City of Melton

Engineering Design and Construction Manual – Addendum

Industrial Subdivision

2017
Contents

10. ROAD DESIGN ........................................... 3
   10.1. Introduction ........................................ 3
   10.2. Design Criteria ...................................... 3
   10.3. Sight Distance ....................................... 4
   10.4. Horizontal Alignment ............................... 4
   10.5. Vertical Alignment .................................. 5
   10.6. Standard Cross-Section ............................. 6
   10.7. Cross Fall ........................................... 8
   10.8. Kerb And Channel .................................... 9
   10.9. Footpaths & Nature Strips ......................... 11
   10.10. Carriageway ........................................ 13
   10.11. Vehicular Crossings ............................... 14
   10.12. Utility Allocations ................................. 14
   10.13. Roundabouts ....................................... 14

11. PAVEMENT DESIGN .................................... 15
   11.1. Scope ................................................ 15
   11.2. Design References ................................... 15
   11.3. Qualified Consultants ............................... 16
   11.4. Pavement Design Parameters ....................... 17
   11.5. Subgrade & Earthworks .............................. 19
   11.6. Pavement Materials .................................. 23
   11.7. Design Traffic ....................................... 25
   11.8. Flexible Pavement Design ......................... 26
   11.9. Subsurface Pavement Drains ....................... 29

12. EARTHWORKS DESIGN ................................. 30
   12.1. General .............................................. 30
   12.2. Planning & Engineering Requirements .......... 30
   12.3. Earthworks And Filling Requirements .......... 31

13. DRAINAGE DESIGN .................................... 32
   13.1. Introduction ........................................ 32
   13.2. Planning & Layout ................................... 33
   13.3. Computation Of Runoff ............................ 34
   13.4. Rainfall Intensity ................................... 34
   13.5. Average Exceedance Probability .................. 34
   13.6. Time Of Concentration .............................. 35
   13.7. Runoff Coefficient ‘C’ ............................. 36
   13.8. Hydraulics .......................................... 40
   13.9. Hydraulic Grade Line ............................... 40
   13.10. Pipe Grade And Alignment ....................... 40
   13.11. Minimum Cover (To Top Of Pipe) ............... 40
   13.12. Pipe Friction ...................................... 40
   13.13. Minimum Pipe Size ............................... 41
   13.14. Pipe Joints ........................................ 41
   13.15. Pipe Flow Velocity And Grade .................. 41
   13.16. Anchor Blocks ..................................... 42
   13.17. Alignment At Pits .................................. 42
   13.18. Pit Locations ....................................... 43
   13.19. Kerb Inlets ......................................... 43
   13.20. Pit Head Losses .................................... 43
   13.21. Property Connections ............................. 43
   13.22. Surface Drainage ................................... 44
   13.23. Water Quality ...................................... 45
   13.24. Sub Surface Drainage .............................. 45

Table 1: Operating Speeds ......................... 3
Table 2: Design and Checking Vehicles ............. 4
Table 3: Vertical Grades .............................. 5
Table 4: Road Elements ............................... 6
Table 5: Minimum VicRoads Pre-Qualification Levels ........... 16
Table 6: Project Reliability Levels ................. 18
Table 7: Typical Design Traffic Data ............... 25
Table 8: Unbound Granular Pavements On Expansive Subgrades ........................ 26
Table 9: Asphalt Pavements on Expansive Subgrades ...................... 27
Table 10: Average Exceedance Probabilities ........ 34
Table 11: Times of Concentration ................. 35
Table 12: Land use fraction impervious .......... 37
Table 13: “C” Values .................................... 39
Table 14: Friction Factors ............................. 40
Table 15: Acceptable Velocities ................. 41
This addendum has been developed to assist in the design of Industrial Subdivisions within the City of Melton. The principles have been based on the Engineering Design and Construction Manual for Subdivision in Growth Areas which has been adopted by City of Melton since 2011.

This addendum is to be read in conjunction with Parts A, B and D of the Engineering Design and Construction Manual.

10. ROAD DESIGN

10.1. INTRODUCTION

This section sets out the standard design criteria for road works. It is not intended to prohibit any alternative arrangements or approaches. Innovative or non-standard designs may be considered, but not necessarily accepted by Council. Sufficient data and principles of design for any innovative or non-standard design shall be submitted for consideration.

Aspects not specifically referred to in this manual should be generally in accordance with the following documents:

- AustRoads: Guide to Road Design,
- Standard Drawings appended.

10.2. DESIGN CRITERIA

10.2.1. Operating speed

The desired maximum operating speed, on which the geometric design of each road type is based, shall be:

Table 1: Operating Speeds

<table>
<thead>
<tr>
<th>Zone</th>
<th>Road Type</th>
<th>Maximum Operating Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial</td>
<td>Access</td>
<td>50 km/h</td>
</tr>
<tr>
<td>Industrial</td>
<td>Connector</td>
<td>60 km/h</td>
</tr>
</tbody>
</table>

* Note that the design speed is not necessarily the posted or operating speed.
10.2.2. **Design Vehicle**

The following designs vehicle(s) are to be adopted. Turning radii and vehicle speeds used in road design shall be confirmed with Council at the commencement of design development.

**Table 2: Design and Checking Vehicles**

<table>
<thead>
<tr>
<th>Intersecting roads</th>
<th>Design Vehicle</th>
<th>Checking vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector/Collector</td>
<td>Prime mover and semi-trailer (19 m) (1) Radius 15 m</td>
<td>B-double (25 m) (3)</td>
</tr>
<tr>
<td>Access/Access</td>
<td>Prime mover and semi-trailer (19 m) (1) Radius 12.5 m</td>
<td>Appropriate vehicle e.g. B-double (25 m) or Prime mover and long semi-trailer (25 m)</td>
</tr>
</tbody>
</table>

1. Select the appropriate vehicle for the design of sites that are frequently used by such vehicles.
2. Simulations show that for this radius the maximum steering angle occurs at the exit of the turn and not applied at the crawl speed.
3. Where the development is within a Precinct Structure Plan (PSP) please refer to the relevant PSP for guidance on the checking design vehicle.

10.3. **SIGHT DISTANCE**

The requirements for sight distance on all roads and intersections shall be in accordance with the current *AustRoads: Guide to Road Design*.

10.4. **HORIZONTAL ALIGNMENT**

10.4.1. **General**

Horizontal alignment of all roads shall be designed in accordance with the requirements of *AustRoads: Guide to Road Design*.

10.4.2. **Superelevated**

Where curves are superelevated, it is necessary to ensure that any low points in the kerb and channel resulting from the application of superelevation are adequately drained.
10.5. VERTICAL ALIGNMENT

10.5.1. Longitudinal Grades

Maximum Grades

The desirable maximum grades, listed in the following table, are to be considered the maximum for normal design purposes.

Where the topography makes it difficult to provide a road location which will conform to desirable maximum grades, grades up to those shown as "Absolute Maximum" grades may be used.

In extreme cases, the use of grades steeper than “Absolute Maximum” values may be approved provided that:

- all possible alternatives have been fully investigated and proven to be impracticable; and
- the grades and access arrangements resulting from steeper grades are proven to be practicable.

Table 3: Vertical Grades

<table>
<thead>
<tr>
<th>Zone</th>
<th>Road Type</th>
<th>Desirable Maximum</th>
<th>Absolute Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Access</td>
<td></td>
<td>6%</td>
<td>10%</td>
</tr>
<tr>
<td>Industrial Connector</td>
<td></td>
<td>6%</td>
<td>8%*</td>
</tr>
</tbody>
</table>

* Bus Routes shall be no greater than 10%.

The designer shall check and comply with the current grading requirements of the relevant fire authority.

