Department of Transport and Main Roads

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Road Planning and Design Manual
Edition 2: Volume 3

Supplement to Austroads Guide to Road Design Part 5A: Drainage – Road Surface, Networks, Basins and Subsurface

January 2024

Queensland Government

Translating and interpreting assistance

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Feedback

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Relationship with Austroads Guide to Road Design – Part 5A (2023)

The Department of Transport and Main Roads has, in principle, agreed to adopt the standards published in the Austroads *Guide to Road Design* (2023) *Part 5A: Drainage – Road Surface, Networks, Basins and Subsurface*.

When reference is made to other parts of the Austroads *Guide to Road Design*, Austroads *Guide to Traffic Management* or the Austroads *Guide to Road Safety*, the reader should also refer to Transport and Main Roads related manuals:

- *Road Planning and Design Manual* (RPDM)
- *Traffic and Road Use Management Manual* (TRUM).

Where a section does not appear in the body of this supplement, the Austroads *Guide to Road Design – Part 5A* criteria is accepted unamended.

This supplement:

1. has precedence over the Austroads *Guide to Road Design – Part 5A: Drainage – Road Surface, Networks, Basins and Subsurface* when applied in Queensland
2. details additional requirements, including *accepted with amendments* (additions or differences), *new* or *not accepted*, and
3. has the same structure (section numbering, headings and contents) as Austroads *Guide to Road Design – Part 5A: Drainage – Road Surface, Networks, Basins and Subsurface*.

The following table summarises the relationship between the Austroads *Guide to Road Design – Part 5A* and this supplement using the following criteria:

Accepted	Where a section does not appear in the body of this supplement, the Austroads *Guide to Road Design – Part 5A* is accepted.
Accepted with amendments	Part or all of the section has been accepted with additions and/or differences.
New	There is no equivalent section in the Austroads Guide.
Not Accepted	The section of the Austroads Guide is not accepted.

Austroads Guide to Road Design – Part 5A		RPDM relationship
1 Introduction		
1.1	Purpose	Accepted
1.2	Scope of this Part	Accepted
1.3	Road Safety	Accepted
2 Major/Minor Drainage Concept		
2.1	General	Accepted
2.2	Minor System	Accepted
2.3	Major System	Accepted
2.4	Regional Approach	Accepted
2.5	Design Considerations	Accepted
2.6	Planning of Major Urban Systems	Accepted

Austroads Guide to Road Design – Part 5A		RPDM relationship
2.7	Worked Examples – Major/Minor Drainage System	Accepted
3 Road Surface Drainage		
3.1	General	Accepted with amendments
3.2	Road Surface Flow	Accepted with amendments
3.3	Capture, Movement and Disposal of Surface Flows	Accepted
3.4	Road Pavement and Subsurface Drainage	Accepted
4 Aquaplaning		
4.1	What is Aquaplaning	Accepted
4.2	Aquaplaning vs Skidding	Accepted
4.3	Assessment Process	Accepted
4.4	Causal Factors	Accepted
4.5	Road Surfacing	Accepted
4.6	Tyres	Accepted
4.7	The Road Tyre Interface	Accepted
4.8	Skid Resistance	Accepted with amendments
4.9	Assessment – Water Firm Depth	Accepted with amendments
4.10	Assessment – Aquaplaning Potential	Accepted with amendments
4.11	Quick Assessment	Accepted
4.12	Puddles/Wheel Ruts	Accepted
4.13	Guidance to Reduce Aquaplaning Potential	Accepted
4.14	Worked Example 1 – Aquaplaning	Accepted
5 Kerbed Drainage		
5.1	Introduction	Accepted
5.2	Design Considerations	Accepted with amendments
5.3	Kerbed Drainage Elements	Accepted with amendments
5.4	Design Criteria	Accepted with amendments
5.5	Design Theory	Accepted with amendments
5.6	Design Procedure	Not Accepted
5.7	Worked Example – Kerbed Drainage	Not Accepted
6 Underground Piped Networks		
6.1	Introduction	Accepted
6.2	Design Considerations	Accepted with amendments
6.3	Piped Network Elements	Accepted with amendments
6.4	Structural Requirements	Accepted with amendments
6.5	Design Criteria	Accepted with amendments
6.6	Design Theory	Not Accepted
6.7	Design Procedure	Not Accepted
6.8	Construction and Maintenance	Accepted with amendments
6.9	Worked Example – Pipes Network	Not Accepted
7 Basins		
7.1	Introduction	Accepted with amendments

Austroads Guide to Road Design – Part 5A		RPDM relationship
7.2	Detention Basins	Accepted with amendments
7.3	Extended Detention Basin	Accepted with amendments
7.4	Retention Basins	Accepted
7.5	Worked Example – Basin	Accepted
8 Subsurface Drainage		
8.1	Purpose of Subsurface Drainage	Accepted with amendments
8.2	Other Relevant Austroads Guides	Accepted
8.3	Sources of Moisture	Accepted with amendments
8.4	Control of Road Moisture	Accepted
8.5	Types of Subsurface Drains	Accepted with amendments
8.6	Locations of Subsurface Drains	Accepted with amendments
8.7	Drainage Details	Accepted with amendments
8.8	Design Procedures	Accepted
8.9	Specialist Subsurface Drainage Techniques	Accepted
8.10	Worked Examples – Subsurface	Accepted
References		
References		Accepted with amendments
Appendices		
Appendix A	Pit Performance Curves used in Victoria	Accepted with amendments
Appendix B	Discharge Velocity Curves	Accepted
Appendix C	Example Pipe Chart for Minimum Pipe Cover for Various Compactors	Accepted

Departmental contacts

- Road Design, Hydraulics, Design & Spatial, Engineering and Technology, Transport and Main Roads email: roaddesignstandards@tmr.qld.gov.au
- Structures, Transport and Main Roads email: roaddesignstandards@tmr.qld.gov.au. Road Design Standards will direct this email to the correct area for reply.
- General enquiries or feedback email roaddesignstandards@tmr.qld.gov.au

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Figures

3 Road Surface Drainage

3.1 General

<u>Addition</u>

Road surface drainage deals with the drainage of stormwater runoff from the road surface and the surfaces adjacent to the road formation. Several elements can be used to intercept or capture this runoff and facilitate its safe discharge to an appropriate receiving location. These elements include:

- kerb and channel
- edge and median drainage
- table drains and blocks
- diversion drains and blocks
- batter drains
- catch drains and banks
- drainage pits, and/or
- pipe networks.

Subsurface drainage deals with the interception and disposal of subterranean (groundwater) flows with predominate drainage element being sub-soil drainage.

3.2 Road Surface Flow

<u>Addition</u>

After falling onto road surfaces, rainfall runoff drains to the lowest point and in moving across the road surface forms a layer of water of varying thickness. This water can be a hazard to the motorist. Splash and heavy spray are thrown up by moving vehicles, reducing visibility, while the water on the pavement reduces friction between the tyres and road surface.

Excessive water on the pavement, whether ponded or flowing, can represent a real risk of aquaplaning or the build-up of a layer of water between the vehicle tyre and the road surface, which leads to a total loss of grip. While part of road surface drainage, aquaplaning is a critically important aspect of road surface drainage.

On reaching the lowest point, runoff is channelled along the pavement edge via kerbing / kerb and channelling or discharged over the shoulders to a suitable collection system such as a natural watercourse, table drain or piped drainage system (pipe network).

Some degree of water quality treatment may be needed between the road and the receiving water to remove litter, heavy metals, nutrients and oils. In this regard, there is a growing trend to place some form of grass filter between the road surface and any concrete-lined drain. This form of drainage is known as ‘indirectly connected impervious surface area’ and is a form of water sensitive urban design.

In all cases, design of the elements for this runoff must adequately cater for the safety and convenience of road users, including pedestrians, and protect adjacent properties and the road pavement from damage.

Where erosion of the batters is not considered likely, pavement runoff discharged over the shoulders and batters directly to the natural surface may be acceptable in some rural situations such as a level stretch of road in flat country.

