisions. Alternatively, town water supplies may be made available where existing infrastructure allows.

The capability for sustainable low density residential development (0.4-2.0 ha) has been based upon two key components:

Effluent disposal Are the inherent landscape and soil conditions capable of supporting a standard septic tank?

Secondary roads Are the inherent landscape and soil conditions capable of supporting a gravel road?

The capability for sustainable rural living (5.0-8.0 ha) has been based upon three key components:

Effluent disposal Are the inherent landscape and soil conditions capable of supporting a standard septic tank?

Secondary roads Are the inherent landscape and soil conditions capable of supporting a gravel road?

Farm dams Are the inherent landscape and soil conditions capable of supporting a farm dam?

In determining the overall land capability class, the Land Resource Data Atlas (White and Kelynack 1985) has been used to identify different land units, and in particular, the various landform and soil attributes. Each land unit has been assigned a land capability class for low density residential development and rural living. These classes have been determined using specific land capability assessment tables. In addition, flood overlays provided by the City of Whittlesea were incorporated to map areas subject to flooding.

The land capability assessment tables contain landform and soil parameters, which strongly influence the ability of the land to sustain the desired land use (refer to section 2). There has been no attempt to rank these parameters in order of importance.

Capability classes are determined by comparing the parameters set out in the land capability assessment tables (refer Tables 2.2-2.5) against the specific landform and soil conditions present in a land unit. The overall land capability class is then determined by identifying the most limiting parameter in each land capability assessment table. This procedure is repeated for every land unit in the study area.

Land capability is broken into five separate classes to differentiate between land with no constraints for development, as opposed to land with few or considerable constraints for development. These classes are represented on the land capability maps as green (very good), to yellow (moderate) through to red (very poor). Definitions for these classes are contained in Table 2.1.

Detailed site assessment will still be required before proceeding with new development.

2.2 Environmental overlays

The land capability analysis has not been undertaken in isolation from the condition of natural resources throughout the study area. The use of a range of environmental overlays has ensured that residential development and environmental protection can be considered in unison.

The environmental overlays have been sourced from existing survey work and GIS layers held by the Department of Natural Resources and Environment Corporate Library, mapping sourced from the NEROC report - Sites of faunal and habitat significance in North East Melbourne (Beardsall 1997), and existing environmental significance overlays provided by the City of Whittlesea.

The overlays prepared include:

Source: DNRE
- Victorian rare or threatened species (VROTS)
- Remnant vegetation
- Wetlands
- Stream buffers
- Salinity discharge

Source: NEROC report
- Sites of faunal significance
- Sites of habitat significance
- Strategic habitat links
- Critical conservation areas
- Ecological references areas
- Bioregions

Source: City of Whittlesea
- ESO-1 River Red Gum Grassy Woodland native habitat area
- ESO-2 Craigieburn grasslands
- ESO-3 Merri Creek Environs

All environmental overlays have been prepared at a scale of 1:40 000. This has necessitated the scale of the environmental layers to be enlarged from a scale of 1:100 000. The level of accuracy has therefore been compromised. This must be considered when utilising this data for decision making.

In some cases, the information layers have been combined to form one overlay. This has been done to reduce the number of necessary overlays. The specific environmental layers and their relevance is discussed in section 3.2.

Table 2.1 Land capability classes for low density residential development and rural living.

Class	Capability	Degree of Limitation to Development	General Descriptions and Management Guidelines
Class 1	Very good (green)	The limitation of long term instability, engineering difficulties or erosion hazards do not occur or are very slight.	Areas with high capability for the proposed use. Standard designs and installation techniques, normal site preparation and management should be satisfactory to minimise the impact on the environment.
Class 2	Good (light green)	Slight limitations are present in the form of engineering difficulties and/or erosion hazard.	Areas capable of being used for the proposed use. Careful planning and the use of standard specifications for site preparation, construction and follow up management are necessary to minimise the impact of the development on the environment.
Class 3	Fair (yellow)	Moderate engineering difficulties and/or moderately high erosion hazard exist during construction.	Areas with a fair capability for the proposed use. Specialised designs and techniques are required to minimise the impact of the development on the environment.
Class 4	Poor (orange)	Considerable engineering difficulties during development and/or a high erosion hazard exists during and after construction.	Areas with poor capability for the proposed use. Extensively modified design and installation techniques, exceptionally careful site preparation and management are necessary to minimise the impact of the development on the environment.
Class 5	Very poor (red)	Long term severe instability, erosion hazards or engineering difficulties, which cannot be practically overcome with current technology.	Performance of the land for the proposed use is likely to be unsatisfactory. Severe deterioration of the environment will occur if development is attempted in these areas.

Table 2.2 Land capability assessment for effluent disposal.

Effluent Disposal Parameter	Class 1	Class 2	Class 3	Class 4	Class 5
Slope (%)	0 – 15			15 - 30	30 - 200
Drainage	Well drained	Moderately well drained	Imperfectly drained	Poorly drained	Very poorly drained
Flooding (%)	0 – 0			0 - 5	5 - 200
Depth to seasonal watertable (cm)	500 – 150	150 - 120	120 - 90	90 - 60	60 - 0
Shallow permeability (litres/m²day)	3000 – 1000	1000 - 300	300 - 150	150 - 100	100 - 0
Depth to hard rock (cm)	500 – 150	150 - 125	125 - 100	100 - 75	75 - 0
Gravel (%)	0 – 5	5 - 20	20 - 40	40 - 75	75 - 100
Stones (%)	0 – 2	2 - 10	10 - 30	30 - 60	60 - 100
Boulders (%)	0 - 0.02	0. 02 - 0.2	0.2 - 2	2 - 10	10 - 100
Rock outcrop (%)	0 - 0.01	0.01 - 0.1	0.1 - 1	1 - 5	5 - 100
Shrink-swell (%)	0 – 5	5 - 15	15 - 20	20 - 30	
Slope failure risk	Nil			Low	High

* Areas capable of absorbing effluent from a standard anaerobic, all-waste, septic tank connected to a single family dwelling (approximate output of 1000 litres per day).

10 mm/day is equivalent to disposing of 1000 l/day along a 0.5 x 200 m effluent disposal trench.

Table 2.3 Land capability assessment for secondary (gravel) roads.

Secondary Roads Parameter	Class 1	Class 2	Class 3	Class 4	Class 5
Slope (%)	0 – 4	4 - 8	8 - 12	12 - 25	25 - 150
Drainage (%)	Well drained	Moderately well drained	Imperfectly drained	Poorly drained	Very poorly drained
Flooding (%)	0 – 1			1-10	10-300
Depth to seasonal watertable (cm)	500 – 150	150 - 90	90 - 60	60 - 30	30 - 0
Unified Soil Group (B horizon)	GW GC SC	SM SW GM	SP CL CH MH GP	ML	PT OH OL
Depth to hard rock (cm)	500 – 100	100 - 75	75 - 40	40 - 15	15 - 0
Stones (%)	0 – 10	10 - 20	20 - 40	40 - 70	70 - 100
Boulders (%)	0 - 0.1	0.1 - 0.5	0.5 - 5	5 - 30	30 - 100
Rock outcrop (%)	0 - 0.05	0.05 - 0.1	0.1 - 1	1 - 5	5 - 100
Shrink-swell (%)	0 – 4	4 - 12	12 - 20	20 - 100	
Slope failure risk	Nil			Low	High

Note: Areas capable of being used for the construction of gravel roads for light vehicles without sealed surfaces or concrete drainage and kerbing.

Table 2.4 Land capability assessment for earthen dams.