Minimum Grades

The minimum grades for all roads, based on kerb and channel drainage requirements, shall be:

<table>
<thead>
<tr>
<th>Desirable Minimum</th>
<th>0.5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolute Minimum</td>
<td>0.33% (subjected to Council approval)</td>
</tr>
</tbody>
</table>
10.5.2. **Vertical Curves**

**General**

A vertical curve, of parabolic form, shall be provided at every change of grade where the arithmetic change of grade is more than:

| Access and Collector | 1.0% |

Every effort should be made to provide lengthy vertical curves for improved appearance.

Generally, the minimum length of a vertical curve shall be 20m.

All vertical curves shall be designed in accordance with *AustRoads: Guide to Road Design*.

10.6. **STANDARD CROSS-SECTION**

The standard cross section for various roads in new subdivisions shall be in accordance with the relevant PSP for the area. Basis for the standard cross sections is outlined in the PSP Guidelines and associated Road note/s.

10.6.1. **Cross-Section Elements**

Standard Cross Section elements shall be as follows:

**Table 4:** Road Elements

<table>
<thead>
<tr>
<th></th>
<th>Access Street 22m</th>
<th>Connector 26m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic volume (vpd)</td>
<td>&lt;3000</td>
<td>&gt;3000</td>
</tr>
<tr>
<td>Target operating speed (km/h)</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>Carriageway width (m)</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Parking within street(^1)</td>
<td>2.6 marked on both sides</td>
<td>2.6 marked on both sides</td>
</tr>
<tr>
<td>Verge width (m)</td>
<td>4.9</td>
<td>3.5, 9.3</td>
</tr>
<tr>
<td>Kerbing(^2)</td>
<td>600B2</td>
<td>600B2</td>
</tr>
<tr>
<td>Footpath provision</td>
<td>2 x 1.5</td>
<td>2 x 1.5</td>
</tr>
<tr>
<td>Two Way Bike Path (m)</td>
<td>N/A</td>
<td>3</td>
</tr>
</tbody>
</table>

1. Kerb outstands to be provided at 100m maximum spacing’s and at intersections
2. SM2 kerb and channel may be used subject to Council approval (refer to Section 10.8)
Figure 1: Industrial Access Street cross section

Figure 2: Industrial Connector Street cross section
10.7. CROSS FALL

10.7.1. Normal Cross Section
On straight lengths of two-way road the pavement cross section will normally be graded with the high point (crown) on the pavement centreline, with a fall to each channel.

However, on steep side slopes, the crown may be offset, towards the higher side of the road to obtain better conformity of road levels with the natural side slope.

On divided roads each pavement will normally be graded to fall from the median to the outer channel, unless Water Sensitive Urban Design (WSUD) is incorporated where the cross fall may grade towards the centre median.

10.7.2. Normal Cross fall
The normal cross fall of pavement on straight alignment shall be:

| Bituminous sealed pavements | 3.33% (1 in 30) |

10.7.3. Maximum and Minimum Cross fall
Where steeper or flatter cross falls than the normal are required, for example at the approach to intersections, or turning circles of cul-de-sacs, the maximum and minimum permissible pavement cross falls shall be:

| Maximum cross fall          | 6.67% (1 in 15) |
| Minimum cross fall          | 2.5% (1 in 40)  |

Intersections should be designed to avoid ponding and be free draining.
10.8. **KERB AND CHANNEL**

10.8.1. **Location**
Concrete kerb and channel shall be provided on both sides of all industrial roads.

10.8.2. **Kerb and Channel Types**
The standard kerb and channel profile shall be as shown on the Standard Drawings. In general Barrier Kerb profiles are to be used in industrial developments.

Exceptions to the use of these profiles may be considered in the following instances:

- Kerb only may be used with one-way cross fall pavements and reverse fall nature strip on high side;
- Medians & Traffic Islands, where semi-mountable is shown, shall be M2, M3, SM2 or SM3;
- Roundabout outer kerbs shall be SM2 from TP to TP. Roundabout splitter islands are to be SM3. Roundabout central island outer kerb shall be SM3;
- For small islands (with an enclosed surface area not greater than 3m2) SM1 may be used;

10.8.3. **Grading**
General minimum kerb and channel grade shall be 0.5% (1 in 200); in exceptional circumstances a 0.3% grade may be used subject to Council approval.

Vertical curves should be as long a length as possible. Generally a minimum length of 20m shall be used.

Where the change in grade in a vertical curve will result in excessively long flat areas, the invert grade shall be extended through to the low point to provide a minimum 0.3% grade.

Designers shall limit crest curves that have minimum grade (0.3% to 0.5%) to between 30m and 50m length.

In kerb returns the desirable minimum grade is 0.75% and absolute minimum is 0.50%.
10.8.4. Kerb Radii

Kerb radii shall allow for the nominated design vehicle to move through the swept path without impedance.

The radius of the kerb and channel, measured to back of kerb, at an intersection shall be selected in accordance with “Austroads Guide to Road Design Part 3 – Geometric Design” and current versions of the “Austroads Design Vehicles and Turning Path Templates”.

Use of the Austroads template for a “Standard Service Vehicle” (19m) is recommended as the governing criteria.

The following kerb radii are considered to be desirable minimums:

| Industrial Access Street and Connector Street | 12.50m |
10.9. **FOOTPATHS & NATURE STRIPS**

10.9.1. **Cross-section**

The cross-section of footpaths and nature strips shall conform to those shown on the current Melton Council suite of Standard Drawings.

10.9.2. **Cross fall**

Where concrete footpath paving is to be provided within a street reserve, the footpath cross fall shall be 2.0% towards the road. In all other instances concrete footpaths and shared paths shall have a maximum cross fall of 2.5%.

Nature strip cross falls shall be within the range of 2.5% and 10.0%, towards the road.

Standard cross falls shall not be exceeded at any location where vehicular access to allotments may be required.

10.9.3. **Provision of Tactile Ground Surface Indicators**

Use of Tactile Ground Surface Indicators (TGSI) shall be in accordance with the Disability Discrimination Act (DDA) requirements and any Council strategies for disabled access. The use of TGSI will be minimised by designing for a continuous path of travel in order to avoid their need at minor access street intersections. Changes of footpath direction at crossings are therefore discouraged.

Footpath and Pram Crossings (kerb ramps) shall be provided in accordance with DDA requirements. Location and alignment shall support the principle of “continuous path of travel” requirements.

TGSI are not required where:

- The geometry of a kerb ramp at an intersection is fully compliant with AS1428.1; and
- The ramp is located on the direct extension of the property line; and
- The top of the ramp is no more than 3000mm from the intersection of property lines.

TGSI are required at all kerb ramps that do not comply with the above, at all mid-block crossings, and at high usage vehicle crossovers, e.g. service stations and shopping centre car parks.

Directional TGSI are to be used where a kerb ramp is not located on the direct extension of the property line in an accessible path of travel from the building / boundary line and will lead to warning indicators installed at the crossing (kerb ramp) point.

Directional and warning TGSI will always be required at mid-block pedestrian or bus stops.

Refer to Melton Councils current Standard Drawings or particular requirements of the Precinct Structure Plan.

10.9.4. **Modification of the Footpath Cross fall**

Modification of the footpath fall will only be considered in extreme circumstance; as this approach may increase the catchment area discharging stormwater into the downhill lots, it shall be avoided where possible.

Reverse fall (away from kerb) nature strips with footpath ‘spoon drain’ will only be considered in extreme% circumstances as this approach requires higher maintenance for drainage without
significant access benefits.
10.10. CARRIAGEWAY

10.10.1. Offsetting of the Crown and one-way cross fall

In circumstances where the natural cross slope of the existing terrain will lead to unreasonably high cut batters, offsetting the crown or one-way cross fall may be considered.

Offsetting of the crown, on a two-way road, is permissible, provided that sufficient stormwater capacity is retained in the channel and roadway on the high side of the road. Required capacity will depend on catchment, and on the spacing of storm water entry pits. Offset crown widths shall be sufficient to ensure that the crown is able to be laid with asphalt machinery.