4 Aquaplaning

4.8 Skid Resistance

Addition

The pavement surface is just one of a large number of contributory factors. The three main areas of control which relate to the pavement surface and which many road authorities use internationally to address the issue of skid resistance are:

- in-service skid resistance (friction)
- aggregate polishing resistance, and
- surface texture depth.

4.9.2 Basis/Limits

Addition

It should be noted that the Gallaway Method is one dimensional and only assesses depth of flow along a single (zero width) flow path. Flow velocity and width or spread of the flow over the pavement surface is not assessed. Some situations can occur where water runoff from off the road surface can flow onto the road and/or where runoff from one flow path crosses a boundary and joins another flow path. The Gallaway Formula is unable to assess these situations properly and cases such as these should be referred to the Director (Road Design), Engineering and Technology Branch, Transport and Main Roads.

4.10 Assessment – Aquaplaning Potential

Addition

In 1986, the National Association of Australian State Road Authorities (NAASRA) publication *Guide to the Design of Road Surface Drainage* stated that it is not completely possible to define recommended design limits for water depths, however:

- critical depth to cause hydroplaning occurs at about 4 mm and above, and
- partial hydroplaning may commence at depths of about 2.5 mm.

5 Kerbed Drainage

5.2 Design Considerations

5.2.2 Drainage Inlet Types

Addition

Refer to below link for Transport and Main Roads drainage inlet types of drawings:

https://www.tmr.qld.gov.au/business-industry/Technical-standards-publications/Standard-drawings-roads/Roadworks-drainage-culverts-and-geotechnical

5.2.8 Structural Considerations

Addition

Advice in relation to structural requirements can be obtained from the Structures Section, Engineering and Technology Branch, Transport and Main Roads. Advice in relation to inspections can be obtained from the Structures Section, Engineering and Technology Branch, Transport and Main Roads.

5.2.11 Computer Programs

Addition

For further information on drainage computer programs, see Section 1.8 of *Road Planning Design Manual* Volume 3, Part 5: *Drainage – General and Hydrology Considerations*.

5.3 Kerbed Drainage Elements

5.3.1 Kerbing

Addition

The department has standardised some of the more common kerbs in Transport and Main Roads Standard Drawing SD1033.

5.3.2 Inlets

Addition

Drainage pits are field inlets and gullies collecting surface flows to the underground drainage system and access chambers at pipe junctions and for maintenance.

Inlet locations should be optimised to collect the design surface flows with the minimum number of installations and, of course, to reduce surface water to an acceptable width.

This requires computations for each area contributing flow to the inlets. Areas may comprise both road pavement and adjacent urban, suburban or rural land.

Proprietary pre-cast pit segments and grates or covers are available. The department has standardised some of the more common field inlets, gullies and access chambers as Transport and Main Roads Standard Drawings SD1307-SD1313, SD1321, SD1322, and SD1442-SD1445.

Four types of kerb inlets are in common use. They are:

- Grate only, such as field inlets and anti-ponding gullies on kerb returns.
- Side inlet – these inlets rely on the ability of the opening under the backstone or lintel to capture flow. They are usually depressed at the invert of the channel to improve capture capacity.
- Combination grate and side inlet – these inlets use the backstone arrangement of the side inlet with the added capacity of a grate in the channel, and
- Special site-specific designs for high inflow.

Design of continuous flow drains must be undertaken in accordance with Transport and Main Roads Technical Note 162 *Trench Drains*.

The capacity of the various categories of drainage inlet may be varied by the amount of depression allowed in the gutter adjacent to the kerb opening.

A flush inlet is one in which the normal channel section is continued to and past the inlet without any alteration to its cross-section.

A depressed inlet is one in which the crossfall of the channel is increased so that the grade of the channel line against the kerb is depressed for the length of the inlet. Depressed inlets provide greater efficiency than flush ones and are shown on the Transport and Main Roads Standard Drawings with suitable transitions.

All pits should be as shallow as practical. As indicated on Transport and Main Roads Standard Drawings, pits deeper than 3 m will require a special design.

5.3.3 Inlet Capacity

Addition

This supplement does not include inflow capacity charts for drainage pit / kerb inlets. Charts approved for use on departmental projects include the Brisbane City Council charts, available from Council's website.

It is understood that there are pit / kerb inlet configurations currently available that do not exactly match any of the configurations as presented in the approved charts. In these situations, the designer can use engineering judgement and first principles to match, as close as possible, an approved inflow capacity chart to the proposed pit / kerb inlet (citing: opening area, grade, crossfall and approach flow), however, the selected chart must be accepted / approved by the department's design representative before use.

An accepted reference document with a suitable inlet analysis method includes the HEC-22 manual produced by the US FHWA (Publication No. FHWA-NHI-10-009), available online.

Charts for other configurations / types of pits may become available in the future. Such charts should reflect the theoretical or measured capacity of the inlet. Before use on departmental projects, the supplier of the charts must have them independently tested / verified and then submit them (including verification) for approval to the Director (Road Design), Engineering and Technology Branch, Transport and Main Roads.

5.3.4 Inlet Locations

Addition

1. Kerb or gully inlets are used where vehicular traffic is expected to reduce the flow width on roadways, as well as to drain low lying areas.

   The standard departmental Concrete Gullies shown on Transport and Main Roads Standard Drawings SD1311 and SD1312 have a combined inlet with a precast side entry (lintel) and grated pit. Precast lintel details are shown on Transport and Main Roads Standard Drawing SD1313.

2. Additional locations where drainage inlets should be provided / considered in kerb and channel:

   a. At the tangent point of kerb returns or small radius convex curves (kerb radius less than 15 m) such that the flow width around the kerb return (that is, beyond the kerb inlet) during the minor design storm does not exceed 1.0 m measured from the invert of kerb and channel. This limitation will also be applicable at important vehicular turnouts or footpath crossovers where high traffic volumes are anticipated, such as at entrances to shopping centres.

   b. Immediately upstream of a potential pedestrian crossing, set-down point and/or bus stop, such that the flow width does not exceed 450 mm from invert of kerb and channel during the minor design storm.

   c. Immediately upstream of any reversal of crossfall (for example, application of superelevation) to prevent flow across the road during the minor design storm. The extent to which such flow onto the pavement is permissible depends upon the catchment area involved and the risk of vehicle aquaplaning.

   d. Where superelevation or reverse crossfall results in flow against traffic islands and medians, kerb inlets shall be provided along the length of the island or median as necessary to meet the flow width limitations and at the downstream end of the island or median to minimise the flow continuing along the road. Where sufficient width of island or median is available, grated kerb inlets should be recessed so that the grate does not project onto the road pavement. Alternatively, side entry inlets with no grate should be installed.

   e. Where it is anticipated that a parking lane may become an acceleration, deceleration or turn lane.

f. Consideration should be given to the positioning of kerb inlets relative to the side property boundaries. In residential and industrial locations, a kerb inlet located near the side property boundary may cause difficulties with driveway access. In commercial areas, and those where there is likely to be a high volume of pedestrian traffic, kerb inlets should be located to avoid set down points or locations where pedestrian movements are likely to be highest.

g. On any higher abutment end of bridge approaches on a grade to minimise flow on to the deck.

3. For kerb inlets on grade:

   a. Where bypass flow from a kerb inlet is required to follow a kerb return at an intersection, it may be necessary, where the longitudinal grade is steep, to check for the effect of superelevation upon flow spread.

   The procedure detailed in Figure 7.5.1 of QUDM is recommended for determining the location of kerb inlets on grade.