Gully Dam Parameter	Class 1	Class 2	Class 3	Class 4	Class 5
Slope (%)	0 - 5	5 - 10	10 - 15	15 - 20	20 - 200
Flooding (%)	0 - 1			1 -10	10 - 200
Stones (%)	0 - 5	5 - 20	20 - 50	50 - 75	75 - 100
Boulders (%)	0 - 0.05	0.05 - 0.1	0.1 - 1	1 - 5	5 - 100
Rock outcrop (%)	0 - 0.05	0.05 - 0.1	0.1 - 1	1 - 5	5 - 100
Deep permeability. (litres/m² day)	0 - 0.1	0.1 - 1	1 - 5	5 - 10	10 - 300
Shrink-swell (%)	0 - 4	4 - 12	12 - 20	20 - 40	
Depth to hard rock (cm)	500 - 300	300 - 200	200 - 150	150 - 80	80 - 0
Dispersible clay (%)	0 - 6	6 - 10	10 - 16	16 - 20	
Topsoil depth (cm)	0 - 25	25 - 50	50 - 100	100 - 200	200 - 500
Unified Soil Group (B Horizon)	GC SC	SM CL	GM CH	ML MH	SP SW GP GW PT OH OL

Note: This table should only be considered for small farm dams to 1000 m^3 in capacity, that have a top water level less than 3 m above the original ground surface at the upstream side of the wall.

***Table 2.5 Land capability assessment for low density residential development and rural* living.**

Low Density Residential Development (0.4 ha – 2.0 ha)	Rural Living Development (5.0-8.0 ha)
Land Use Activities Required	
Secondary roads	Secondary roads
Effluent disposal	Effluent disposal
	Farm dams

Low density residential development and rural living involve a range of land uses including effluent disposal, secondary roads, and earthen dams. For this study, each land unit has been assigned a land capability class for effluent disposal, secondary roads and farms dams. These land use activities are then combined as in Table 2.5 to identify the most limiting land capability class for low density residential development and rural living.

It should be noted that landform and soils can vary within certain land units. It must therefore be recognised that in areas greater than two hectares, detailed site inspection can highlight areas with a higher or lower capability to support a given land use activity.

For example, effluent disposal may be restricted by poor soil drainage on a small allotment (less than 2 ha), however soil variation within a larger allotment may enable soils with improved drainage to be located. Larger allotments also allow for greater flexibility in management and design, while an allotment of less than 0.4 ha will place absolute limits on options for development.

3. SUSTAINABLE DEVELOPMENT IN THE RURAL ZONE - KEY FACTORS

3.1 Land capability assessment

The capability of land to support residential development is based upon an analysis of land use activities required when establishing subdivisions and housing. These land use activities include the establishment of gravel roads, septic tanks and farm dams. When assessing the land capability class for low density residential development or rural living, these land use activities are assessed separately, but are later combined to determine the most limiting land use activity.

The land capability classes (1 very good - 5 very poor) provide an indication of the likely risks associated with development. It is generally acceptable to steer development to land classed as very good to moderate capability. Within these classes, few to no landform and soil limitations exist for development. Subsequently, standard design and management techniques can safely be used to develop the land without the risk of failure. Therefore, lower maintenance costs and land management skills are required to manage the land and minimise on site and off site environmental impacts.

It is not acceptable to guide development to land classed as poor to very poor capability. Significant landform and soil limitations exist which require substantial investigation and specialist design to overcome (where possible). Under these circumstances, land uses such as effluent disposal, gravel roads and farm dams can be expected to fail. This may result in infrastructure and maintenance costs increasing markedly. In addition, landowners would require a much higher skill level to cope with the associated on site and off site land management issues.

Land capability maps for low density residential development and rural living have identified land considered to be very good to very poor capability for development. In reality, there are already subdivisions developed in areas considered to be of poor or very poor capability for development. Where land capability is considered poor, this would indicate that the current zoning is in conflict with capability of the land to support and sustain these forms of development. Under these circumstances, further inappropriate development should be restricted in these areas with a view to amending the current zoning of the land.

In addition, the land capability analysis can assist in the development of overlays and provisions, particularly in regard to allotment size. The allotment size is particularly important as gradual changes in landform and soil type occur across the landscape. This is most useful where land is considered to be of moderate capability for development. Larger allotments can provide greater flexibility in design and may allow limitations such as depth to hard rock and slope to be overcome. In addition, large allotments provide a more reliable yield for farm dams due to the available catchment area, and may also enable the protection and enhancement of native vegetation.

3.2 Environmental considerations

The long term protection and conservation of the natural environmental is important for a number of reasons. These include maintaining biological diversity, provision of a healthy living environment, and the minimisation of land and water degradation.

The need to protect biological diversity has been identified at all levels of Government. Sustaining Our Living Wealth, Victoria's biodiversity strategy and the NEROC report (Beardsall, 1997) both recognise the need to protect all native habitat where species of national, state and regional significance are depleted or threatened by inappropriate development.

Although there are a diverse range of habitat types in the region, many of these are degraded. In the Plenty River Catchment, many of the vegetation communities that existed prior to European settlement have been removed through agricultural and urban development. Wetlands have also suffered considerable losses through alteration, drainage, and declining water quality. It is recommended that readers seek further information on sites of faunal and habitat significance by referring to the NEROC report.

Therefore, areas of environmental significance have been mapped to assist in the protection and conservation of biological diversity in the City of Whittlesea. This mapping has accessed environmental

information from a number of different sources. This information has subsequently been collated to identify areas of environmental significance that may be threatened by future residential development.

The environmental overlays provide a concise picture of the key conservation areas, key habitat linkages and threats to biodiversity. The environmental overlays should be used in conjunction with the land capability analysis to identify zoning conflicts, particularly where rural residential development or rural living may result in the destruction or fragmentation of significant vegetation or habitat. These conflicts can then be overcome through rezoning the land as environmental rural zone, or by specifying overlays and provisions based on the mapping provided.

Each environmental overlay should be considered in any review of the City of Whittlesea planning scheme.

3.2.1 Victorian rare or threatened species (VROTS)

There are a range of rare and threatened flora and fauna in the study area. Many of these species are related to depleted vegetation types. Broadscale clearing for agriculture and residential development may result in the continued decline of the habitat required to support these rare and threatened species. Many of the sites shown on the map are located within isolated remnants where habitat management and protection are extremely important for the conservation of the species. It is particularly important to restrict development on or adjacent to these sites. Incremental loss of habitat is a serious problem, particularly on the urban fringes of Melbourne. The provision of buffer areas and clearing controls adjacent to these sites is recommended to provide maximum protection for rare and threatened species.

All known sites of rare and threatened flora and fauna have been identified from the Department of Natural Resources and Environment Corporate Library as point data on the map. Please note that these sites are not positionally accurate. This has been done to protect these species from intentional destruction. Correct positions should be sought from the Department of Natural Resources and Environment when development is intended within the vicinity of a recorded site. Please refer to Map 3 - Sites of Environmental Significance

3.2.2 Ecological vegetation classes and remnant vegetation

Agriculture and residential development have resulted in the depletion of many vegetation communities throughout the study area. Much of the remnant vegetation is now restricted to state forest. However, large stands of remnant vegetation do occur on private land. These remnants are particularly important for maintaining biodiversity within the region.

Ecological Vegetation Classes (EVC's) have been identified from 1:100 000 scale mapping undertaken by the Department of Natural Resources and Environment. EVC's provide an indication of the biological diversity of the study area and can be used to highlight where vegetation communities may be threatened.

Of high importance are linkages between different EVC's, as these provide migratory fauna with access to food and shelter throughout the year. Particular attention should be paid to protection of EVC's that have become fragmented or isolated. It is recommended that all EVC's be included in a vegetation protection overlay.

Other areas of remnant vegetation greater than one hectare in size are also included on the map. These areas have been mapped from 1:100 000 scale satellite imagery analysed by the Department of Natural Resources and Environment. Please refer to Map 4 - Ecological vegetation classes and remnant vegetation.

3.2.3 Wetlands

Wetlands within the study area have been mapped from existing information held by the Department of Natural Resources and Environment. Few wetlands now exist, with many suffering losses through habitat alteration, salinity, drainage and declining water quality.

Consideration should be given to protection of wetlands through the provision of buffer areas and protection of upstream water quality. This may be achieved through zoning of land as environmental rural zone, or through the application of environmental significance overlays and associated provisions. Please refer to Map 3 - Sites of environmental significance.

3.2.4 Stream buffers and environmental flows

Stream buffers have been highlighted for each of the major creeks and associated drainage lines. This has been done to recognise land where inappropriate clearing, siting of water storages and poor land management may lead to deterioration in water quality or a considerable reduction in environmental flows.