A pavement with one-way cross fall may be approved only where drainage requirements can be adequately met.

10.10.2. Reverse Cross fall – Divided Roads

In extreme cases, reverse cross fall, on the uphill lane of divided roads, is permissible provided that adequate drainage capacity is provided in the uphill median channel, and precautions taken to intercept flow at median openings.

10.10.3. Median Cross fall

Median Cross fall, on divided roads, should desirably not exceed a maximum of 16% (1 in 6), with 33% (1 in 3) as an absolute maximum, unless a retaining wall is provided and there are no proposed median breaks in the median.

At median openings however, the pavement cross fall shall not exceed 5% (1 in 20).

10.10.4. A Split-Level Road

Modification of the road section to accommodate a split level road will only be considered in extreme circumstance.
10.11. VEHICULAR CROSSINGS

Vehicle crossings are not required to be provided unless they are required as a condition of the Planning Permit. Where industrial vehicle crossings are provided they are to be in accordance with Melton Councils Standard Drawings.

10.11.1. Driveway Grades

Where vehicle crossings are provided the desirable maximum driveway grade is 5% (1 in 20) for industrial allotments. In steep terrain, driveway cut or fill earthworks into the allotments are to be shown on the plans so that the driveway access is created with the subdivision works (where required).

10.12. UTILITY ALLOCATIONS

The location of utility services is to be in accordance with the requirements of the relevant Council and Service Authority. Further reference can be made to the Code of Practice for Management of Infrastructure in Road Reserves.

For clarity, typical cross sections showing service allocations are indicated in Appendix D of the Engineering Design and Construction Manual.

Utility services are an important component of infrastructure provided for our newest suburbs.

Standard placement of utility services within road reserves ensures appropriate clearances and access, while minimising conflicts between other road reserve infrastructure.

Layouts and road cross sections may need to be reviewed if non-standard trunk utilities are to be provided because these utilities are typically larger infrastructure requiring larger clearances.

10.13. ROUNDABOUTS

Roundabouts shall be designed according to AustRoads Guide to Road Design.
11. PAVEMENT DESIGN

11.1. SCOPE
The scope of this Section covers the design of pavements for Industrial subdivisions.

For asphalt pavement design, requirements are restricted to the design and construction of road pavements with **not less than two layers of asphalt and flanked by kerb and channel**. A minimum of two layers of asphalt has been adopted as the standard.

11.2. DESIGN REFERENCES
The design of the pavements shall be carried out by qualified engineering consultants in accordance with this Manual and the principles, practices and procedures detailed in the following design references:

- VicRoads (Current). Code of Practice RC 500.20 : Assignment of CBR (Strength) and Percent Swell to Earthworks and Pavement Materials. (RC 500.20)
11.3. QUALIFIED CONSULTANTS

Pavement design and associated geotechnical field and laboratory investigation testing shall be undertaken by qualified consultants who have relevant experience in the required field of practice. To ensure that this requirement is met, only those consultants who are currently registered on the VicRoads “Register of Pre-Qualified Contractors & Consultants” are eligible to provide services within the categories outlined in Table 5 below.

Table 5: Minimum VicRoads Pre-Qualification Levels

<table>
<thead>
<tr>
<th>Description of Service</th>
<th>VicRoads</th>
<th>Prequalification Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td>Service</td>
<td>Level</td>
</tr>
<tr>
<td>Pavement</td>
<td></td>
<td>ND1</td>
</tr>
<tr>
<td>Pavement Types E1-E4, N1-N4</td>
<td></td>
<td>Basic Pavement Design</td>
</tr>
<tr>
<td>Design</td>
<td></td>
<td>ND2</td>
</tr>
<tr>
<td>Pavement types E5-E6, N5-N6</td>
<td></td>
<td>Intermediate Pavement Design</td>
</tr>
<tr>
<td>Rigid Pavements</td>
<td></td>
<td>ND3</td>
</tr>
<tr>
<td>Geotechnical</td>
<td></td>
<td>PT2</td>
</tr>
<tr>
<td>At Grade Subgrade Investigation</td>
<td></td>
<td>Field Investigation &amp; Laboratory Testing</td>
</tr>
<tr>
<td>Investigation</td>
<td></td>
<td>AB1</td>
</tr>
<tr>
<td>Road Alignment</td>
<td></td>
<td>Alignment &amp; Bridge Investigation (Minor)</td>
</tr>
<tr>
<td>Ground Contamination</td>
<td></td>
<td>GEV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Geo-Environmental Investigation</td>
</tr>
</tbody>
</table>
11.4. PAVEMENT DESIGN PARAMETERS

11.4.1. General

The general aim of pavement design is to select the most economical pavement thickness and composition which will provide a satisfactory level of service over the adopted design life taking into account the prevailing subgrade conditions, the characteristics of the materials in the pavement and the anticipated level of traffic.

The pavement design process accordingly requires that a number of input variables be selected and assigned to any particular design. These design parameters are listed below, together with their associated reference in this guide:

- Project Reliability Level (Section 11.4.2)
  - Assignment of a Project Reliability Level for mechanistic pavement design purposes and for design of rigid pavements.

- Subgrade (Section 11.5)
  - Assignment of subgrade strength, its associated classification as expansive or otherwise, capping layer fills, and subgrade improvement measures where required.

- Pavement Materials (Section 11.6)
  - Selection and specification of appropriate pavement materials, their properties, and assignment of associated characteristics to be used in the design process.

- Design Traffic (Section 11.7)
  - Assessment of forecast future traffic for the required design period, including future growth, the proportion of heavy vehicles and their associated loading characteristics.
11.4.2. **Project Reliability Levels**

The Project Reliability for a particular project is defined as the probability that the pavement, when constructed in accordance with the chosen design, will outlast its design traffic before major rehabilitation is required.

The Project Reliability Level shall be selected by the designer in accordance with Table 6 below for each category of road as appropriate. A designer may choose to select a higher Project Reliability Level if the circumstances for any particular project are warranted.

**Table 6: Project Reliability Levels**

<table>
<thead>
<tr>
<th>Road Type</th>
<th>Project Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Access</td>
<td>95%</td>
</tr>
<tr>
<td>Industrial Connector</td>
<td>95%</td>
</tr>
</tbody>
</table>
11.5. SUBGRADE & EARTHWORKS

11.5.1. Subgrade Evaluation

Subgrade investigation testing, including both field and laboratory testing and associated evaluation and determination of subgrade strength, shall be undertaken in accordance with all relevant Australian Standards and relevant requirements of the following references in descending order:

- VicRoads Manual of Codes of Practice, test methods and design guides;
- Standards Australia test methods; and
- Austroads Design Guides.

The scope, extent and location of investigation testing should be commensurate with the location and magnitude of the proposed works. Notwithstanding the requirements outlined in the above guides, the following minimum testing shall be undertaken for each project for the purpose of characterising the nature and condition of the subgrade:

- excavation of test bores or pits to a depth of at least 1.0 m or more than 0.5m below the proposed subgrade (whichever is the greater), at intervals not exceeding 120 m, with a minimum of 3 test sites on any one project;
- dynamic cone penetrometer testing and measurement of field moisture content at each test site;
- grading and Atterberg limit testing on at least 2 representative samples of subgrade material; and
- laboratory soaked (4 day) CBR tests on at least 2 representative laboratory remoulded samples of subgrade material.

If rock is encountered during the field investigation, the requirement to excavate bores or pits to a depth of 1.0 m may be waived.
11.5.2. Maximum Subgrade Design CBR

To ensure that uniform minimum pavement design standards are met, the subgrade design CBR assigned for pavement design purposes shall not exceed 10%.