5.4 Design Criteria

5.4.2 Pavement Spread and Gutter Flow Limits

Addition

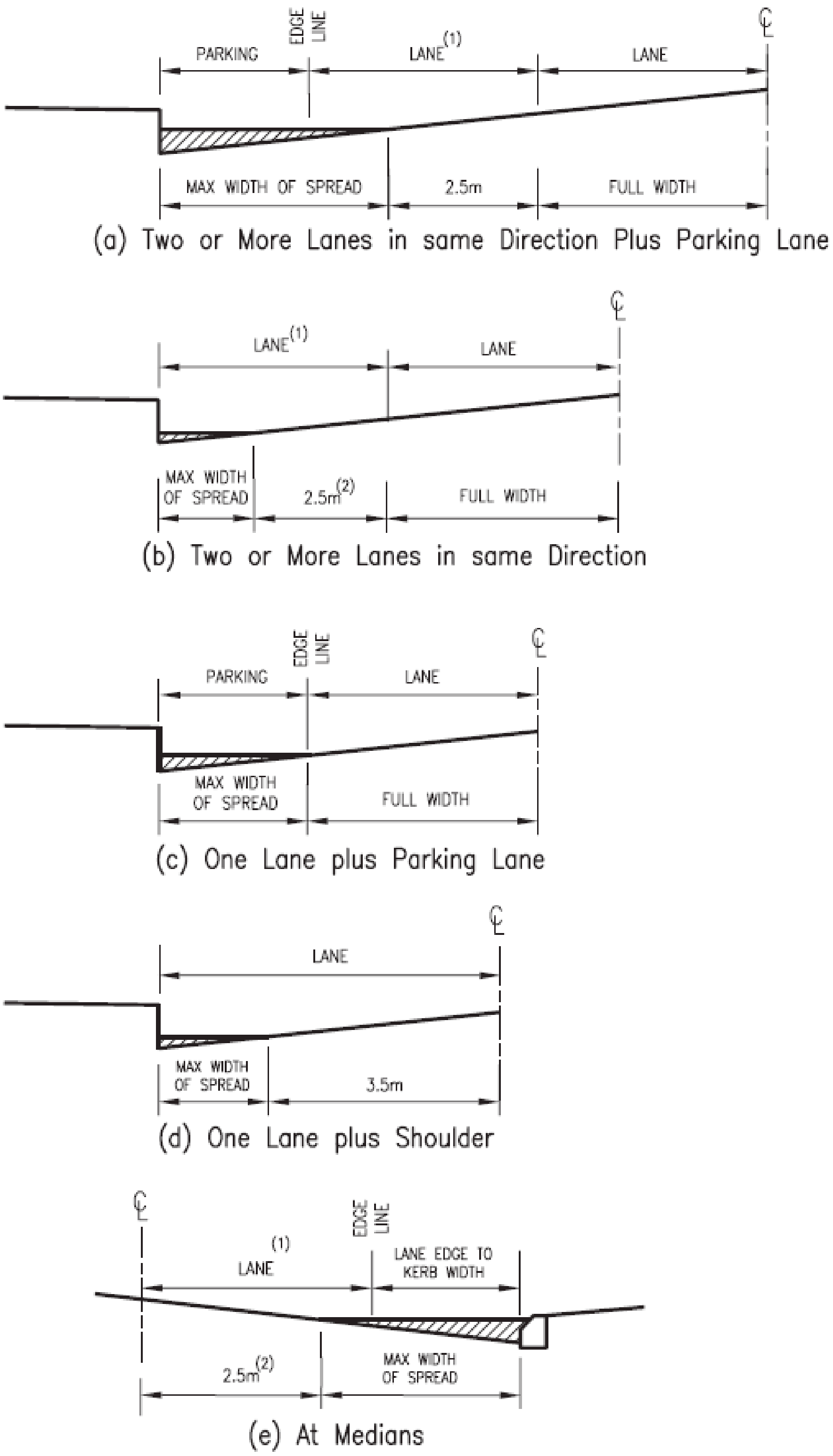
For the safety of vehicular traffic other than requirements against aquaplaning, flow width criteria apply. Water depths and velocities are also limited by the width restrictions.

Flow widths in both the minor and major storms need to be considered.

Minor storm flow limits

Adopting the 10% AEP flood as that arising from the design minor storm of the same likelihood, flow width criteria are shown on Figures 5.4.2(a) and 5.4.2(b).

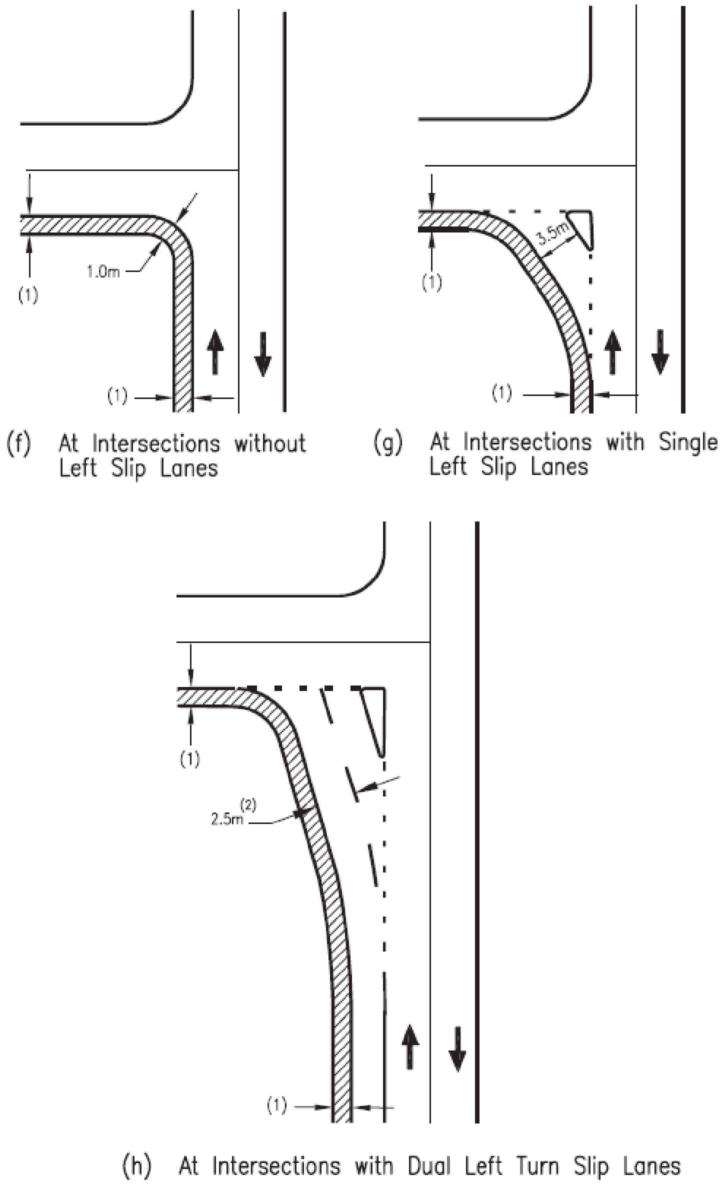
Figure 5.4.2(a) – Allowable flow widths on roadways – 10% AEP flood (cross-section views)



Notes:

1. Lane includes auxiliary lanes and any parking lane that has the potential in the future to become used as a through lane for full-time or part-time.
2. In situations where it is difficult to achieve the required clear width of 2.5 m, the clear width may be reduced to 1.0 m for roads of lesser importance.

Figure 5.4.2(b) – Allowable flow widths on roadways – 10% AEP flood (plan views)



Notes:

1. Refer to Figure 5.4.2(a).
2. In situations where it is difficult to achieve the required clear width of 2.5 m, the clear width may be reduced to 1.0 m for roads of lesser importance.
3. At pedestrian crossings check both width and velocity.

These diagrams represent the following:

a) For two lanes (or more) in the same direction plus parking lane, the maximum allowable width of spread leaves the inside and any lane-locked lanes clear plus 2.5 m clear width in the remaining lane; that is, water is kept out of the wheel paths of lanes. The term 'lane' includes auxiliary lanes and any parking lane that has the potential to become used as a full or part-time through lane.
b) For two lanes (or more) in the same direction, the maximum allowable width of spread leaves the inside and any lane-locked lanes clear plus 2.5 m clear width in the remaining lane. The term 'lane' includes auxiliary lanes.
c) For one lane plus parking lane, water is not allowed to spread past the edge of the through lane.
d) For one lane, a minimum clear width of 3.5 m is to remain in the lane.
e) At medians, the allowable spread of water leaves 2.5 m clear width in the traffic lane next to the median. The term 'lane' includes auxiliary lanes.
f) At intersections without left slip lanes, the allowable width of spread adjacent to the kerb is 1.0 m.
g) At intersections with single left slip lanes, the allowable width of spread leaves 3.5 m clear width in the slip lane.
h) At intersections with dual left slip lanes, the allowable width of spread leaves 2.5 m clear in outer turning lane.