Although most of the drainage lines and creeks have few water storages or vegetated stream banks, the identification of the 30m stream buffer enables provisions or conditions to be attached to planning permit applications. This will encourage the protection of water quality, enhance long term environmental flows, conserve wetlands and contribute to regional habitat links.

These stream buffers are not presented at correct scale. They have been enhanced to highlight their location throughout the study area. The stream buffers identified have been sourced from 1:25 000 scale hydrological information. Please refer to Map 1 - Land capability for low density residential development , and Map 2 - Land capability for rural living.

3.2.5 Salinity

Known salinity discharge areas have been mapped for the City of Whittlesea from existing 1:25 000 dryland salinity mapping held by the Department of Natural Resources and Environment. Salinity occurs in many of the larger drainage lines of the study area. Further residential development should be avoided in areas where significant salinity problems are identified

Salinity has a direct and substantial impact upon infrastructure associated with residential development, particularly road and building foundations. It can also increase the risk of sheet and gully erosion, result in the deterioration of ground and surface water quality, and cause a reduction in the diversity of flora and fauna (particularly in relation to aquatic habitats).

In existing subdivisions where salinity is present, the City of Whittlesea should encourage management and control options for salinity mitigation in the surrounding catchment. Advice should also be sought from the Department of Natural Resources and Environment in this respect. All saline discharge areas should be mapped with a salinity management overlay. Please refer to Map 4 - Ecological vegetation classes and remnant vegetation.

3.2.6 Sites of habitat significance

The NEROC report has identified sites of high habitat significance. These areas should be protected from development that may lead to further depletion of vegetation communities and the loss of flora and fauna species.

The sites of habitat significance have been classified by the NEROC report into the following categories:

Very high - Includes multiple reference stands or areas supporting an endangered or multiple vulnerable species, very high species diversity of other botanical attributes potentially of national significance.

High - Includes one reference stand or areas supporting multiple rare species, high species diversity or other botanical attributes potentially of state significance.

Medium - Includes relatively intact and extensive stands and some partially intact or small stands or areas supporting rare species, medium species diversity or other botanical attributes potentially of regional significance.

Sites of very high to medium habitat significance should be included in the environmental rural zone or be protected through an environmental significance overlay and associated planning provisions. Please refer to Map 6 - Sites of habitat significance.

3.2.7 Sites of faunal significance

The NEROC report has identified extensive areas of faunal habitat that should be maintained and enhanced to protect faunal values in the study area. These sites of faunal significance have been classified by the NEROC report into the following categories:

National - The occurrence of an attribute contributes substantially to its conservation in Australia. These sites contain very high heritage values and it would be desirable on faunal conservation grounds if they were protected under Commonwealth government legislation.

State - The occurrence of an attribute contributes substantially to its conservation in Victoria but not necessarily Australia. These sites contain high natural heritage and conservation values and it would be desirable if they were protected under Victorian government controls.

Regional - The occurrence of an attribute contributes substantially to its conservation in Greater Melbourne but not necessarily in Victoria. These sites contain medium natural heritage and conservation values and it would be desirable on faunal conservation grounds if they were protected under local government conservation controls.

Sites of very high to medium faunal significance should be included in the environmental rural zone or be protected through an environmental significance overlay and associated planning provisions. Please refer to Map 7- Sites of faunal significance

3.2.8 Habitat links

Habitat links have been identified in the NEROC report. Habitat links are broken into a number of categories to indicate their level of importance in maintaining biodiversity in the region. Habitat links will enhance depleted vegetation types and provide seasonal migratory pathways for fauna. The links identified on the map represent opportunities where planting of indigenous vegetation will provide maximum habitat benefit for both flora and fauna.

Of particular importance are Strategic habitat links. These links connect the most significant and extensive areas of native habitat and will provide the best opportunity for enhancement of various habitat types.

Long term planning is required to integrate habitat links with rural and residential development in the study area. Habitat links should be considered for inclusion in environmental significance or vegetation protection overlays. The enhancement of roadside corridors, stream buffer areas, and the establishment of greenbelts within new subdivisions provide the best opportunity for this integration. Please refer to Map 5 - Habitat links.

3.2.9 Critical conservation and ecological reference areas

Critical conservation and ecological reference areas have been identified by the NEROC report. These areas identify the most important habitat and faunal sites, and those strategic habitat links which are critical in conserving biodiversity in the study area.

These should be considered the most important environmental features in the City of Whittlesea and must receive adequate protection. These areas should be included in the environmental rural zone or be mapped on environmental significance overlays. Strict controls on development and land management are required to minimise processes that will result in the deterioration of these areas. Please refer to Map 5 - Habitat links.

3.2.10 Biophysical zones

Biophysical zones have been identified by the NEROC report. Biophysical zones are distinguished by factors such as geology, landform, soil and climate. Each different zone will have common landform, soil and climate patterns which influence the types of vegetation and fauna present.

Biophysical zones are not linked to environmental significance. However, certain biophysical zones have landforms and soil types which have been exploited for agricultural and urban development. It is typically these biophysical zones where remnant vegetation is most depleted and fragmented. In these circumstances, small isolated stands of vegetation may be highly significant. Consideration should be given to protecting these stands. Please refer to Map 5 - Habitat links.

3.2.11 Environmental significance overlays (ESO's)

Environmental significance overlays prepared by the City of Whittlesea have been incorporated in this study, primarily to ensure all mapped environmental information is presented at the same scale across the municipality. These ES0's relate to areas of environmental significance identified in the City of Whittlesea Planning Scheme.

A detailed comparison should be made with the sites of faunal and habitat significance, habitat link, critical conservation and ecological reference area overlays to determine the need for additional ESO's and associated provisions.

4 LAND CAPABILITY ANALYSIS

This section of the report provides landform, soil and land capability information for each land unit identified in the study area. The information presented here has been interpreted from existing information contained in the Land Data Resource Atlas (White & Kelynack 1985).

4.1 Land capability summary table

The following table presents the capability class assigned to each land unit identified in the City of Whittlesea for the following land uses:

- secondary (gravel) roads,
- septic tank effluent disposal and
- farm dams (water supply).

These capability classes are combined to determine an overall capability class for :

- low density residential development, and
- rural living.

Please note:
Soil and landform information was not provided for a number of map units in the Land Data Resource Atlas.

In applying the land capability analyses, it has been necessary to make an adjustment to the land capability class assigned to unit If 34 (crests and ridges). The rating has been downgraded from class 2 to class 4 to account for the steepness of the terrain adjacent to the unit. This will adequately consider site access and side slope issues adjacent to the crest.

In addition, flooding overlays provided by the City of Whittlesea will override any land capability class determined by the Land Data Resource Atlas in section 4.2. These areas are highlighted on the land capability maps and have been assigned a capability class of five.

Table 4.1 Land capability classes - summary table

Land Unit	Secondary Roads	Septic Tanks	Farm Dams	Low Density	Rural Living
Da11	5	5	4	5	5
Da25	5	5	4	5	5
Da26	5	5	5	5	5
Da34	5	5	5	5	5
Da36	5	5	3	5	5
Db11	5	5	4	5	5
Db25	5	5	4	5	5
Db26	5	5	5	5	5
Db27	5	5	5	5	5
Db34	5	5	5	5	5
Dc25	5	5	4	5	5
Dc26	5	5	5	5	5
Dp34	5	5	5	5	5
Fp 5	2	3	3	3	3
Fp 9	1	2	5	2	5
Fp11	3	3	2	3	3
Fp25	3	5	4	5	5
Fp26	4	3	3	4	4
Fp27	4	3	3	4	4
Fp34	2	2	2	2	2
Ha25	3/4	5	4	5	5
Ha26	4	4	3	4	4
Ha27	4	4	3	4	4
Ha28	4	5	1	5	5
Ha34	2	2	2	2	2
Ha36	2	2	3	2	3
Hb25	3/4	5	4	5	5
Hb26	4	4	5	4	5
Hb36	4	4	4	4	4
Ia 9	1	1	5	1	5
Ia11	3	3	2	3	3
Ia25	4	5	3/4	5	5
Ia26	3	4	3	4	3
Ia34	2	2	2	2	2
Ia35	2	2	2	2	2
Ia36	2	2	3	2	3
Ia38	3	3	2	3	3
Ib 9	2	1	5	2	5
Ib11	3	3	3	3	3
Ib25	4	5	4	5	5
Ib26	3	4	3	4	4
Ib28	4	5	3	5	5
Ib34	3	2	4	3	4
Ib35	2	2	3	2	3
Ib36	3	2	3	3	3
Ib38	3	3	3	3	3
Ic 9	4	4	4	4	4
Ic11	3	4	3	4	4