11.5.3. Expansive Subgrades

Subgrade Classification

Subgrade materials with an assigned swell ≥ 2.5% as determined in accordance with RC 500.20 shall be classified as expansive for the purpose of this guide. These materials are categorised by Austroads Guide to Pavement Technology part 2 (AGPT02)02 to be at the very least highly expansive.

Treatment of Expansive Subgrades

Since expansive subgrades exhibit seasonal volume changes with resulting shape loss and environmentally induced cracking, appropriate measures shall be incorporated into the design of the pavement as outlined in RC 500.22 Section 5.2 and AGPT02 Section 5.3.5.

These shall include, without being limited to, incorporation of the following features into the design in accordance with the referenced sections of this guide:

- minimum total pavement thickness as specified herein;
- provision of a capping layer as specified herein; and
- attention to the placement of subsurface drainage as specified herein.
11.5.4. Weak Subgrade

In addition to the pavement composition requirements outlined in this guide, an appropriate working platform, or subgrade improvement layer, may need to be incorporated into the pavement structure at the time of construction to facilitate placement and compaction of subsequent pavement layers. The subgrade improvement layer may be incorporated into the pavement design in accordance with the following guidelines:

- subgrade design CBR of 2% or greater - the thickness of the working platform may be included within the required overall pavement thickness provided that the materials satisfy the requirements of this guide;

- subgrade design CBR < 2% - the pavement thickness design may be based upon a subgrade design CBR of 2%, provided that the subgrade is first improved to a depth of not less than 150 mm and that the subgrade improvement layer is not incorporated into the overall pavement thickness.

Where subgrade improvement layers are incorporated into the pavement structure, the usual requirements for compaction shall apply. In the case of test rolling however, only the uppermost improvement layer shall be required to be test rolled so as to withstand visible deformation and springing. The requirement to test roll any underlying improvement layers, and subgrade, may be waived.

Subgrade improvement is most often required because of the presence of unsuitable materials or the presence of high moisture contents at the time of construction. In determining the need for subgrade improvement, it is important to take into account the potential for the subgrade to be weakened if drainage of the formation is inadequate during construction.

Any isolated small areas of subgrade which are weaker than the subgrade CBR assigned for design of the pavement, or which are weak at the time of construction, shall be treated by excavation to a sound base and backfilled to subgrade level with either of the following materials:

- suitable surplus earthworks materials from the site; or

- imported Type A capping layer material.
11.5.5. Type A Materials

Capping Layer

To ensure that long term environmental effects are minimised, a capping layer shall be placed immediately above subgrades classified as being expansive. The capping layer shall comprise lower subbase quality material, or in-situ stabilised material, or imported Type A capping layer material, with the following additional properties:

- assigned swell \( \leq 1.5\% \); and
- permeability \( \leq 5 \times 10^{-9} \text{ m/s} \).

In addition to the material properties outlined above, the capping layer shall have the following minimum physical characteristics:

- thickness \( \geq 150 \text{ mm} \), or 2.5 times the maximum particle size of the capping layer material, whichever is the greater; and
- extend for a distance \( \geq 0.6 \text{ m} \) behind the back of kerb and channel, or the edge of the pavement if there is no kerb and channel, except for arterial roads where the distance shall be \( \geq 1.5 \text{ m} \).

The capping layer may be included in the total thickness of unbound granular pavements (see Section 11.5.4) if the laboratory soaked CBR of the material complies with the requirements for lower subbase materials, or the following requirements.

Selected Material

All Type A selected material shall have an assigned swell \( \leq 1.5\% \).

Unbound Granular Pavements

Where unbound granular pavements are designed for a subgrade design CBR of 2% and the total pavement thickness \( \geq 440 \text{ mm} \), as much as the lower 150 mm of the pavement may comprise the following materials in lieu of lower subbase materials, provided that the material has a laboratory soaked CBR \( \geq 8\% \):

- imported Type A capping layer material; or
- imported Type A selected material; or
11.6. PAVEMENT MATERIALS

11.6.1. General

Pavement materials shall be designed to be supplied, placed and compacted in accordance with the version of the VicRoads Standard Specifications current at the time of commencing the pavement design. The principal requirements relating to the following materials selected for pavements designed in accordance with this guide are outlined in the sections below.

11.6.2. Asphalt

Wearing Course Asphalt

Designers are required to pay particular attention to the selection of wearing course asphalt at roundabouts and at signalised intersections on Connector Streets and Arterial Roads where the computed HVs/lane > 500 hvpd in accordance with RC 500.22 Appendix D.

Bituminous Prime

In the case of all unbound granular pavements, a prime, or alternatively a primerseal, shall be selected and designed by the contractor and applied to the top of the base course crushed rock. Its role is to bind the subsequent asphalt base course to the crushed rock base and to waterproof the pavement.

Where a primerseal is selected, it shall comprise:

- Size 5 or Size 7 bitumen emulsion primerseal (not exceeding 60% bitumen content)
- Application of residual binder of > 0.9 l/m2.
11.6.3. **Unbound Granular Pavements**

Minimum requirements for materials to be selected for use in unbound granular pavements are:

- **Base**
  - 20 mm Class 2 crushed rock, or
  - 20 mm Class CC2 crushed concrete.

- **Upper Subbase**
  - 20 mm Class 3 crushed rock, or better, or
  - 20 mm Class CC3 crushed concrete, or better,

- **Lower Subbase**
  - Class 4 crushed rock or better, or
  - Class CC4 crushed concrete or better, or
  - subbase quality gravel, sand or soft and rippable rock with previous proven performance and a laboratory soaked CBR ≥ 15%.

11.6.4. **Asphalt Pavements**

Minimum requirements for materials to be selected for use as subbase in asphalt pavements, comprising either deep strength asphalt or full depth asphalt, are outlined in RC 500.22.
11.7. DESIGN TRAFFIC

11.7.1. Design Period
Calculation of Design Traffic shall be based upon a minimum design period of 20 years. A designer may choose to select a longer design period if the circumstances for any particular project are warranted.

11.7.2. Calculation of Design Traffic
Calculation of Design Traffic shall be undertaken in accordance with VicRoads Code of Practice: Selection and Design of Pavements and Surfacings RC 500.22 and Austroads Guide to Pavement Technology: Pavement Structural Design to suit the characteristics and requirements of each particular project. In addition to the design period outlined above, the calculations will require an appropriate assessment of the following input data:

- forecast total traffic over the duration of the design period, including any necessary provision for future traffic growth;
- the proportion of heavy vehicles, including waste management vehicles, and an allowance for buses where the street will form part of a bus route;
- heavy vehicle traffic generated by construction during development of subdivisions in the case of Access Streets;
- vehicular trafficking patterns including the directional split, vehicle wander on wide pavements and lane distribution on multi-lane roads; and
- heavy vehicle load factors, incorporating the average number of HVAG per HV, and the average number of ESA per HVAG in the case of flexible pavements.

Typical Design Traffic parameters are outlined in Appendix B of the Engineering Design and Construction Manual and are provided as a guide only. The data shall not be used as a substitute for the designer making an assessment of relevant parameters for each particular project, particularly in the case of industrial subdivisions where detailed heavy vehicle traffic forecasts are necessary.

Where the width of a street, or the presence of parked vehicles, results in two way traffic either partially or fully using the same travel path, consideration needs to be given to assignment of the appropriate Direction Factor, required to be within the range of 0.5 to 1.0.