In situations where it is difficult to achieve the required clear width of 2.5 m in cases '(b)', '(e)' and '(h)' above, the clear width may be reduced to 1.0 m for roads of lesser importance. This practice is not recommended for reasons of consistency and the use of a reduced clear width must be specified in design brief and/or contract documents or approved by the department.

Where pedestrians will cross the road, allow no more than 0.5 m width of spread in a 1 Exceedances per Year (EY) flood. The 0.5 m requirement is based on the typical overstep / short jump of most people. Checks should also be undertaken on:

$$d_g . V_{avg} \leq 0.3\ m^2/s$$

where d_g = flow depth in the channel adjacent to the kerb (m)

V_{avg} = average velocity of the flow (m/s)

There is also a water depth-velocity relationship which is applicable for both minor and major floods in the channel next to a kerb. This is for pedestrian safety in longitudinal flows along the kerb.

Where a road contains separate bicycle lanes, the flow spread should be limited to 0.5 m. For a shared bicycle and vehicle lane, the flow spread width should be limited to 1.5 m. Design rainfall intensity to use for on-road cyclist facilities is the lesser of the 63% AEP, five-minute rainfall event, or 50 mm/h.

Major storm flow limits

Flow limit criteria are applicable to both sag and on-grade pits / locations.

5.4.3 Spacing

Addition

Refer to Section 5.3.4 of this supplement.

5.4.4 Size

Difference

All pits should be as shallow as practical. As indicated on Transport and Main Roads Standard Drawings, pits deeper than 3 m will require a special design.

5.5 Design Theory

5.5.1 Gutter Flow

Addition

Section 5.5.1 of the Austroads *Guide to Road Design – Part 5A* is accepted for this section with the following amendments:

- The Rational Method in the form of equation 14 as presented in Section 5.5.1 of the Austroads *Guide to Road Design – Part 5A* is not to be used for departmental projects. The pavement runoff is to be determined as per the guidance in below.

Pavement runoff

Pavement runoff is calculated by the Rational Formula:

$$Q_y = k.C_y.I_{tc,y}.A$$

The contribution to the flow at the kerb or median channel is given by a modification of the Rational Formula and is expressed as:

$$q_y = \frac{C_y.I_{tc.y}.W}{3.6 \times 10^6}$$

Where q_y	=	contribution per longitudinal metre of pavement (m^3/s) for an ARI[1] of y years
C_y	=	Runoff coefficient (dimensionless for an ARI of y years) as defined in AGRD Part 5A Section 5.5.1
$I_{tc,y}$	=	average rainfall intensity (mm/h) for design duration of tc and ARI of y years
W	=	width of contributing cross-section (m)

A runoff coefficient C10 of 0.9 (or higher) is typical for most road surfaces.

Where the pavement width varies or the runoff coefficient is different, total runoffs or lengths for given runoffs have to be calculated algebraically.

5.5.2 Inlet Capture Rates

Addition

The inflow capacity of a field inlet depends upon the depth of water over the inlet. For shallow depths, the flow will behave as for a sharp crested weir. For greater depths, the inlet will become submerged, and inflow will behave as for an orifice. It is recommended that the capacity of the inlet be checked using both procedures and the lesser inlet capacity adopted.

Section 7.5.4 of QUDM for inflow capacity calculations under weir flow and orifice flow conditions is accepted for this section.

5.5.3 Blockage

Addition

The blockage factors and procedures detailed in the Austroads *Guide to Road Design – Part 5A* take precedence over the procedures described in *The Australian Rainfall and Runoff: A guide to flood estimation* (ARR).

5.6 Design Procedure

Difference

A general design procedure is detailed in Section 7.15.2 of QUDM and provides a sound basis and understanding for the design of pipe networks required for departmental projects. It is recommended that designers should refer to this procedure for the initial design assessment.

5.6.1 Data Collection

Difference

A general design procedure is detailed in Section 7.15.2 of QUDM and provides a sound basis and understanding for the design of pipe networks required for departmental projects. It is recommended that designers should refer to this procedure for the initial design assessment.

5.6.2 Site Investigation

Difference

A general design procedure is detailed in Section 7.15.2 of QUDM and provides a sound basis and understanding for the design of pipe networks required for departmental projects. It is recommended that designers should refer to this procedure for the initial design assessment.

5.6.3 Identify Drainage Outfalls

Difference

A general design procedure is detailed in Section 7.15.2 of QUDM and provides a sound basis and understanding for the design of pipe networks required for departmental projects. It is recommended that designers should refer to this procedure for the initial design assessment.

5.6.4 Establish Design Criteria

Difference

A general design procedure is detailed in Section 7.15.2 of QUDM and provides a sound basis and understanding for the design of pipe networks required for departmental projects. It is recommended that designers should refer to this procedure for the initial design assessment.

5.6.5 Select Inlet Type

Difference

Refer to Section 5.6 of this supplement and below amendment.

Field inlets are used to drain low lying areas and located in areas where vehicular traffic would not be expected (except for maintenance). Such locations are medians, drainage easements, table drains and catch drains.

Entry of water is from the top only in Field Inlets Type 1 (Transport and Main Roads Standard Drawing SD1309).

The frame and grate of Field Inlet Type 2 (Transport and Main Roads Standard Drawing SD1310) is raised to allow side entry of water as well to a depth of 175 mm before water reaches the top of the grate. It is therefore more efficient than the Type 1 Inlet and less prone to obstruction. However, it should only be used where the possibility of pedestrians, bicycles and vehicular traffic is remote.

The following discussion has been extracted from QUDM with some minor modification:

- Field inlets (also known as 'drop inlets') should be provided in footpaths and medians, and so on as necessary, to drain all low points.
- Where there is considerable pedestrian traffic adjacent to a field inlet, for example, in a footpath, a grate with close bar spacing should be used. The recommended bar spacing is provided in Section 7.5.4(d) of QUDM.
- Elsewhere, a grate with wide bar spacing is preferable, because of the reduced risk of blockage by debris.

In all situations, an allowance for a minimum blockage of 50% of the clear opening area of the grate should be made.

5.6.6 Placement of Trial Inlets

Difference

A general design procedure is detailed in Section 7.15.2 of QUDM and provides a sound basis and understanding for the design of pipe networks required for departmental projects. It is recommended that designers should refer to this procedure for the initial design assessment.

5.6.7 Define Sub-catchments

Difference

A general design procedure is detailed in Section 7.15.2 of QUDM and provides a sound basis and understanding for the design of pipe networks required for departmental projects. It is recommended that designers should refer to this procedure for the initial design assessment.

5.6.8 Calculate Run-off Coefficients

Difference

A general design procedure is detailed in Section 7.15.2 of QUDM and provides a sound basis and understanding for the design of pipe networks required for departmental projects. It is recommended that designers should refer to this procedure for the initial design assessment.

5.6.9 Calculate Time of Concentration

Difference

A general design procedure is detailed in Section 7.15.2 of QUDM and provides a sound basis and understanding for the design of pipe networks required for departmental projects. It is recommended that designers should refer to this procedure for the initial design assessment.

5.6.10 Establish Design Rainfall Intensity

Difference

A general design procedure is detailed in Section 7.15.2 of QUDM and provides a sound basis and understanding for the design of pipe networks required for departmental projects. It is recommended that designers should refer to this procedure for the initial design assessment.

5.6.11 Calculate Design Flows

Difference

A general design procedure is detailed in Section 7.15.2 of QUDM and provides a sound basis and understanding for the design of pipe networks required for departmental projects. It is recommended that designers should refer to this procedure for the initial design assessment.

5.6.12 Spread Compliance Check

Difference

A general design procedure is detailed in Section 7.15.2 of QUDM and provides a sound basis and understanding for the design of pipe networks required for departmental projects. It is recommended that designers should refer to this procedure for the initial design assessment.

5.6.13 Establish Inlet Capture Flows

Difference

A general design procedure is detailed in Section 7.15.2 of QUDM and provides a sound basis and understanding for the design of pipe networks required for departmental projects. It is recommended that designers should refer to this procedure for the initial design assessment.