Land Unit	Secondary Roads	Septic Tanks	Farm Dams	Low Density	Rural Living
Ic25	4	4	3/4	4	4
Ic26	4	4	4	4	4
Ic34	4	2	3	4	3
Ic35	3	3	4	3	4
Ic38	3	3	4	3	4
Id11	5	5	5	5	5
Id25	5	4	5	5	5
Id34	4	4	5	4	5
Id35	4	4	5	4	5
Id38	4	4	4	4	4
Ie11	5	5	5	5	5
Ie25	5	5	5	5	5
Ie26	5	5	5	5	5
Ie27	5	5	5	5	5
Ie34	5	5	5	5	5
Ie38	5	5	5	5	5
If11	2	3	2	3	3
If25	3	4	3	4	4
If26	2	4	2	4	4
If34	2	2	2	2	2
If35	3	2	3	3	3
If38	3	3	2	3	3
N99					
Te 9	5	5	5	5	5
Te11	5	5	4	5	5
Te17	5	5	4	5	5
Te18	5	5	4	5	5
Te34	5	5	5	5	5
Up11	3	3	2	3	3
Up25	3	5	4	5	5
Up26	3	2	3	3	3
Up27	3	3	3	3	3
Up28	4	5	5	5	5
Up34	2	2	2	2	2
Wa11	5	5	3	5	5
Wa17	5	5	4	5	5
Wa18	5	5	4	5	5
Wa34	5	5	5	5	5
Wb11	5	5	3	5	5
Wb17	5	5	4	5	5
Wb18	5	5	4	5	5

source: White & Kelynack (1985)

4.2 Land unit descriptions

Landform and soil information has been attached to each land unit identified in the City of Whittlesea. Land units are distinguished by a recurring pattern of landform, soil and geology. Land units are described using a key relating to their landform and soil type. A key to the landform elements and soil types is present in Tables 4.2.1 and 4.2.2 below.

The information attached to these land units is analysed against the relevant land capability assessment table in section 2 to determine the capability of the land to sustain a particular land use. Each land unit has been assigned a land capability class based on this analysis in section 4.1.

The soil and geological relationships are compared in Appendix A.

Table 4.2.1 Landform elements

Code	Landform Elements	
Wa	Drainage Line	Open Channel Banks
Da	Depression	Open
Db	Depression	Drainage
Dc	Depression	Swamp
Te	Terraces	Upper and Lower
Fp	Plains	Flat
Up	Plains	Undulating
Dp	Plains	Drainage
Ha	Hilly Terrain	Low Minor rises side slopes 5%
Ia	Inclining Terrain	Low Slopes < 4%
Ib	Inclining Terrain	Gentle Mid Slopes 4 – 10%
Ic	Inclining Terrain	Moderate Mid Slopes 10 – 20%
Id	Inclining Terrain	Steep mid slopes 20 – 35%
Ie	Inclining Terrain	Steep Upper Slopes > 35%
If	Inclining Terrain	Hill Crests

source: White & Kelynack (1985)

Table 4.2.2 Soil Types

Soil Type	Soil description
5(a)	Deep, medium and poorly structured loams
5(b)	Deep, well structured clay loams
9	Deep uniform coarse loamy sands
11	Deep, well structured duplex soils with a friable surface
17	A complex of deep and uniform soils, A2 horizons and Calcareous inclusions may occur.
18	Deep, strongly structured uniform saline clays
25	Moderately deep heavy plastic cracking clays
26	A complex of deep well structured duplex and gradational soils of basaltic origin
27	Deep, well structured gradational and duplex soils which are calcareous at depth
28	Moderately deep self-mulching cracking clays
34	Moderately deep to deep duplex soils which often exhibit a bleached A2 horizon
35	Deep friable well structured gradational and duplex soils
36	Shallow to deep gradational soils with loamy topsoils overlying gritty clay subsoils
38	A complex of deep well structured duplex soils with clayey subsoils

source: White & Kelynack (1985)

Information relating to landform, soil characteristics and capability class is presented in table form for each soil type below. Parameters which constrain development are also identified for the benefit of the user. These land unit descriptions follow in ascending order based on the soil type number.

Soil Type 5 Deep, medium and poorly structured loams

THE TABLES BELOW PRESENT INFORMATION RELEVANT TO THE LAND UNIT, SOIL TYPE, SOIL CHARACTERISTICS, LAND CAPABILITY CLASS AND LIMITATIONS FOR SOIL TYPE 9.

Soil Information Summary: Soil type 5

Land units	Characteristics								
	Principal Profile Class	Unified Soil Group	Shrink-Swell Potential	Land Slip Potential	Permeability Class	Site Drainage Class	Flood Risk	Seasonal Watertable	Erosion & Deterioration
Fp5	Um 5	ML-CL	Low	Nil	Moderate	Moderate	Nil	Nil	Nil
	Um 6	Some CP	Moderate						

Land Capability Class and Limitations

Land units	Secondary roads	Septic tanks	Farm dams
Fp 5	***2; Unified Soil Group***	***3; soil profile permeability***	***3; unified soil group***

source: White & Kelynack (1985)

Soil Type 9 Deep Uniform Coarse Sands

THE TABLES BELOW PRESENT INFORMATION RELEVANT TO THE LAND UNIT, SOIL TYPE, SOIL CHARACTERISTICS, LAND CAPABILITY CLASS AND LIMITATIONS FOR SOIL TYPE 9.

Soil Information Summary: Soil Type 9

Land Units	Characteristics								
	Principal Profile Class	Unified Soil Group	Shrink-Swell Potential	Land Slip Potential	Permeability Class	Site Drainage Class	Flood Risk	Seasonal Watertable	Erosion & Deterioration
Fp9	Uc 6 Uc 5	SW	Low	Nil	Mod Slow	Moderate	Very Slow	Temporarily ponded	Subsurface tunnelling & Gullying
Ia 9, Ib 9, Ic 9	Uc 6 Uc 5	SW	Low	Low	Moderate	Rapid	Nil	Nil	Some gullying & tunnelling
Te 9	Uc 6 Uc 5	SW	Low	Nil	Moderate	Ponding	Freq.	Seasonally Water Logged	Sheet wash Erosion

Land Capability Class and Limitations

Land units	Secondary roads	Septic tanks	Farm dams
Fp 9	1	2; stones &/or gravel	5; unified soil group
Ia 9	1	1	5; unified soil group
Ib 9	2;stones &/or gravel, unified soil group	1	5; unified soil group
Ic 9	4; slope	4; slope	4; unified soil group, slope
Te 9	5;site drainage, inundation	5; site drainage, inundation	5; unified soil group

source: White & Kelynack (1985)

Soil Type 11 Deep Well Structured Duplex Soils With A Friable Surface

THE TABLES BELOW PRESENT INFORMATION RELEVANT TO THE LAND UNIT, SOIL TYPE, SOIL CHARACTERISTICS, LAND CAPABILITY CLASS AND LIMITATIONS FOR SOIL TYPE 11.