11.7.3. Minimum Permissible Standards
To ensure that minimum pavement design standards are met, values of Design Traffic parameters, and the resultant computed Design Traffic, shall not be less than the lower range outlined below:

<table>
<thead>
<tr>
<th>Table 7: Typical Design Traffic Data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Road Type</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Access Street</td>
</tr>
<tr>
<td>Upper Range</td>
</tr>
<tr>
<td>Connector</td>
</tr>
<tr>
<td>Upper Range</td>
</tr>
</tbody>
</table>
11.8. **FLEXIBLE PAVEMENT DESIGN**

11.8.1. **Expansive Subgrades**

**Unbound Granular Pavements**

Where subgrades are defined as expansive, the use, thickness and composition of unbound granular pavements shall satisfy the following criteria:

- only permissible where DESA ≤ 1.0 x 10^6 ESAs;
- two layers of asphalt surfacing to allow staged construction of new subdivisions;
- the design chart in Appendix B, subject to the minimum requirements outlined in Table 8 below; and
- minimum total thickness defined by the expansive subgrade curve in Appendix B of the Engineering Design and Construction Manual.

**Table 8:** Unbound Granular Pavements On Expansive Subgrades

<table>
<thead>
<tr>
<th>Road Type</th>
<th>Industrial Access Street</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pavement Type</td>
<td>N1</td>
</tr>
<tr>
<td>Wearing Course</td>
<td>Size 14 type HP Asphalt</td>
</tr>
<tr>
<td>Base Course*</td>
<td>Size 14 Bitumen Crumb Rubber Asphalt</td>
</tr>
<tr>
<td>Bituminous Prime</td>
<td>Prime or Primeseal</td>
</tr>
<tr>
<td>Base</td>
<td>Base Material refer Section 11.6.3</td>
</tr>
<tr>
<td>Upper Subbase</td>
<td>Upper Subbase Material refer Section 11.6.3</td>
</tr>
<tr>
<td>Lower Subbase</td>
<td>Lower Subbase Material refer Section 11.6.3</td>
</tr>
<tr>
<td>Capping Layer</td>
<td>Type A Capping Layer Material</td>
</tr>
</tbody>
</table>

* Note that Bitumen Crumb Rubber Asphalt is mandatory for all Base Course in pavements on expansive subgrades.
Asphalt Pavements

Where subgrades are defined as expansive, the use, thickness and composition of asphalt pavements, comprising either deep strength asphalt or full depth asphalt as defined by RC 500.22, shall satisfy the following criteria:

- mandatory where DESA \(>1.0 \times 10^6\) ESA;
- Section 11 and Appendix D of RC 500.22, subject to the minimum requirements outlined in Table 9 below; and
- minimum total thickness defined by Figure 5.1 of RC 500.22, or by the expansive subgrade curve in Appendix B where DESA \(<1.0 \times 10^6\) ESA.

Table 9: Asphalt Pavements on Expansive Subgrades

<table>
<thead>
<tr>
<th>Road Type</th>
<th>Industrial Connector and Access Street</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pavement Type</td>
<td>N2</td>
</tr>
<tr>
<td>Max Permissible DESA (ESA)</td>
<td>No Limit</td>
</tr>
<tr>
<td>Wearing Course</td>
<td>Size 14 Type H Asphalt</td>
</tr>
<tr>
<td>Intermediate Course</td>
<td>Size 20 Type SI Asphalt (or Type SS)</td>
</tr>
<tr>
<td>Base Course</td>
<td>Size 20 Type SI Asphalt (or Type SF)</td>
</tr>
<tr>
<td>Subbase</td>
<td>(Cementitious and/or unbound materials)</td>
</tr>
<tr>
<td>Capping Layer</td>
<td>Type A Capping Layer Material</td>
</tr>
</tbody>
</table>
11.8.2. Pavement Design Speeds

Unbound Granular Pavements

In view of the requirement for unbound granular pavements to be surfaced with two layers of asphalt as specified in Sections 11.8.1 and 11.8.2 above, the Granular Pavement Design Chart in Appendix B has been derived from mechanistic design procedures using CIRCLY on the basis of the following pavement design parameters:

- Project Reliability Level of 95%;
- Pavement Design Speeds of both 10 km/h and 40 km/h, applicable for a designated speed limit of up to 60 km/h.

If there are circumstances for a particular project where the use of parameters other than those outlined above is warranted, designers will need to check their proposed designs in order to satisfy any necessary alternative design criteria.

This is particularly important in relation to the adoption of pavement design speeds as specified in VicRoads Code of Practice: Selection and Design of Pavements and Surfacings RC 500.22 for designated speed limits > 60 km/h. For the unbound granular pavements outlined in this guide, there would be a detrimental effect on the fatigue life of the asphalt surfacing because of the consequential elastic layer properties required to be used in the mechanistic design process.

Asphalt Pavements

Asphalt pavements, comprising either deep strength asphalt or full depth asphalt as defined by RC 500.22, will require thickening where the pavement is located in the following locations:

- at roundabouts and at signalised intersections; or
- where the designated speed limit is ≤ 40 km/h.

Designers are also required to pay particular attention to the selection of wearing course asphalt on Connector Streets and Arterial Roads in these locations where the computed HVs/lane > 500 hvpd in accordance with VicRoads Code of Practice: Selection and Design of Pavements and Surfacings RC 500.22.
11.9. SUBSURFACE PAVEMENT DRAINS

11.9.1. General
Subsurface pavement drains shall be provided in association with all kerb and channel. The design and location of drains or filter blankets shall be carried out in accordance with the requirements of VicRoads Code of Practice: Selection and Design of Pavements and Surfacings RC 500.22.

11.9.2. Expansive Subgrades
Where the subgrade is classified as being expansive, subsurface pavement drains shall be designed to be contained wholly within the capping layer. In addition, no part of the subsurface drainage trench shall be located within 150 mm of the underlying subgrade. If necessary, the capping layer may have to be thickened to satisfy this requirement.
12. **EARTHWORKS DESIGN**

12.1. **GENERAL**

Objectives which should be met for earthworks and lot filling are:

- To ensure that development does not cause or aggravate flooding of other properties by filling land or undertaking other flood diversion works;
- To ensure that buildings are located on a natural surface above the 1% AEP flood level or on approved filled ground, so as to comply with the constraints of the Building Regulations 1994 and the Health Act;
- To ensure that the recommendations of the Catchment Management Authorities or other relevant agencies or organisations are complied with;
- To ensure earthworks and lot filling activities do not result in the spread of noxious weeds, as per Section 70A and 71 of the Catchment Management and Land Protection Act 1994;
- To ensure that earthworks and lot filling works does not result in erosion dust, mud or debris leaving the site; and
- To maintain privacy and security of adjacent landowners.

12.2. **PLANNING & ENGINEERING REQUIREMENTS**

Typical earthworks may include lot filling or the construction of open drainage systems, levees, access tracks, flood protection devices overland flow paths and vegetation removal.

Assessment of design submissions should focus on the above objectives and achievement of suitable road and drainage systems. Engineering approval does not negate the need for planning approval of such earthworks.

For any earthworks that are separate from subdivision works a planning permit shall be obtained and engineering plans submitted for approval shall be accompanied by a construction specification. Where works are to be staged it is recommended that consideration be given to the entire site and not individual stages. This will eliminate the need for multiple planning permits.

Existing depressions shall not be filled unless the consent of the Relevant Authority is given in writing, and any required permits obtained.
12.3. EARTHWORKS AND FILLING REQUIREMENTS

The following earthworks and lot filling requirements apply to all developments:

- All allotments shall be graded from either the rear to front or front to rear, by cutting or filling, such that a desirable minimum grade of 0.67% (1:150) is achieved from the high point of the allotment toward the low side of the allotment having the drainage outlet; an absolute minimum grade of 0.5% (1 in 200) will be considered in extreme circumstances. Grades shall be calculated along the side boundary of the allotment.