5.6.14 Design of Underground Piped Network

Difference

A general design procedure is detailed in Section 7.15.2 of QUDM and provides a sound basis and understanding for the design of pipe networks required for departmental projects. It is recommended that designers should refer to this procedure for the initial design assessment.

5.6.15 Major Event Check

Difference

A general design procedure is detailed in Section 7.15.2 of QUDM and provides a sound basis and understanding for the design of pipe networks required for departmental projects. It is recommended that designers should refer to this procedure for the initial design assessment.

5.6.16 Design Documentation

Difference

A general design procedure is detailed in Section 7.15.2 of QUDM and provides a sound basis and understanding for the design of pipe networks required for departmental projects. It is recommended that designers should refer to this procedure for the initial design assessment.

5.7 Worked Example – Kerbed Drainage

5.7.1 Example 1: Gutter Flow

Difference

A general design procedure is detailed in Section 7.15.2 of QUDM and provides a sound basis and understanding for the design of pipe networks required for departmental projects. It is recommended that designers should refer to this procedure for the initial design assessment.

5.7.2 Example 2: Pit Spacing

Difference

A general design procedure is detailed in Section 7.15.2 of QUDM and provides a sound basis and understanding for the design of pipe networks required for departmental projects. It is recommended that designers should refer to this procedure for the initial design assessment.

6 Underground Piped Networks

6.2 Design Considerations

6.2.3 Access Chamber Location

Addition

Where an access chamber is located within a carriageway, the chamber top, or access point, should be positioned to avoid wheel paths and should be finished with the top flush with the finished surface.

Elsewhere, access chambers should be finished 25 mm above natural surface with the topsoil or grassed surface around the chamber graded gently away. On playing fields, they may be finished 200 mm below the finished level, but only when located in a straight line between two permanently accessible chambers.

6.2.7 Structural Considerations

Addition

Australian Standard AS 3996 *Access Covers and Grates* specifies design loads for access covers, road grates and frames. They are to be designed to support, without structural failure, the specified minimum ultimate limit state design loads.

The Class D loading is used where normal vehicular traffic (includes heavy duty commercial vehicles) may be expected. The standard departmental access chamber tops and roadway gullies are designed for this loading.

Class B loading is used for units designed for a footway loading.

Class C loading is used for units in locations where slow moving (light duty commercial) vehicles are expected, such as light maintenance vehicles (light trucks and driven grass cutters / mowers). Departmental field inlets, Types 1 and 2 are in this category.

6.2.8 Road User Considerations

Addition

AS 3996 specifies two test wheels with pneumatic tyres to ensure the covers and grates are bicycle safe.

At all times where there is a possibility of bicycles, the designer should ensure that bicycle safe covers and grates are specified.

6.3 Piped Network Elements

6.3.2 Pipes

<u>*Addition*</u>

- Pipeline requirements:
    - Furthermore, where box culverts are constructed on a skew, special consideration is required where units join pits and access chambers.
- Location in urban areas:
    - Minor pipes connecting one kerb inlet or pit directly to another are acceptable at the top of the drainage system and these pipes may be located under the kerb and channel.
    - For pipelines greater than 600 mm, it is recommended that the location for pipelines in the road pavement – other than a kerb inlet to kerb inlet connection – be 2.0 m measured towards the road centreline from the invert of the kerb and channel; however, access chamber tops or access points should be located to avoid wheel paths.
    - Where sufficient verge width is available, stormwater pipes may be located in the verge to suit the services allocations of the relevant authorities / owners.
    - In divided roads, drainage pipelines may be located within the median, normally offset 1.5 m from the centreline (as street lighting poles are normally on the centreline).
- Splay pipes:
    - The use of splay pipe components to construct 'bends' in pipelines is not permitted between pits / access chambers. This requirement may be relaxed in special circumstances. Refer to Section 3.6.13 of RPDM Volume 3, Part 5B *Drainage – Open Channels, Culverts and Floodway Crossings* for further details.

6.4 Structural Requirements

6.4.1 Pipes

<u>*Addition*</u>

- Use of PipeClass Ver 2.0 for pipe classification for the department's projects is not acceptable.
- The structural requirements for pipelines are detailed in relevant departmental structural drawings and specifications. However, for pipe networks in urban areas, 'trench installation' is typical.
- All other structural aspects should be referred to the department's Structures Section, Engineering and Technology Branch or a suitably prequalified structural engineering consultant.

6.4.3 Bedding and Haunch Support

<u>*Addition*</u>

The department generally specifies either H2 or HS3 support types – refer AS/NZS 3725 *Design for installation of buried concrete pipes*, Transport and Main Roads Standard Drawing SD1359 and Section 3.6.1 of RPDM Volume 3, Part 5B *Drainage – Open Channels, Culverts and Floodway Crossings*. Other support types can be used; however, the use of these types be fully detailed and specified in the project's documents as they are not covered by the department's Technical Specifications and/or Standard Drawings.

6.5 Design Criteria

6.5.2 Size

Addition

The minimum diameter of any pipe in a drainage system should be 375 mm.

Refer to Section 7.6.4 of QUDM for further consideration in relation to sizing of an access chamber.

6.5.3 Depth of Installation/Minimum Cover

Addition

The geometric tolerances for location / position of culverts and minimum cover requirements will be as specified in the drawings or as per the Transport and Main Roads Technical Specification MRTS03 *Drainage, Retaining Structures and Protective Treatments*.

6.6 Design Theory

6.6.1 Hydraulic Calculations – General

Difference

The detailed HGL method is recommended for the analysis of underground stormwater pipe systems. It is further recommended that this be based on an analysis proceeding from downstream to upstream through the system.

Section 7.16 of QUDM provides guidance, understanding and the hydraulic calculations required to undertake the design of a pipe network for departmental projects. All subsections of Section 7.16 of QUDM apply, except for Section 7.16.10 where splay pipes apply.

6.6.2 Hydraulic Grade Line and Total Energy Line

Difference

Refer to Section 7.16 of QUDM.

6.6.3 Starting HGL (Tailwater)

Difference

Refer to Section 7.16 of QUDM.

6.6.4 Losses – General

Difference

Refer to Section 7.16 of QUDM.

6.6.5 Friction Losses

Difference

Refer to Section 7.16 of QUDM.

6.6.6 Losses at Pipe Bends

Difference

Refer to Section 7.16 of QUDM.

6.6.7 Exit Losses

Difference

Refer to Section 7.16 of QUDM.

6.6.8 Pit Losses

Difference

Refer to Section 7.16 of QUDM.

6.6.9 Drop Through Pits

Addition

The nominal drop of 0.1 m mentioned in AGRD – Part 5a relates to the assumed drop of HGL not invert.

It is desirable that, in the design, there is a drop in invert level of 10 to 20 mm across an access chamber between upstream and downstream pipes. This is to account for the construction tolerances for pipe construction as detailed in Section 7.3 of MRTS03 *Drainage, Retaining Structures and Protective Treatments*.

6.6.10 Drop Pits

Difference

Refer to Section 7.16 of QUDM.

6.6.11 Pipe Sizing

Difference

Refer to Section 7.16 of QUDM.

6.6.12 Reduction in Pipe Size

Difference

Additional situations may exist where a pipe reduction may be considered appropriate; for example, to facilitate inline storage for the purpose of flow attenuation. Each case must be assessed separately, and approval obtained from the department.

Refer to Section 7.16.13 of QUDM for calculation of head losses due to reduction in pipe size.

6.6.13 Special Design Case

Difference

Refer to Section 7.16 of QUDM.

6.7 Design Procedure

Difference

A general design procedure is detailed in Section 7.15.2 of QUDM and provides a sound basis and understanding for the design of pipe networks required for departmental projects. It is recommended that designers should refer to this procedure for the initial design assessment.

6.7.1 Data Collection

Difference

Refer to Section 7.15.2 of QUDM.

6.7.2 Site Investigation

Difference

Refer to Section 7.15.2 of QUDM.