Soil Information Summary: Soil Type 11

Land units	Characteristics								
	Principal Profile Class	Unified Soil Group	Shrink-Swell Potential	Land Slip Potential	Permeability Class	Site Drainage Class	Flood Risk	Seasonal Watertable	Erosion & Deterioration
Da 11,Db 11	Dy 5 Db 4	ML-CL	High	Nil	Very Slow	Very low	Freq.	Seasonally Water logged	Nil
Fp 11,Up 11	Dy 5 Db 4	ML-CL	High	Nil	Slow	Moderate	Nil	Nil	Minor Sheet
Te 11	Dy 5 Db 4	ML-CL	High	Nil	Slow	Ponding	Freq.	Seasonally Water logged	Marked
Wa 11,Wb 11	Dy 5 Db 4	ML-CL	Moderate	Nil	Slow	Transmitting	Freq.	Seasonally Water logged	Minor stream Bank

Land Capability Class and Limitations

Land units	Secondary roads	Septic tanks	Farm dams
Da 11, Db 11	5;site drainage, inundation	5; site drainage, inundation	5; site drainage, inundation
Fp 11, Up 11	3; site drainage, soil unification	3; site drainage, soil profile permeability, shrink-swell potential	2; depth to hard rock, unified soil group
Te 11	5; inundation, site drainage	5; inundation, site drainage	4; inundation, site drainage
Wa11,Wb 11	5; Site drainage, inundation, depth to watertable	5; site drainage, inundation, depth to watertable	3; inundation

source: White & Kelynack (1985)

Soil Type 17 A Complex Of Deep And Uniform Soils.

THE TABLES BELOW PRESENT INFORMATION RELEVANT TO THE LAND UNIT, SOIL TYPE, SOIL CHARACTERISTICS, LAND CAPABILITY CLASS AND LIMITATIONS FOR SOIL TYPE 17.

Soil Information Summary: Soil Type 17

Land units	**Characteristics**								
	Principal Profile Class	Unified Soil Group	Shrink-Swell Potential	Land Slip Potential	Permeability Class	Site Drainage Class	Flood Risk	Seasonal Watertable	Erosion & Deterioration
Te 17	Db 3 Dd 3 Some Um 7	CH-CL	Moderate	Nil	Very Slow	Slow	Freq.	Nil	Nil
Wa 17,Wb 17	Db 3 Dd3 Some Um 7	CH-CL	Moderate	Nil	Very Slow	Transmitting	Freq.	Seasonally water logged	(Wa) Very slight (Wb) Stream & Bank erosion

Land Capability Class and Limitations

Land units	**Secondary roads**	**Septic tanks**	**Farm dams**
Te 17	5; inundation, depth to watertable	5; inundation, depth to watertable	5; inundation, depth to watertable
Wa 17,Wb17	5; inundation, depth to watertable	5; inundation, depth to watertable	4; shrink-swell potential, depth to hard rock

source: White & Kelynack (1985)

Soil Type 18 Deep Strongly Structured Uniform Saline Clays

THE TABLES BELOW PRESENT INFORMATION RELEVANT TO THE LAND UNIT, SOIL TYPE, SOIL CHARACTERISTICS, LAND CAPABILITY CLASS AND LIMITATIONS FOR SOIL TYPE 18.

Soil Information Summary: Soil Type 18

Land units	Characteristics								
	Principal Profile Class	Unified Soil Group	Shrink-Swell Potential	Land Slip Potential	Permeability Class	Site Drainage Class	Flood Risk	Seasonal Watertable	Erosion & Deterioration
Te 18	Ug 5 Uf 6 Minor Dd 4	CH	High	Nil	Very slow	Slow	Freq.	Nil	
Wa, Wb 18	Ug 5 Uf 6 Minor Dd 4	CH	High	Nil	Very slow	Transmitting	Freq.	Seasonally water logged	(Wa) Minor (Wb) Stream bed & bank erosion

Land Capability Class and Limitations

Land units	Secondary roads	Septic tanks	Farm dams
Te 18	5; inundation, depth to watertable	5; inundation, depth to watertable	4; shrink-swell potential, depth to hard rock
Wa 18,Wb18	5; inundation, depth to watertable	5; inundation, depth to watertable	4; depth to hard rock, shrink-swell potential

source: White & Kelynack (1985)

Soil Type 25 Moderately Deep Heavy Plastic Clays

THE TABLES BELOW PRESENT INFORMATION RELEVANT TO THE LAND UNIT, SOIL TYPE, SOIL CHARACTERISTICS, LAND CAPABILITY CLASS AND LIMITATIONS FOR SOIL TYPE 25.

Soil Information Summary: Soil Type 25

Land units	Characteristics								
	Principal Profile Class	Unified Soil Group	Shrink-Swell Potential	Land Slip Potential	Permeability Class	Site Drainage Class	Flood Risk	Seasonal Watertable	Erosion & Deterioration
Da, Db, Dc 25	Ug 5 Dd3 Minor Dd1	CH	High	Nil	Slow	Ponding	Freq.	Seasonally water logged	Nil
Fp, Up 25	Ug 5 Dd 3 Minor Dd1	CH	High	Nil	Slow	Slow	Occ.	Nil	Nil
Ha, Hb, Ia, Ib, If 25	Ug 5 Dd3 Rare Dd1	CH	High	Nil	Very Slow	Moderate	Nil	Nil	Nil
Ic, Id, Ie 25	Ug 5 Dd3 Rare Dd1	CH	High	Nil	Very Slow	Rapid	Nil	Nil	Nil

Land Capability Class and Limitations

Land units	Secondary roads	Septic tanks	Farm dams
Da, Db 25	5;site drainage, depth to watertable	5; site drainage, depth to watertable	4; depth to hard rock
Dc 25	5; site drainage, depth to watertable, inundation	5; site drainage, depth to watertable, inundation	4; depth to hard rock
Fp 25	3; unified soil group, shrink-swell potential	5; soil profile permeability	4; depth to hard rock
Up 25			
Fp 25 (R)	3; rock outcrop, unified soil group, shrink-swell potential	5; soil profile permeability, depth to hard rock	4; boulders, rock outcrop, depth to hard rock
Up 25(R)	3/4; rock outcrop, unified soil group, shrink-swell potential	5; soil profile permeability, depth to hard rock	4; boulders, rock outcrop
Ha 25	3/4; depth to hard rock, shrink-swell potential	5; soil profile permeability, depth to hard rock	4; unified soil group, depth to hard rock

Land units	Secondary roads	Septic tanks	Farm dams
Ha 25(R)	3/4; stones &/ or gravel, boulders, rock outcrop, shrink-swell potential	5; soil profile permeability, depth to hard rock	4; unified soil group, rock outcrop, boulders
Hb 25	3/4; shrink-swell potential, depth to hard rock	5; soil profile permeability, depth to hard rock	4; slope, unified soil group
Hb 25 (R)	3/4; boulders, rock outcrop, shrink-swell potential	5; soil profile permeability, depth to hard rock, rock outcrop	4; slope, stones &/or gravel
Ia 25	4; depth to hard rock, shrink-swell potential	5; soil profile permeability, rock outcrop	3/4 unified soil group, shrink-swell potential, depth to hard rock
Ib 25			
Ia 25(R)	4; depth to hard rock, shrink-swell potential	5; soil profile permeability, rock outcrop	3/4; unified soil group, shrink-swell potential
Ib 25(R)	4; rock outcrop, shrink-swell potential, depth to hard rock	5; soil profile permeability, rock outcrop	3/4; unified soil group, shrink swell potential, rock outcrop
Ic 25	4; depth to hard rock, shrink-swell potential	4; soil profile permeability, rock outcrop	3/4; unified soil group, shrink-swell potential, depth to hard rock
Ic 25(R)	5; depth to hard rock, shrink-swell potential	4; depth to hard rock, stones & / or gravel, soil profile permeability, rock outcrop	4; slope, depth to hard rock
Id 25	5; slope, rock outcrop	4; slope, soil profile permeability, depth to hard rock, stones &/or gravel	5; slope
Id 25(R)			
Ie 25	5; slope	5; slope	5; slope
Ie 25(R)			
If 25	5; unified soil group, depth to hard rock	4; soil profile permeability, depth to hard rock	3; depth to hard rock, stones &/ or gravel, boulders

source: White & Kelynack (1985)

Soil Type 26 A Complex Of Deep Well Structured Duplex And Gradational Soils

THE TABLES BELOW PRESENT INFORMATION RELEVANT TO THE LAND UNIT, SOIL TYPE, SOIL CHARACTERISTICS, LAND CAPABILITY CLASS AND LIMITATIONS FOR SOIL TYPE 26.