- The finished floor level of all buildings shall be a minimum of 300mm above the 1% AEP flood level, or as otherwise specified in the planning permit or by the responsible drainage authority;

- The extent and depth of all proposed filling shall be shown on construction plans. Where depths of fill on allotments exceeds 200 mm, those areas are to be clearly differentiated from fill of depth less than 200mm;

- Full records shall be kept of all areas filled. The areas filled, the depths of fill and the finished surface levels shall be recorded on the “as constructed” plans. Refer to Part D of the Engineering Design and Construction Manual for additional details regarding construction;

- Details of the safety and integrity of any structure shall be provided to the Council where earthworks abut structures;

- The desirable maximum depth of fill allowable against fencing is 200mm provided a suitable plinth is provided at the bottom of the fencing;

- Retaining walls are required when the depth of fill exceeds 500mm or maximum batter slopes are exceeded. Prior to designing retaining walls, the designer should discuss their proposal with Council;

- Concentrated stormwater runoff must not flow onto adjoining properties;

- Natural overland flow paths in adjoining properties must be accommodated and any restriction or alteration must not cause detriment to adjoining properties; and

- All reasonable precautions must be taken to prevent the spread of noxious weeds from or to the worksite.
13. DRAINAGE DESIGN

13.1. INTRODUCTION

This section of the Manual outlines the relevant standards necessary to meet best practice and accommodate various needs in relation to the design and construction of stormwater systems, and more generally to ensure the management of stormwater fits within an overall integrated water management approach for industrial subdivision development.

Innovative or non-standard approaches to design may be considered subject to sufficient data and supporting details being provided on the philosophy and principles that are proposed.

The drainage design shall:

- Incorporate water quality and water quantity treatment measures to enhance quality of the drainage runoff before discharging it to a creek or other main drainage network; and
- Maintain pre-development flows at the outlet from the subdivision, unless otherwise approved by the responsible drainage authority.

Council is the responsible authority for all drainage works outside the authority of the relevant regional catchment management authority. All cross drainage works on creeks and waterways shall be to the approval of the regional catchment management authority. For other minor and major drainage, Council is the responsible drainage authority.

13.1.1. Stormwater and Water Sensitive Urban Design (WSUD)

Where the industrial subdivision is required to provide WSUD under the planning permit it shall be designed and constructed to meet the following current best practice performance objectives for stormwater quality as contained in the Urban Stormwater – Best Practice Environment Management Guidelines (1999):

- 80% retention of the typical annual load of total suspended solids
- 45% retention of the typical annual load of total phosphorus; and
- 45% retention of the typical annual load of total nitrogen

Please refer to the Water Sensitive Urban Design Guidelines addendum for Melton Council for further information particular to Melton.

13.1.2. Melbourne Water Stormwater Offset Contribution

Melbourne Water operates a stormwater offset service which involves a financial contribution paid by developers for stormwater management works to be undertaken in another location when the development cannot meet best practice of stormwater quality treatment. These works ‘offset’ stormwater impacts not treated within the development.

Stormwater offset contributions apply primarily for areas outside of drainage schemes. However, some drainage schemes also include a stormwater offset rate.

Please refer to Melbourne Water for further information.
13.1.3. **Drainage Design References**

Design and construction of stormwater management systems for industrial development needs to be in accordance with the current edition/version of the following documents:

- "Urban Stormwater – Best Practice Environmental Management Guideline", EPA, CSIRO, Melbourne Water et al;
- "Australian Runoff Quality Guidelines", Engineers Australia;
- "Australian Rainfall and Runoff", Institution of Engineers Australia, (AR&R);
- "Land Development Manual", Melbourne Water;
- "Drainage Design Guidelines", VicRoads; and
- "Design for Installation of buried concrete pipes" AS 3725.

13.2. **PLANNING & LAYOUT**

Where required in proposed developments, the drainage system shall accommodate runoff from the upstream catchment, and provide for downstream drainage works.

Council and regional catchment management authority schemes shall be shown on plans.

Main drains should follow the valleys in reasonably straight alignments, with a minimum of deviation. Natural drainage paths shall be preserved, in the form of roadways, parkland, walkways, etc., and shall have a discharge capacity at least equal to that of the pipe drain.

**Private allotments will not be permitted downstream of low points in roadways, downhill court bowls, or any other locations where drainage flows may concentrate.**

Gap flows shall be confined to roadways and reserves and under no circumstances encroach onto private allotments.
13.3. **COMPUTATION OF RUNOFF**

Computation of runoff shall be determined using the **Rational Method**:

Where

\[ Q = \frac{CIA}{360} \]

- \( Q \) = design discharge (m\(^3\)/s)
- \( C \) = runoff coefficient
- \( I \) = rainfall intensity (mm/h)
- \( A \) = catchment area (ha)

For large catchments the designer shall be responsible for ensuring that possible ‘Partial Area Effects’ are taken into account when calculating peak flows using the Rational Method.

Hydraulic programs using other than the Rational Formula may be permitted by Council.

13.4. **RAINFALL INTENSITY**

**Australian Rainfall and Runoff** shall be used to calculate rainfall intensities for the relevant location.

13.5. **AVERAGE EXCEEDANCE PROBABILITY**

The following values shall be used for drainage design; they do not apply for Water Sensitive Urban Design schemes.

**Table 10: Average Exceedance Probabilities**

<table>
<thead>
<tr>
<th>Industrial and Commercial Areas</th>
<th>10% (Q10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floodways</td>
<td>Gap Flow or 1% (Q100) if no pipe provided</td>
</tr>
</tbody>
</table>
13.6. TIME OF CONCENTRATION

Table 11: Times of Concentration

<table>
<thead>
<tr>
<th>Development Category</th>
<th>Maximum Time Of Concentration (Tc) For Flow To Enter System (Minutes)</th>
<th>Average Recurrence Interval (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road Reserves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connector Street</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Arterial Road</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Parklands</td>
<td>Calculated</td>
<td>10</td>
</tr>
<tr>
<td>Industrial:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Block Area (m²) &lt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>600-4000</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>&gt; 4000</td>
<td>Calculated</td>
<td>10</td>
</tr>
<tr>
<td>Major System</td>
<td>Calculated</td>
<td>MWC criteria</td>
</tr>
</tbody>
</table>

\[ t_c = t_1 + t_2 + t_3 \]

where \( t_c \) = time of concentration

\[ t_1 = \text{time to reach the pipe or kerb and channel} \]

\[ t_2 = \text{kerb and channel travel time} \]

From Australian Rainfall and Runoff

\[ t_3^* = \text{pipe travel time From Australian Rainfall and Runoff; or} \]

\[ t_3^* = \frac{L}{V} \]

where \( L \) = pipe length

* \( t_3 \) shall be determined up to but not including the pipe reach being designed
13.7. **RUNOFF COEFFICIENT ‘C’**

Due to the variability of rainfall across Metropolitan Melbourne, runoff coefficients have not been standardised across all municipalities but have been calculated in accordance with the Australian Rainfall and Runoff (AR&R) Volume 1 (May 2003), Book VIII, Section 1.5.5 (iii) Runoff Coefficients.

The following formulas have been applied in calculating runoff coefficients for the growth areas:

\[ C'_{10} = 0.1 + 0.0133 \left(10 - 25 \right) \]

Where \( C'_{10} \) is the pervious runoff coefficient

\( 10I_1 \) is the 10 year ARI, 1 hour duration rainfall intensity

And;

\[ C_{10} = 0.9f + C'_{10} \left(1 - f \right) \]

Where \( C_{10} \) is the 10 year ARI runoff coefficient.

And;

\( f \) is the fraction impervious (0.0 to 1.0)

\[ C_y = F_y C_{10} \]

Where \( C_y \) is an average recurrence interval

\( F_y \) is a frequency factor

<table>
<thead>
<tr>
<th>ARI (Years)</th>
<th>Frequency Factor, FY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.80</td>
</tr>
<tr>
<td>2</td>
<td>0.85</td>
</tr>
<tr>
<td>5</td>
<td>0.95</td>
</tr>
<tr>
<td>10</td>
<td>1.00</td>
</tr>
<tr>
<td>20</td>
<td>1.05</td>
</tr>
<tr>
<td>50</td>
<td>1.15</td>
</tr>
<tr>
<td>100</td>
<td>1.20</td>
</tr>
</tbody>
</table>

Intensity Frequency Duration Data has been obtained from the Bureau of Meteorology website [http://www.bom.gov.au/hydro/has/cdirswebx/index.shtml](http://www.bom.gov.au/hydro/has/cdirswebx/index.shtml), using coordinates that are central to the area for which the runoff coefficient has been calculated.