6.7.3 Computer Software

Difference

Refer to Section 1.8 of *Road Planning Design Manual* Volume 3, Part 5: *Drainage – General and Hydrology Considerations*, which describes software acceptable to use.

6.7.4 Design Process

Difference

Refer to Section 7.15.2 of QUDM.

6.7.5 Design Flow Chart

Difference

Refer to Section 7.15.2 of QUDM.

6.8 Construction and Maintenance

Addition

When designing, construction and future maintenance requirements must be considered with appropriate treatments incorporated into the design. Some guidance with respect to construction requirements and methods can be found within various Transport and Main Roads Standard Drawings and Technical Specifications. However, this must not prevent all hydraulic and environmental requirements from being satisfied.

Relevant Transport and Main Roads Standard Drawings for pipes are: SD1240, SD1241, SD1243, SD1250, SD1260, SD1304, SD1305 and SD1359.

Additional Transport and Main Roads Standard Drawings related to fish passage are: SD1270 and SD1271.

The main Transport and Main Roads Technical Specifications are MRTS03 *Drainage, Retaining Structures and Protective Treatments* and MRTS04 *General Earthworks*.

For any possible non-standard or complicated culvert configurations, it is highly recommended that designers should involve construction personnel early in the design process to provide site-specific construction / constructability advice.

6.9 Worked Example – Pipes Network

6.9.1 Example 1: Pipeline Design (Hydraulic Gradeline Design)

Difference

Refer to Section 7.16 of QUDM.

7 Basins

7.1 Introduction

7.1.2 Types of Basins

Addition

- detention basins and extended detention basins are designed to reduce and delay peak flood flows
- sediment basins are designed to trap and retain a range of sediment particle sizes, thereby reducing both coarse sediment and turbidity values from the inflow, and
- retention basins are designed to retain some or all of the flow, allowing it to infiltrate into the soil.

Retention basins are rarely used on departmental projects and their design is specialised. Where retention basins are deemed necessary, reference should be made to the Austroads *Guide to Road Design – Part 5A* Section 7.4 and/or *Water by Design Bioretention Technical Design Guidelines* (refer to Water by Design website – www.waterbydesign.com.au).

7.1.3 Characteristics of Basins

Addition

Stormwater 'detention' systems are typically used for the following purposes:

- Controlling or attenuating peak discharges to minimise the potential for a stormwater nuisance to occur within down-slope properties.
- Controlling or attenuating peak discharges to ensure new developments do not cause existing drainage systems to exceed their desired operational capacity (this issue may relate to the hydraulic capacity of a piped drainage system, or the depth-velocity safety limits of an established overland flow path).
- Controlling or attenuating peak discharges for the purpose of reducing or preventing increases in downstream creek flooding.
- Controlling or attenuating peak discharges for the purpose of minimising accelerated channel erosion within downstream waterways.

Stormwater 'retention' systems include a broad range of urban water features, including many constructed lakes, wetland and water quality treatment systems. Even though flow attenuation may not be a key feature of a particular lake, pond or wetland, each of these features are likely to provide one or more of the following benefits:

- capturing a proportion of stormwater runoff from minor rain events for the purpose of minimising potential nuisance within down-slope properties as a result of the increased frequency and/or duration of minor surface flows
- treating stormwater runoff to improve its quality and thus reduce potential adverse effects on receiving waterways
- reducing the volume of stormwater runoff for the purpose of reducing stresses on aquatic life within receiving waters (for example, minimising increases in 'frequent flows')
- reducing the volume of stormwater runoff for the purpose of reducing the risk of accelerated channel erosion within receiving waters (for example, minimising increases in the frequency and duration of near-bankfull flows)
- reducing the volume of stormwater runoff for the purposes of reducing the annual runoff of certain pollutants
- reducing the volume of stormwater runoff for the purposes of reducing the potential for the overlapping of flood hydrographs discharged from basins, thus reducing the risk of increased flooding downstream of multiple basins, and/or
- collecting rainwater or stormwater runoff for the purpose of reducing a region's dependence on town water.

7.1.4 Basin Construction

Addition

Additional construction guidance is included in Section 7.2.9.

7.2 Detention Basins

7.2.1 General

Addition

Sections 7.2.1 and 7.2.2 of the Austroads *Guide to Road Design – Part 5A* are accepted for this section, subject to the following addition:

Major projects are applying infrastructure sustainability requirements. This scheme requires that the projects consider impacts of the project on peak stormwater flows. The aim is to mitigate any increase in the existing peak stormwater flow. There is evidence that increasing the peak stormwater flow causes adverse impacts to receiving environments, in particular waterbodies through increased velocities, turbulence and subsequent erosion causing changes to stream morphology. For sites discharging into high ecological significant waterbodies, changes to the peak stormwater discharge from the asset should be considered. Where increases in peak stormwater discharge are identified, detention of stormwater flows on site to avoid increases in the peak stormwater discharge may be considered depending on the site, scope of work and potential environmental impact.

7.2.2 Types of Detention Basins

Addition

Accepted as per Section 7.2.1 of this supplement.

7.2.5 Design Principles – On-site Detention

Addition

There are generally three design standards set by regulating authorities. They are:

(i) a specified minimum site storage requirement (SSR) and permissible site discharge (PSD) relative to either the site area, land use, or the change in impervious area

(ii) a PSD for the specified design storm frequency with no minimum storage volume specified, and/or

(iii) a requirement not to exceed pre-development peak discharge rates for a range of design storm frequencies.

The first two design criteria are often adopted by local governments following the development of a regional flood control strategy, Master Drainage Plan, or Stormwater Management Plan.

Most small on-site detention systems incorporate in-ground tanks. When appropriate soil and groundwater conditions exist, some of these systems can be converted into infiltration systems. Above-ground stormwater detention tanks are not normally recommended for single residential properties because of the risk of the systems being decommissioned or being converted into stormwater harvesting systems that no longer provide the required discharge control.

7.2.6 Design Procedure for a Detention Basin

Addition

Accepted as per Section 7.2.4 of Austroads *Guide to Road Design – Part 5A*.

7.2.7 Initial Design and Feasibility

Difference

The simplified volume estimation techniques in Section 7.2.7 of the Austroads *Guide to Road Design – Part 5A* are not acceptable to the department.

7.3 Extended Detention Basin

7.3.2 Design Guidelines

Addition

Further design information may be obtained from below design references:

- *Best Practice Erosion and Sediment Control* (IECA), and
- *General Principles Review Manual Vol. 1 & 2* (EnviroCert International, Inc.).

8 Subsurface Drainage

8.1 Purpose of Subsurface Drainage

<u>*Addition*</u>

- Further consideration should be given to the detailed recommendations in respect of design and installation of subsoil drains contained within the ARRB's *Special Report No. 35 Subsurface Drainage of Road Structures*.