Soil Information Summary: Soil Type 26

Land units	Characteristics								
	Principal Profile Class	Unified Soil Group	Shrink-Swell Potential	Land Slip Potential	Permeability Class	Site Drainage Class	Flood Risk	Seasonal Watertable	Erosion & Deterioration
Da, Db, Dc 26	Db 3 Gn 4	CL-CH	Moderate	Nil	Slow to Mod	Slow	Freq.	Seasonally water logged	Nil
Fp, Up 26	Db 3	CL-CH	Moderate	Nil	Moderately slow to moderate	Moderate to slow	Nil	Nil	Very slight sheeting
Ha, Hb 26	Db 3 Gn 4	CL-CH	Moderate	Nil	Moderately slow	Moderate to rapid	Nil	Nil	Slight sheeting & rill
Ia, Ib 26	Db 3 Gn 4	CL-CH	Moderate	Nil	Moderately slow	Moderate	Nil	Nil	Slight sheeting
Ic, Ie 26	Db 3 Gn 4	CL-CH	Moderate	Nil	Moderately slow	Moderate	Nil	Nil	Very slight sheeting
If 26	Db 3 Db 4 Rare Gn 4	CL-CH	Moderate	Nil	Slow to moderate	Slow to moderate	Nil	Nil	Nil

Land Capability Class and Limitations

Land units	Secondary roads	Septic tanks	Farm dams
Da 26	5; site drainage, depth to watertable	5; site drainage, depth to watertable	5; depth to hard rock
Db 26			
Dc 26			
Fp 26	3; unified soil group	4; Soil profile permeability	3; unified soil group
Fp 26(R)	4; rock outcrop, boulders, stones &/or gravel	3; stones &/or gravel, soil profile permeability	3; unified soil group, stones &/or gravel
Up 26	3; unified soil group	3; soil profile permeability	3; unified soil group
Up 26(R)	4; rock outcrop, stones &/or gravel	3; stones &/or gravel	3; unified soil group, stones &/or gravel
Ha 26	3; unified soil group	4; soil profile permeability	3; unified soil group
Ha 26(R)	4; rock outcrop, stones &/or gravel	4; Soil profile permeability, stones &/or gravel	3; unified soil group, stones &/or gravel,

Land units	Secondary roads	Septic tanks	Farm dams
			boulders
Hb 26	4; slope, stones &/or gravel, rock outcrop	4; soil profile permeability, slope, stones &/or gravel	5; slope
Hb (R)			
Ia 26	3; unified soil group	4;soil profile permeability	3; unified soil group
Ia 26(R)	4; stones &/or gravel, boulders, rock outcrop	4; soil profile permeability	4; stones &/or gravel, boulders, rock outcrop
Ib 26	3; slope, unified soil group	4; soil profile permeability	3; unified soil group, slope
Ib 26(R)	3; stones &/or gravel, rock outcrop	4; soil profile permeability	4; slope, stones &/or gravel, boulders
Ic 26	4; slope, unified soil group	4;slope, soil profile permeability	4; slope, unified soil group, stones &/or gravel, shrink-swell potential
Ie 26	5; slope	5; slope	5; slope
If 26	2; unified soil group, depth to watertable, stones &/or gravel	4; depth to watertable, stones &/or gravel, unified soil group	2; stones &/or gravel, depth to hard rock, unified soil group

source: White & Kelynack (1985)

Soil Type 27 Deep Well Structured Gradational And Duplex Soils Which Are Calcareous At Depth

THE TABLES BELOW PRESENT INFORMATION RELEVANT TO THE LAND UNIT, SOIL TYPE, SOIL CHARACTERISTICS, LAND CAPABILITY CLASS AND LIMITATIONS FOR SOIL TYPE 27.

Soil Information Summary: Soil Type 27

Land units	Characteristics								
	Principal Profile Class	Unified Soil Group	Shrink-Swell Potential	Land Slip Potential	Permeability Class	Site Drainage Class	Flood Risk	Seasonal Watertable	Erosion & Deterioration
Db 27	Gn 4 Dr 4 Rare Dr 5	CL	Low to moderate	Nil	Slow to moderate	Rapid	Nil	Nil	Slight wind erosion
Fp, Up 27	Gn 4 Dr 4 Rare Dr 5	CL	Low to moderate	Nil	Moderate	Moderately fast	Nil	Nil	Minor wind erosion
Ha 27	Gn 4 Dr 4 Rare Dr 5	CL	Low to moderate	Nil	Rapid	Rapid	Nil	Nil	Slight wind and sheeting
Ie 27	Gn 4 Dr 4 Dr 5	CL	Moderate	Low (Ic) Moderate	Moderate	Rapid	Nil	Nil	Landslip (Ie) Minor sheeting

Land Capability Class and Limitations

Land units	Secondary roads	Septic tanks	Farm dams
Db 27	5;site drainage, depth to watertable	5; site drainage, depth to watertable	5; depth to hard rock
Fp 27	4;unified soil group	3; soil profile permeability	3; unified soil group
Up 27			
Fp 27(R)	4; stones &/or gravel, rock outcrop, boulders	3; soil profile permeability	3;unified soil group, stones &/or gravel, boulders
Up 27(R)	4; stones &/or gavel, rock outcrop	3; soil profile permeability, rock outcrop, stones &/or gravel	4;unified soil group, rock outcrop, stones &/or gravel
Ha27	4; unified soil group	3; soil profile permeability	3; unified soil group
Ha 27(R)	4; stones &/or gravel, rock outcrop, boulders	4; stones &/or gravel, rock outcrop, boulders	3; unified soil group, stones &/or gravel, rock outcrop, boulders
Ie 27	5; slope	5; slope	5; slope

source: White & Kelynack (1985)

Soil Type 28 Moderately Deep Self Mulching Cracking Clays

THE TABLES BELOW PRESENT INFORMATION RELEVANT TO THE LAND UNIT, SOIL TYPE, SOIL CHARACTERISTICS, LAND CAPABILITY CLASS AND LIMITATIONS FOR SOIL TYPE 28.

Soil Information Summary: Soil Type 28

Land units	Characteristics								
	Principal Profile Class	Unified Soil Group	Shrink-Swell Potential	Land Slip Potential	Permeability Class	Site Drainage Class	Flood Risk	Seasonal Watertable	Erosion & Deterioration
Ha 28	Ug 5 Rare Dd	CH	High	Low	Slow to moderately slow	Moderate	Nil	Nil	Slight sheeting
Ib 28	Ug 5 Rare Dd	CH	High	Moderate to high	Poor	Rapid	Nil	Nil	Slight sheeting
Up 28	Ug 5 Rare Dd	CH	High	Nil	Moderate to slow	Moderate	Nil	Nil	Generally stable

Land Capability Class and Limitations

Land units	Secondary roads	Septic tanks	Farm dams
Ha 28	4; unified soil group, shrink-swell potential, stones &/or gravel, depth to hard rock	5; site drainage, soil profile permeability, stones &/or gravel	1
Ib 28	4; site drainage, unified soil group, stones &/or gravel, shrink-swell potential	5; site drainage, unified soil group, stones &/or gravel, shrink-swell potential, soil profile permeability	3; site drainage, unified soil group, stones &/or gravel, shrink-swell potential, soil profile permeability, depth to hard rock
Up 28	4; unified soil groups, shrink-swell potential, stones &/or gravel, distance to hard rock	5; site drainage, soil profile permeability, stones &/or gravel	5; unified soil group, stones &/or gravel

source: White & Kelynack (1985)

Soil Type 34 Moderately Deep To Deep Duplex Soils

THE TABLES BELOW PRESENT INFORMATION RELEVANT TO THE LAND UNIT, SOIL TYPE, SOIL CHARACTERISTICS, LAND CAPABILITY CLASS AND LIMITATIONS FOR SOIL TYPE 34.