Fraction impervious values for discrete sub-catchments of uniform use shall be taken from the ‘Typical Values’ column in Table 12 below. Averaging values across multiple use zones or allotment density as listed is not permitted.
### Table 12: Land use fraction impervious

<table>
<thead>
<tr>
<th>Zone</th>
<th>Zone Code</th>
<th>Brief Description / Examples</th>
<th>Normal Range</th>
<th>Typical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Industrial Zones</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industrial 1 Zone</td>
<td>IN1Z</td>
<td>Main zone to be applied in most industrial areas.</td>
<td>0.70 - 0.95</td>
<td>0.90</td>
</tr>
<tr>
<td>Industrial 2 Zone</td>
<td>IN2Z</td>
<td>Large industrial zones away from residential areas.</td>
<td>0.70 - 0.95</td>
<td>0.90</td>
</tr>
<tr>
<td>Industrial 3 Zone</td>
<td>IN3Z</td>
<td>Buffer between Zone 1 and Zone 3.</td>
<td>0.70 - 0.95</td>
<td>0.90</td>
</tr>
<tr>
<td>- for garden supplies/nurseries.</td>
<td></td>
<td></td>
<td>0.30 - 0.60</td>
<td>0.50</td>
</tr>
<tr>
<td>- for quarries.</td>
<td></td>
<td></td>
<td>0.10 - 0.40</td>
<td>0.30</td>
</tr>
<tr>
<td><strong>Business Zones</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Business 1 Zone</td>
<td>B1Z</td>
<td>Main zone to be applied in most commercial areas.</td>
<td>0.70 - 0.95</td>
<td>0.90</td>
</tr>
<tr>
<td>Business 2 Zone</td>
<td>B2Z</td>
<td>Offices and associated commercial uses.</td>
<td>0.70 - 0.95</td>
<td>0.90</td>
</tr>
<tr>
<td>Business 3 Zone</td>
<td>B3Z</td>
<td>Offices, manufacturing industries &amp; associated uses.</td>
<td>0.70 - 0.95</td>
<td>0.90</td>
</tr>
<tr>
<td>Business 4 Zone</td>
<td>B4Z</td>
<td>Mix of bulky goods retailing &amp; manufacturing industries.</td>
<td>0.70 - 0.95</td>
<td>0.90</td>
</tr>
<tr>
<td>Business 5 Zone</td>
<td>B5Z</td>
<td>Mix of offices &amp; multi-dwelling units.</td>
<td>0.70 - 0.95</td>
<td>0.90</td>
</tr>
<tr>
<td><strong>Public Land Zones</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public Use Zone</td>
<td>PU1Z</td>
<td>Use of land for public purposes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Service and Utility</td>
<td>PU2Z</td>
<td>- power lines, pipe tracks and retarding basins.</td>
<td>0.20 - 0.30</td>
<td>0.25</td>
</tr>
<tr>
<td>- Reservoirs.</td>
<td>0.40 - 0.60</td>
<td>0.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Education</td>
<td>PU3Z</td>
<td>- schools and universities.</td>
<td>0.60 - 0.80</td>
<td>0.70</td>
</tr>
<tr>
<td>- Health and Community</td>
<td>PU4Z</td>
<td>- hospitals.</td>
<td>0.90 - 0.80</td>
<td>0.70</td>
</tr>
<tr>
<td>- Transport</td>
<td>PU4Z</td>
<td>- railways and tramways.</td>
<td>0.60 - 0.80</td>
<td>0.70</td>
</tr>
<tr>
<td>Zone</td>
<td>Zn</td>
<td>Description</td>
<td>Runoff Coefficient</td>
<td></td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>-----</td>
<td>-----------------------------------------------------------------------------</td>
<td>--------------------</td>
<td></td>
</tr>
<tr>
<td>Cemetery / Crematorium</td>
<td>PU5Z</td>
<td>- cemeteries and crematoriums.</td>
<td>0.50 - 0.70 0.60</td>
<td></td>
</tr>
<tr>
<td>Local Government</td>
<td>PU6Z</td>
<td>- libraries, sports complexes and offices / depots.</td>
<td>0.70 - 0.90 0.80</td>
<td></td>
</tr>
<tr>
<td>Other Public Use</td>
<td>PU7Z</td>
<td>- museums.</td>
<td>0.50 - 0.80 0.60</td>
<td></td>
</tr>
<tr>
<td>Public Park and Recreation Zone</td>
<td>PPRZ</td>
<td>Main zone for public open space, incl golf courses.</td>
<td>0.20 - 0.30 0.25</td>
<td></td>
</tr>
<tr>
<td>Public Conservation and Resource Zone</td>
<td>PCRZ</td>
<td>Protection of natural environment or resources.</td>
<td>0.05 - 0.25 0.25</td>
<td></td>
</tr>
<tr>
<td>Road Zone – Category 1</td>
<td>RDZ1</td>
<td>Major roads and freeways.</td>
<td>0.60 - 0.90 0.75</td>
<td></td>
</tr>
<tr>
<td>Road Zone – Category 2</td>
<td>RDZ1</td>
<td>Secondary and local roads.</td>
<td>0.50 - 0.80 0.60</td>
<td></td>
</tr>
<tr>
<td>Special Purpose Zones :</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Special Use Zone</td>
<td>SUZn</td>
<td>Development for specific purposes.</td>
<td>0.50 - 0.80 0.60</td>
<td></td>
</tr>
<tr>
<td>Comprehensive Development Zone</td>
<td>CDZn</td>
<td>Large and complex developments – residential.</td>
<td>0.40 - 0.80 0.50</td>
<td></td>
</tr>
<tr>
<td>Urban Floodway Zone</td>
<td>UFZ</td>
<td>Land identified as part of an active floodway.</td>
<td>0.05 - 0.25 0.25</td>
<td></td>
</tr>
<tr>
<td>Capital City Zone</td>
<td>CCZn</td>
<td>Special Use Zone for land in Melbourne’s central city.</td>
<td>0.70 - 0.90 0.80</td>
<td></td>
</tr>
<tr>
<td>Docklands Zone</td>
<td>DZn</td>
<td>Special Use Zone for land in Docklands area.</td>
<td>0.70 - 0.90 0.80</td>
<td></td>
</tr>
<tr>
<td>Commonwealth Land :</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commonwealth Land</td>
<td>CA</td>
<td>Army barracks, CSIRO.</td>
<td>0.50 - 0.80 0.60</td>
<td></td>
</tr>
</tbody>
</table>

To simplify the number of coefficients applied, runoff coefficients have been limited to the Melton region listed in Table 13.
Table 13:  “C” Values

<table>
<thead>
<tr>
<th>Melton</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$C'_{10}$</td>
<td>0.15445632</td>
</tr>
<tr>
<td>$f$</td>
<td>$C_{10}$</td>
</tr>
<tr>
<td>0.2</td>
<td>0.304</td>
</tr>
<tr>
<td>0.5</td>
<td>0.527</td>
</tr>
<tr>
<td>0.6</td>
<td>0.602</td>
</tr>
<tr>
<td>0.7</td>
<td>0.676</td>
</tr>
<tr>
<td>0.8</td>
<td>0.751</td>
</tr>
<tr>
<td>0.9</td>
<td>0.825</td>
</tr>
<tr>
<td>1.0</td>
<td>0.900</td>
</tr>
</tbody>
</table>
13.8. HYDRAULICS

Drainage design shall be based on hydraulic grade line analysis, using appropriate pipe friction and drainage structure head loss coefficients. All pipe sizes are to be computed using a velocity and discharge diagram based upon Manning’s equation. HGL’s shall be shown on drainage plans.