8.3 Sources of Moisture

<u>*Addition*</u>

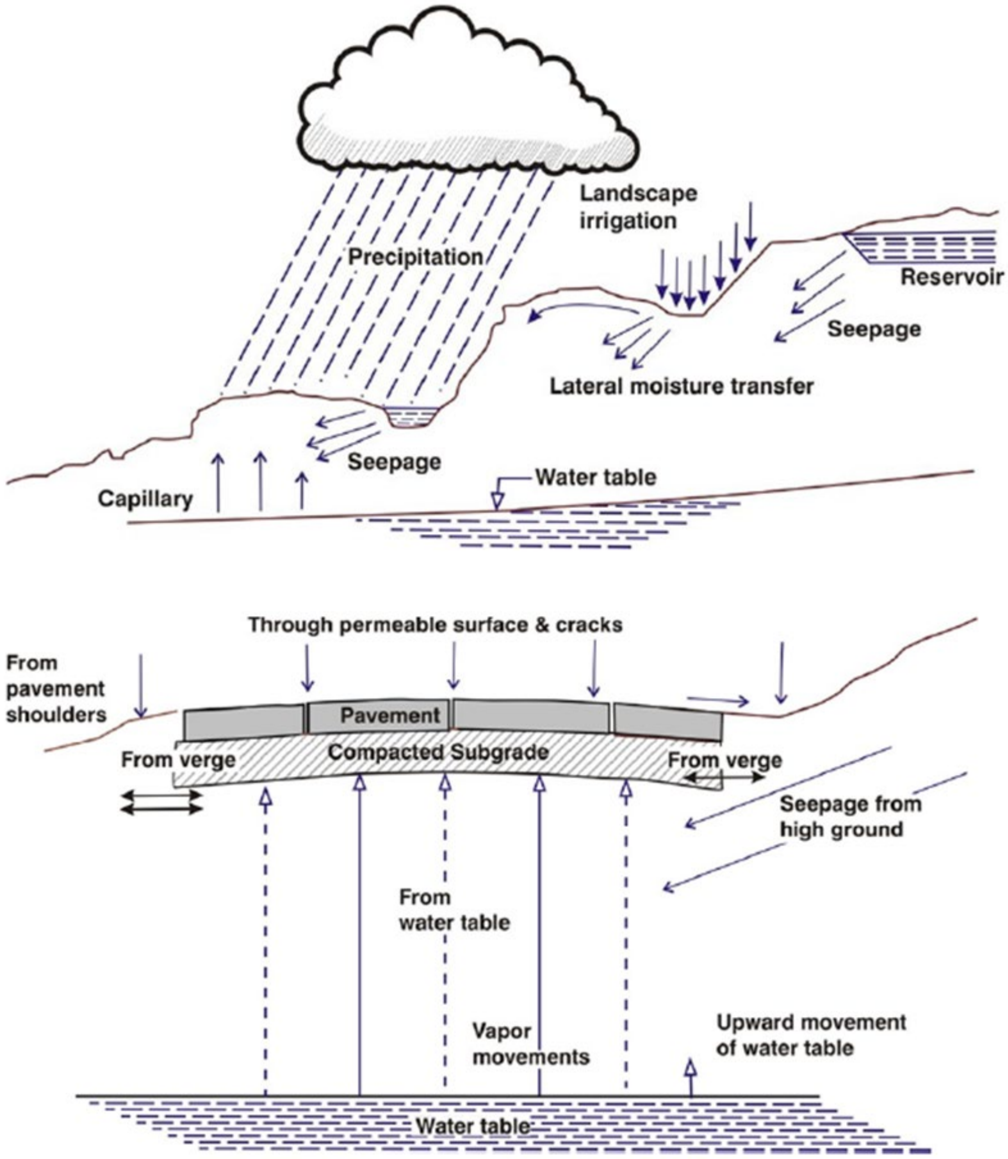
Some moisture is always present in the subgrade and unbound paving materials due to capillary moisture movement controlled by the environment. If this becomes excessive, the subgrade and pavement can be weakened appreciably. Consequently, it is important to minimise ingress of water into the pavement and subgrade. Control of subsurface water is the key to longevity of the pavement.

The main mechanisms by which moisture can enter a road subgrade and/or pavement are shown diagrammatically in Figure 8.3 and include:

- longitudinal seepage from higher ground, particularly in cuttings and in sag vertical curves
- rise and fall of water table level under a road
- rainfall infiltration through the road surfacing
- capillary moisture from the verges
- capillary water from a water table
- vapour movements from a water table
- lateral movement of moisture from pavement materials comprising the road shoulder
- water flowing or standing in table drains, in catch drains, in median areas, within raised traffic islands or adjacent to the road (not illustrated)
- leakage of water supply and drainage lines (not illustrated), and/or
- passage of water through construction joints in pavements, back and front of kerb and channel, between old and new pavements and behind bridge abutments (not illustrated).

It is important to note that, in some flood plains and low-lying areas, a permanent, high-level water table may exist. Subsoil drains may be ineffective in such areas, particularly where it is difficult to provide an outlet. In some cases, such drains could act in reverse and provide a means of access for water to the pavement.

Figure 8.3 – Sources of moisture (Adapted from ARRB (1987))



In these circumstances, the most effective measure which can be taken to control subgrade moisture conditions is to raise the subgrade above the surface of the ground. A height of 1.2 m above the water table is suggested (Earley 1979). This is usually impossible in urban street construction; in which case the pavement design should take into consideration the soaked conditions. In some situations, a cement or bituminous stabilised sub-base and/or base may be used. Reference should be made to the department's *Supplement to 'Part 2: Pavement Structural Design' of the* Austroads *Guide to Pavement Technology*.

Roads on a thick layer of soft, compressible clay also need special consideration, and geotechnical advice should be sought for requirements, such as preloading and other possible drainage mechanisms.

8.5 Types of Subsurface Drains

Addition

Consideration of the permeability and capillary moisture characteristic of the material surrounding the pavement is a major factor in assessing the need and type of subsurface drainage required.

Suitable drainage systems for various conditions are presented below:

a) Drainage for surface infiltration

Figure 8.5(a) illustrates the type of subsoil drainage suitable for a permeable base and surface contained in relatively impermeable material.

Figure 8.5(b) illustrates an embankment with the permeable base and surface on a relatively impermeable subgrade. A free draining layer is provided in the shoulders below a low permeability material.

A variation is to carry the full permeable base course over the full width of the shoulders.

b) Groundwater

A static water table may be lowered by using either drainage trenches shown in Figure 8.5(c) or a horizontal filter blanket shown in Figure 8.5(d).

The horizontal filter blanket will also act as an intercepting barrier for capillary moisture in some situations.

If water flows along an inclined permeable layer, as shown in Figure 8.5(e), a trench should be constructed to divert the subsurface flow into a drainage pipe before it can enter the road structure. The trench should be excavated to at least the depth of the permeable strata.

Upward flow from a previous aquifer is usually controlled by constructing a horizontal filter blanket in the base of the excavation as shown on Figure 8.5(f).