Soil Information Summary: Soil Type 34

Land units	**Characteristics**								
	Principal Profile Class	Unified Soil Group	Shrink-Swell Potential	Land Slip Potential	Permeability Class	Site Drainage Class	Flood Risk	Seasonal Watertable	Erosion & Deterioration
Da, Db, Dp 34	Dy 5 & Gn 3	CL	Moderate	Nil	Slow	Ponding	High	Seasonally water logged	Nil
Fp, Up 34	Dy 5 & Gn 3	CL	Moderate	Nil	Moderate	Moderate	Nil	Nil	Nil
Ha 34	Dy 5 & Gn 3	CL	Moderate	Nil	Moderate	Rapid	Nil	Nil	Nil
Ia, Ib 34	Dy 5 & Gn 3	CL	Moderate	Low	Moderate	Rapid	Nil	Nil	Sheet & rill erosion
Ic, Id, Ie 34	Dy 5 & Gn 3	CL	Moderate	Moderate to high	Moderate	Rapid	Nil	Nil	Sheet & rill erosion
If 34	Dy 5 & Gn 3	CL	Moderate	Nil	Moderate	Moderate	Nil	Nil	Nil
Te 34	Dy 5 & Gn 3	CL	Moderate	Nil	Moderate	Ponding	Very high	Seasonally water logged	Nil
Wa 34	Dy 5 & Gn 3	CL	Moderate	Nil	Moderate	Transmitting	Very high	Seasonally water logged	Streambank & streambed

Land Capability Class and Limitations

Land units	**Secondary roads**	**Septic tanks**	**Farm dams**
Da 34	5; site drainage, inundation	5; site drainage, inundation, unified soil group	5; site drainage, inundation, unified soil group
Db 34			
Dp 34	5; site drainage, inundation, unified soil group	5; site drainage, inundation, unified soil group	4/5; site drainage, inundation, unified soil group
Fp 34	2; unified soil group, stones &/or gravel	2;stones &/or gravel	2; stones &/or gravel, unified soil group
Up 34			
Ha 34	2; unified soil group, stones &/or gravel	2; stones &/or gravel	2; stones &/or gravel, unified soil group
Ia34	2; unified soil group, stones &/or gravel	2; stones &/or gravel	3; soil depth, stones &/or gravel, soil profile permeability

Land units	Secondary roads	Septic tanks	Farm dams
Ib 34	3; slope, stones &/or gravel, unified soil group	2; stones &/or gravel	4; soil depth, soil profile permeability, stones &/or gravel
Ic 34	4; slope, stones &/or gravel, unified soil group	2; slope, stones &/or gravel	3; slope, unified soil group, stones &/or gravel
Id 34	5; slope	4; slope	5; slope
Ie 34	5; slope	5; slope	5; slope
If 34	2; unified soil group, stones &/or gravel	2; stones &/or gravel	2; unified soil group, stones &/or gravel
Te 34	5; site drainage, inundation, unified soil group	5; site drainage, inundation	5; site drainage, inundation, unified soil group
Wa 34	5; site drainage, inundation	5; site drainage, inundation	5; site drainage, inundation

source: White & Kelynack (1985)

Soil Type 35 Deep Friable Well Structured Gradational And Duplex Soils

THE TABLES BELOW PRESENT INFORMATION RELEVANT TO THE LAND UNIT, SOIL TYPE, SOIL CHARACTERISTICS, LAND CAPABILITY CLASS AND LIMITATIONS FOR SOIL TYPE 35.

Soil Information Summary: Soil Type 35

Land units	Characteristics								
	Principal Profile Class	Unified Soil Group	Shrink-Swell Potential	Land Slip Potential	Permeability Class	Site Drainage Class	Flood Risk	Seasonal Watertable	Erosion & Deterioration
Ia, Ib If 35	Gn 4, Gn 3 Db 4, Dr 4	CH	Moderate	Nil	Moderately rapid	Moderately rapid (If) Rapid (Ia, Ib)	Nil	Nil	Nil
Ic, Id 35	Gn 4, Gn 3 Dr 4, Db 4	CH	Moderate	Nil to low	Moderately rapid	Rapid	Nil	Nil	Slight sheeting & gullying

Land Capability Class and Limitations

Land units	Secondary roads	Septic tanks	Farm dams
Ia 35	2; unified soil group	2; stones &/or gravel	2; unified soil group, stones &/or gravel
Ib 35	2; unified soil group	2; stones &/or gravel	3; unified soil group
Ic 35	3; slope, unified soil group	3; slope, stones &/or gravel	4; slope, stones &/or gravel, unified soil group
Id 35	4; slope	4; slope	5; slope
If 35	3; unified soil group	2; stones &/or gravel, soil profile permeability	3; unified soil group, stones &/or gravel

source: White & Kelynack (1985)

Soil Type 36 Shallow To Deep Gradational Soils With Loamy Topsoils Overlying Gritty Clay Subsoils

THE TABLES BELOW PRESENT INFORMATION RELEVANT TO THE LAND UNIT, SOIL TYPE, SOIL CHARACTERISTICS, LAND CAPABILITY CLASS AND LIMITATIONS FOR SOIL TYPE 36.

Soil Information Summary: Soil Type 36

Land units	Characteristics								
	Principal Profile Class	Unified Soil Group	Shrink-Swell Potential	Land Slip Potential	Permeability Class	Site Drainage Class	Flood Risk	Seasonal Watertable	Erosion & Deterioration
Da 36	Gn 3	CL	Low to mod	Nil	Moderate	Slow to moderate	Very freq.	Seasonally water logged	Nil
Ha, Hb 36	Gn 3	CL	Low to mod	Nil	Moderate	Moderate to rapid	Nil	Nil	Nil
Ia, Ib 36	Gn 3	CL	Low to mod	Nil	Moderate	Moderate	Nil	Nil	Minor tunnelling

Land Capability Class and Limitations

Land units	Secondary roads	Septic tanks	Farm dams
Da 36	5; site drainage, inundation	5; site drainage, inundation	3; site drainage, inundation
Ha 36	2; slope, stones & gravel	2; depth to hard rock, stones &/or gravel	3; stones &/or gravel, soil profile permeability
Hb 36	4; slope, stones &/or gravel	4; depth to hard rock, stones &/or gravel	4; slope, stones &/or gravel, soil profile permeability
Ia 36	2; unified soil group, depth to hard rock, stones &/or gravel	2; depth to hard rock, stones &/or gravel	3; soil profile permeability, stones &/or gravel
Ib 36	3; slope, unified soil structure, depth to hard rock	2; depth to hard rock, soil profile permeability	3; soil profile permeability, stones &/or gravel, unified soil group

source: White & Kelynack (1985)

Soil Type 38 A Complex Of Deep Well Structured Duplex Soils With Clayey Subsoils

THE TABLES BELOW PRESENT INFORMATION RELEVANT TO THE LAND UNIT, SOIL TYPE, SOIL CHARACTERISTICS, LAND CAPABILITY CLASS AND LIMITATIONS FOR SOIL TYPE 38.

Soil Information Summary: Soil Type 38

Land units	Characteristics								
	Principal Profile Class	Unified Soil Group	Shrink-Swell Potential	Land Slip Potential	Permeability Class	Site Drainage Class	Flood Risk	Seasonal Watertable	Erosion & Deterioration
Ia, Ib 38	Dy 5	CL	Moderate	Nil to slow	Slow to mod.	Moderate	Nil	Nil	Slight to mod sheeting & rill
Ic, Id, Ie 38	Dy 5	CL	Moderate	Low	Slow to mod.	Rapid	Nil	Nil	Nil
If 38	Dy 5	CL	Moderate	Nil to slow	Moderately slow	Slow	Nil	Nil	Nil

Land Capability Class and Limitations

Land units	Secondary roads	Septic tanks	Farm dams
If38	3; site drainage, stones &/or gravel	3; site drainage, stones &/or gravel	2; soil profile permeability, unified soil group, depth to hard rock
Ia 38	3; unified soil group	3; soil profile permeability, stones &/or gravel	2; unified soil group, stones &/or gravel, rock outcrop
Ib 38	3; unified soil group	3; soil profile permeability, stones &/or gravel	3; slope, stones &/or gravel, rock outcrop
Ic 38	3; unified soil group, stones &/or gravel, rock outcrop	3; unified soil group, stones &/or gravel	4; soil profile permeability, rock outcrop
Id 38	4; slope	4; slope	4; slope
Ie 38	5; slope	5; slope	5; slope

source: White & Kelynack (1985)