13.9. HYDRAULIC GRADE LINE

The hydraulic grade line shall be at least 300mm below the surface or kerb or channel invert, and not more than 2m above the pipe obvert.

13.10. PIPE GRADE AND ALIGNMENT

Pipes shall be uniformly graded and generally designed in a straight line between pits.

13.11. MINIMUM COVER (TO TOP OF PIPE)

Under road pavements for concrete pipes, the greater of 750mm below design surface level or 150mm below pavement depth (including any capping layer).

NOTE: Pipe Class may need to be increased if cover is not sufficient under subgrade due to construction traffic loading

Elsewhere 450mm for concrete pipes subject to pipe class requirements

The design of pipe cover shall consider the effects of all utility services and conduits and provide the necessary clearances required by the relevant utility authority. The design shall also consider the control of sub surface drains.

13.12. PIPE FRICTION

<table>
<thead>
<tr>
<th>Table 14: Friction Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manning</td>
</tr>
<tr>
<td>N</td>
</tr>
<tr>
<td>Concrete</td>
</tr>
<tr>
<td>Other Materials</td>
</tr>
</tbody>
</table>
13.13. **MINIMUM PIPE SIZE**

The minimum pipe size shall be 300mm where road runoff is being collected or the pipe crosses the road.

A reduction in the size of pipes may be permitted for 450mm pipes and above.

13.14. **PIPE JOINTS**

All pipes shall be rubber ring jointed.

For pipes greater than 900mm and changes in direction between 2 connecting pipes exceeding 10° construct segmented curves using splayed pipes with bandage joints, having deflections within the manufacturer’s specification.

13.15. **PIPE FLOW VELOCITY AND GRADE**

The following is based on pipes running full but not under pressure.

**Table 15: Acceptable Velocities**

<table>
<thead>
<tr>
<th></th>
<th>Desirable</th>
<th>General</th>
<th>Flat Terrain</th>
<th>Steep Terrain</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Minimum</strong></td>
<td>1.0 m/s</td>
<td>0.9 m/s</td>
<td>0.6 m/s</td>
<td>NA</td>
</tr>
<tr>
<td><strong>Maximum</strong></td>
<td>4.0 m/s</td>
<td>5.0 m/s</td>
<td>NA</td>
<td>6.0 m/s</td>
</tr>
</tbody>
</table>
13.16. ANCHOR BLOCKS
Anchor blocks shall be provided where the pipe slope is steeper than 1 in 6 (16%) and the pipe length is greater than 15m. Refer to the attached standard drawings for details of anchor block construction.

13.17. ALIGNMENT AT PITS
Where possible, drops and deflections shall be kept to the minimum requirements to maintain the flow through pits as a jet and minimise head loss created by turbulence.

Required drops (at invert):

- Generally 50mm to 100mm for same size pipes.
- Match springing lines for change in diameter, but a drop shall not be less than 50mm.
- Drops in the range 100mm to 1.5Do are not permitted except:
  - where springing lines are matched.
  - for minor branches - (Db < 2/3 Do)(Db = branch diameter) (D o = outlet diameter)
  - to dissipate head in steep terrain.
- Drops greater than 1.5Do are acceptable on long pipe reaches (where there are considerable savings in excavation) for pipe sizes up to 450mm.

The maximum permitted deflections in pits are:

\[
D^\circ \leq 600\text{mm} \quad 0^\circ - 50^\circ : \text{align as in standard detail}
\]
\[
50^\circ - 90^\circ : \text{provide deflector in pit floor}
\]
\[
>90^\circ : \text{not permitted}
\]

\[
D^\circ 675\text{mm} - 900\text{mm} \quad \text{Maximum deflection} - 45^\circ
\]
\[
D^\circ \geq 1050\text{mm} \quad \text{Maximum deflection} - 10^\circ
\]
13.18. **PIT LOCATIONS**
Pits should, preferably, be located at or about the mid-point of the frontage of allotments, to reduce the likelihood of conflict with future driveway locations.
Pits shall be located a minimum clearance of 1m from a vehicle crossing.

13.19. **KERB INLETS**
Pits shall be spaced to capture all surface flow resulting from the design minor rainfall event with a maximum spacing of 90m.

Kerb inlets are required at the following locations:

- Adjacent to tangent points at intersections where the channel falls towards the intersection;
- At low points; and
- At construction boundaries, unless existing drainage inlets downstream are adequate.
- Additional kerb inlets shall be provided at;
- Double entry pits at low points of streets where one or both channel grades are greater than 7%.
- Flat vertical curves approximately 10m either side of the low point, except where saw tooth grading of the kerb is employed.

A 50% blockage factor shall be allowed when designing the inlet capacity of grated entry pits at low points.

13.20. **PIT HEAD LOSSES**
To be calculated using procedure in the ARR and AustRoads design procedures.

13.21. **PROPERTY CONNECTIONS**
A property connection shall be placed at the lowest point of each property.

Stormwater outlets for all allotments shall be connected to an underground drain within the road reserve via a pit.

Whenever depth of a connection is critical for adequate lot control the invert level shall be calculated and shown on the plans.
13.22. SURFACE DRAINAGE

13.22.1. Flow
The maximum depth of flow in a channel, for a 10% AEP design storm, shall be 0.14m for barrier type kerb and channel and 0.11m for SM2 roll-over type kerb and channel.

The maximum width of flow in the channel and roadway for a design storm shall not be greater than 3.0m, or the width of a parking lane if one is provided.

In locations where the level at a property line is below the kerb level, care should be taken to ensure the maximum allowable depth of flow is not exceeded.

Where a low point occurs in a longitudinal road grading or at the end of a court bowl, the footpath or fixed level at the property line shall be designed to prevent inundation of adjoining lots while providing for any overland flow path required for the 1% AEP runoff.

13.22.2. Gap Flows
The maximum depth and velocity of flow along an overland flow path for a 1% AEP design storm shall be in accordance with relevant requirements including the Melbourne Water ‘Land Development Manual’.

13.22.3. Freeboard
Finished levels of allotments adjacent to overland flow paths for a 1% AEP design storm should ensure gap flows are retained in the road reserve. The 150mm freeboard (i.e. the level 150mm above the gap flow level) will be allowed to extend a maximum of 2.0m into the lot.

13.22.4. Overland Flow Paths
Trapped low points in streets and reserves adjacent to private property shall only be permitted where an overland flow path can be provided for the 1% AEP design storm clear of private property and unencumbered open space. The use of surface grates and pipes with capacity exceeding the 10% AEP design shall not be relied upon to avoid the provision of the overland flow path.
13.23. **WATER QUALITY**

Where required, drainage design will incorporate water quality treatment measures to enhance quality of the drainage runoff before discharging into waterways or other main drainage networks.

Water Sensitive Urban Designs shall be prepared in consultation with Council’s engineering and planning departments and in accordance with the requirements of Melbourne Waters publication “WSUD Engineering Procedures”.

13.24. **SUB SURFACE DRAINAGE**

Sub surface drainage is to be provided as indicated in the attached standard drawings and shall discharge into pits at a level above the highest obvert of any stormwater pipe open to the pit.

In situations where the swell potential of the sub grade is 2.5% or more (i.e. highly expansive subgrade), a continuous unbroken capping layer is generally required. In these cases the invert of the sub surface drain is to be raised such that it drains the pavement only. Trenches for the sub surface drains must not be below the capping layer into the subgrade. (see also Section 11.9)

Provision should be made for “flush-out-risers” at crests in accordance with standard drawings and the construction specification.