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APPENDIX A

Table A.1 Relationship between Soil Types and Geology

Soil Type	Geology
5a	Recent Quaternary alluvials (Qra) from Silurian and Devonian sediments.
5b	Recent Quaternary swamp deposits from Silurian sediments (Qrm).
9	Recent Quaternary alluvials from Silurian sediments.
11	Recent Quaternary river alluvials (Qra) and swamp deposits (Qrm) arising from Silurian sediments.
17,18	Recent Quaternary alluvial arising from
25,26,27	Quaternary and late Tertiary basalts (Qvn).
28	Tertiary basalts (Tvo) overlying silurian sandstones.
34,35	Complex of Silurian (Sud, Sla, Sum) and Devonian (Dlh, Dly) Sediments.
36	Upper Ordovician Shales (Ou).
37	Silurian sediments (S) with some Ordovician inclusions (Omd, Ou), Frankston formations.
38,39	Upper Devonian Bulla Granodiorite and granite (Dgb, Dg).

source: White & Kelynack (1985)

APPENDIX B GLOSSARY

Alluvium: Material such as sand, silt and clays which have been deposited on land by waterflow.

Colluvium: Rock fragments and soil which are deposited at the base of a slope by gravity and erosion by water.

Drainage: Drainage is a term used to summarise local soil wetness conditions. It is affected by internal attributes which include soil structure, texture, porosity, hydraulic conductivity, water holding capacity, and external attributes such as evapotranspiration, gradient and length of slope and position in the landscape. Categories are as follows:

Very poorly drained: Free water remains at or near the surface for most of the year. Soils are usually strongly gleyed. Typically a level or depressed site and/or a clayey subsoil.

Poorly drained: All soil horizons remain wet for several months each year. Soils are usually gleyed, strongly mottled and/or have orange or rusty linings of root channels.

Imperfectly drained: Some soil horizons remain wet for periods of several weeks. Subsoils are often mottled and may have orange or rusty linings of root channels.

Moderately well-drained: Some soils may remain wet for a week after water addition. Soils are often whole coloured, but may be mottled at depth and of medium to clayey texture.

Well-drained: No horizon remains wet for more than a few hours after water addition. Soils are usually of medium texture and not mottled.

Rapidly drained: No horizon remains wet except shortly after water addition. Soils are usually of coarse texture, or shallow, or both, and are not mottled.

Duplex profile form: A primary profile form of the Northcote Factual Key (1979) classification. It describes a soil where there is a sharp contrast in the texture between the A and B horizons (often sandy or loamy surface horizons with a sharp to clear boundary to clay subsoils).

Erosion and deterioration: Determined from observation of soil performance under a range of land uses in the study area.

Floodplain: A level plain adjacent to a river or stream which is subject to flooding.

Flood risk: Flood risk provides an estimation of flooding frequency. Flood frequency has been determined from observations of landform, catchment geometry, and soil types.

Flooding Class	*Estimated Return Period (years)*
Nil	>100
Low	25-100
Moderate	5-25
Frequent	1-5
Very High	<1

Land capability assessment: A systematic and rational method of determining the relative ability of different areas of land to sustain a specific land use under a nominated level of management without being degraded or causing any long term off-site degradation.

Land units or components: An area of land, distinct from adjacent units or components because of specific slope, soil, or geomorphological characteristics, e.g. crest, gentle slope, drainage depression.

Land slip potential: This is related to slope and soil type. Land slip risk increases where deep permeable soils with low wet strengths are encountered.

Land slip class	*Definition*
Nil	No evidence of landslip
Low	Some evidence of landslip
Moderate	Common evidence of landslip
High	Frequent evidence of landslip

Land system: An area of land, distinct from surrounding terrain, that has a specific climatic range, parent material and modal slope. Made up of a recurring sequence of land elements or components, e.g. sedimentary rolling hills.

Perched watertable: The watertable of a saturated layer of soil which is separated from an underlying permanent watertable by an unsaturated soil layer.

Permeability: The characteristic of a soil, soil horizon or soil material which governs the rate at which water moves through it. It is a composite expression of soil properties and depends largely on soil texture, soil structure, the presence of compacted or dense soil horizons and the size and distribution of pores in the soil. In this study, the permeability has been measured by maintaining a constant head of water at 15 cm in a 10 cm diameter auger hole which has been saturated before hand.

Value range (//m2/day)	*Interpretation*
<2	Very slow
2-5	Slow
5-15	Moderately slow
15-50	Moderate
50-200	Moderately Rapid
200-500	Rapid
>500	Very Rapid

Plain: Any flat area, large or small, having few if any prominent surface features.

Plateau: An elevated plain, limited on at least one side by an abrupt descent.

Principal profile form (Northcote 1979): A soil classification system used in Australia that groups soils into recognisable profile forms. These are based on visible morphological properties and simple chemical properties and simple chemical properties of a soil and are labelled used an alphanumeric code.

Rock outcrop: Any exposed area of rock that is inferred to be continuous with the underlying parent material.

Salinity: A measure of the total soluble salts in a soil. A saline soil is one with an accumulation of free salts at the soil surface and/or within the profile affecting plant growth and/or land use. It is generally attributed to changes in land use or natural changes in drainage or climate that affects the movement of water through the landscape. Salinity levels of soil or water can be tested using Electrical Conductivity (see EC).

Seasonal watertable: Saturated soil horizon which inhibits the downward movement of water.

Waterlogging class	*Definition*
Nil	watertable drops below 1m after 24 hours
Temporarily ponded	local areas of ponding persist for several days after heavy rain
Temporarily waterlogged	watertable perches on an impermeable soil layer which may persist for a week after heavy rain
Seasonally waterlogged	watertable within pasture root zone up to one month after heavy rain, surface ponding common
Watertable seasonally at surface	water at soil surface for several months during winter

Shrink swell potential: Relates to the amount of swelling clays present in a soil. These clays swell on wetting and shrink on drying and can severely effect foundations and earthworks.

Shrink swell	*Potential linear shrinkage*
Low	less than 4%
Moderate	4 to 12%
High	12 to 12%
Very high	>20%

Slope: Landform element that is neither a crest nor a depression and that has an inclination greater than 1%. Slope can be broken up into the following categories:

Value range (%)	*Interpretation*
< 1%	Level
1 - 3%	Very gentle slope
4 - 10%	Gentle slope
10 - 20%	Moderate slope
20 - 35%	Moderately steep slope
> 35%	Steep slope

Soil profile: A portion of a soil exposed in a vertical section, extending usually from the land surface to the parent material. In very general terms, a profile is made of three major layers designated A, B and C horizons. The A and B horizons are those modified by soil development. The C horizon is weathering parent material that has not yet been significantly altered by soil forming processes.

Soil texture: The relative proportions of sand, silt and clay particles in a sample of soil. The field assessment of texture is based on the characteristics of a bolus of wetted soil moulded by hand. Six main soil texture groups are recognised

Texture group	*Approx. clay content (%)*
1. Sands	< 10
2. Sandy loams	10 - 20
3. Loams	20 - 30
4. Clay loams	30 - 35
5. Light clays	35 - 40
6. Heavy clays	> 45

Soil texture groups: The topsoil and subsoil texture classes were grouped according to Northcote (1979).

S Sand, loamy sand, clayey sand
SL Sandy loam, fine sandy loam, light sandy clay loam
L Loam, loam fine sandy, silt loam, sandy clay loam
CL Clay loam, silty clay loam, fine sandy clay loam
LC Sandy clay, silty clay, light clay, light medium clay
MHC Medium heavy clay, medium clay, heavy clay

Uniform profile form: A Primary Profile form of the Factual Key Classification (Northcote, 1979). These soil profiles have little, if any texture change throughout the profile. There is generally no textural boundary found within the profile, except for possibly a surface crust.

Unified soil group: Engineering classification based on soil texture and plasticity which indicates the likely stability of soils for construction of roads, foundations and embankments