Figure 8.5(a) – Drainage for surface infiltration with subsoil drains

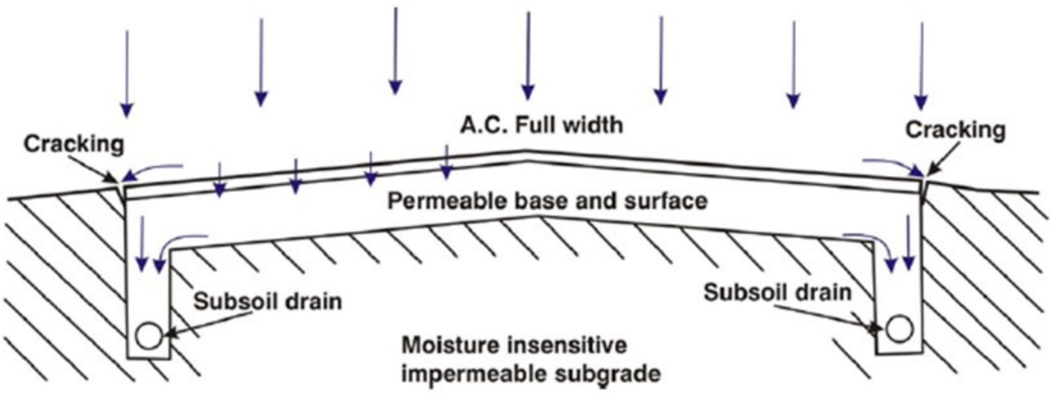


Figure 8.5(b) – Drainage for surface infiltration with free draining layer

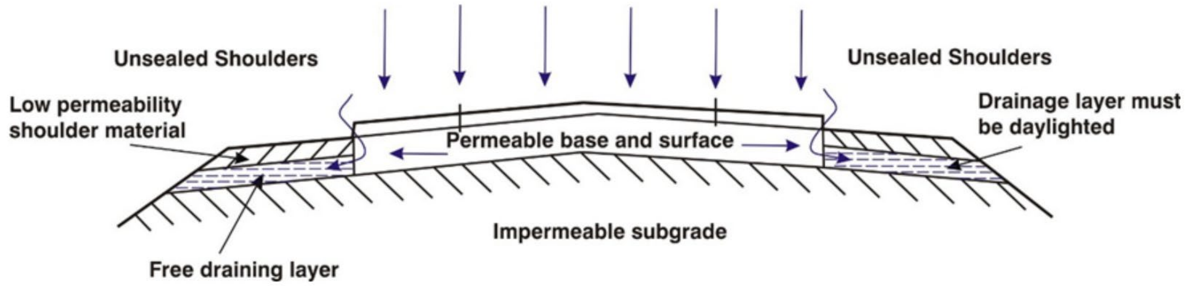


Figure 8.5(c) – Drainage trenches to lower water table

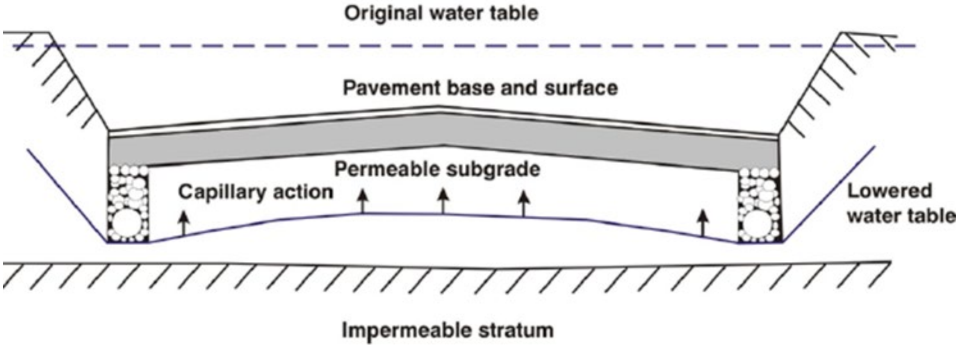


Figure 8.5(d) – Horizontal filter blanket to lower water table

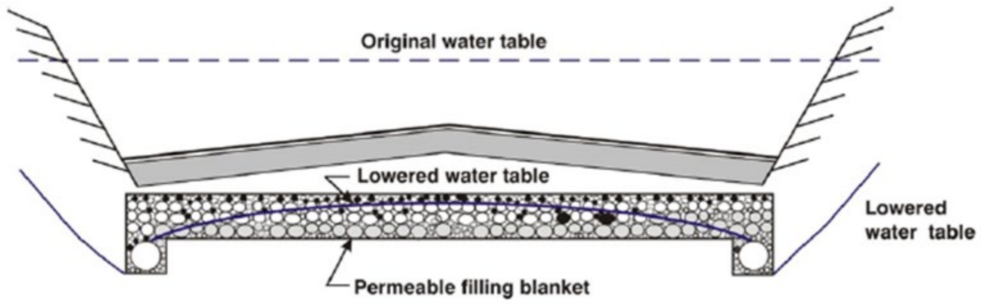


Figure 8.5(e) – Trenches to intercept flow through an inclined permeable layer

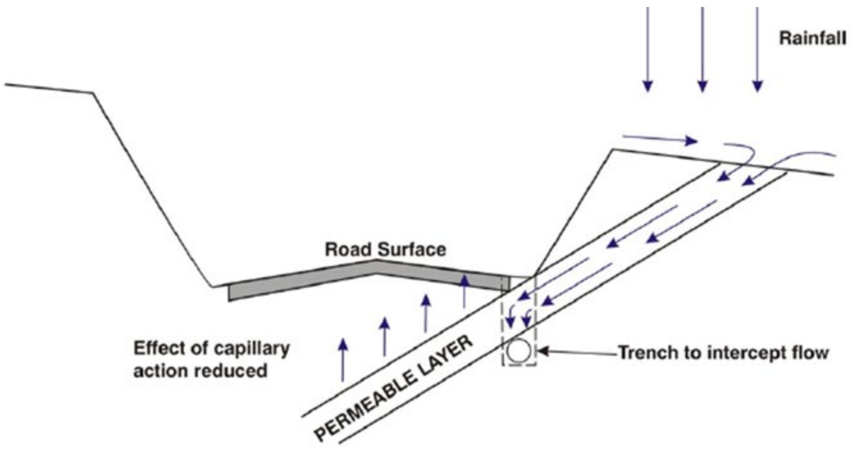
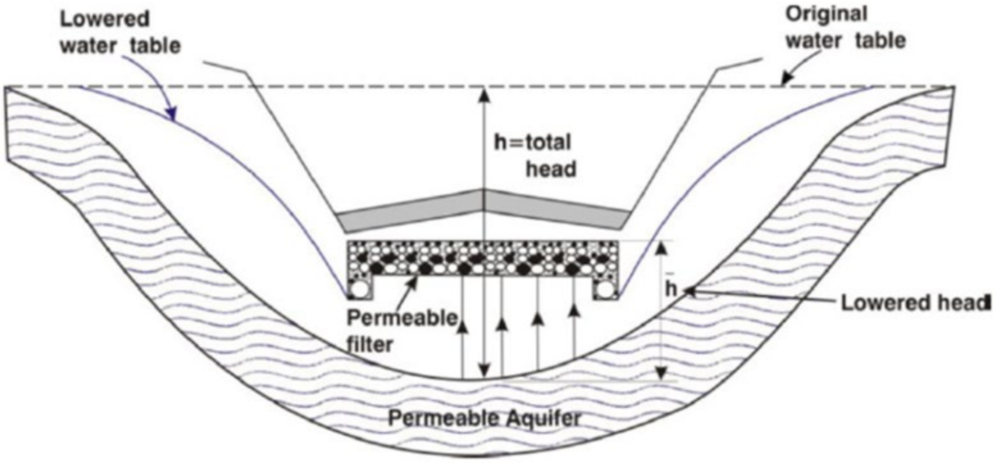


Figure 8.5(f) – Permeable filter to lower the effect of head from a permeable aquifer



c) Standard drains

Subsoil drains, described in Transport and Main Roads Technical Specification MRTS03 *Drainage, Retaining Structures and Protective Treatments*, are shown in Figure 8.5(g). The depth of these drains may be increased to suit the particular installation.

Subsurface drainpipes may be surrounded by a single stage filter or by two-stage filters. Filter materials can consist of aggregates (ranging in size from sand to cobble size), geotextiles or combinations of aggregates and geotextiles.

Material requirements are contained in Transport and Main Roads Technical Specification MRTS03 *Drainage, Retaining Structures and Protective Treatments*, including those for sheet filter drains, trench backfill, fibre reinforced concrete pipes, corrugated steel pipes, polyvinylchloride pipes, and plastic pipes (perforated and unperforated).

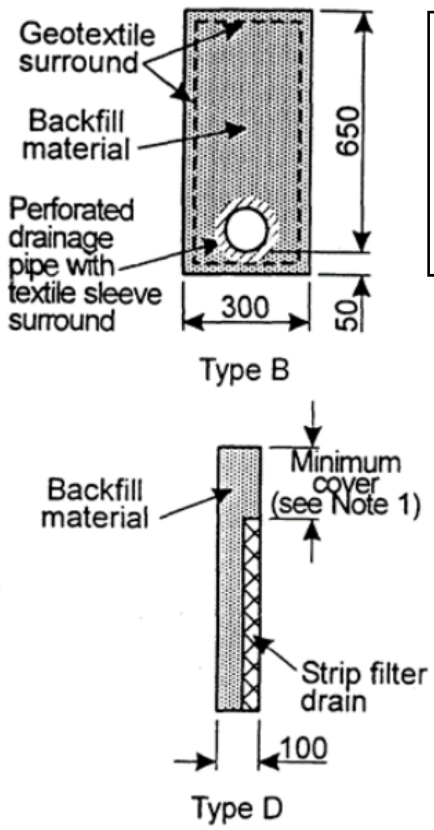
Transport and Main Roads Technical Specification MRTS04 *General Earthworks* is also relevant.

Figure 8.5(h) shows typical subsoil drain outlets and cleanouts in an urban environment. Transport and Main Roads Standard Drawing SD1116 provides further details, including treatments for rural environments.

Outlets of subsoil drains discharging into gully pits, manholes or culvert endwalls are preferred. Outlets discharging to natural surface should be made accessible for maintenance operations and a concrete headwall should be constructed together with a small area concreted or rockpitched around it as shown on the Transport and Main Roads Standard Drawing. To aid finding the outlet, a timber marker post should be maintained.

Accurate records of the position, depth and type of subsoil drains which are installed should be maintained.

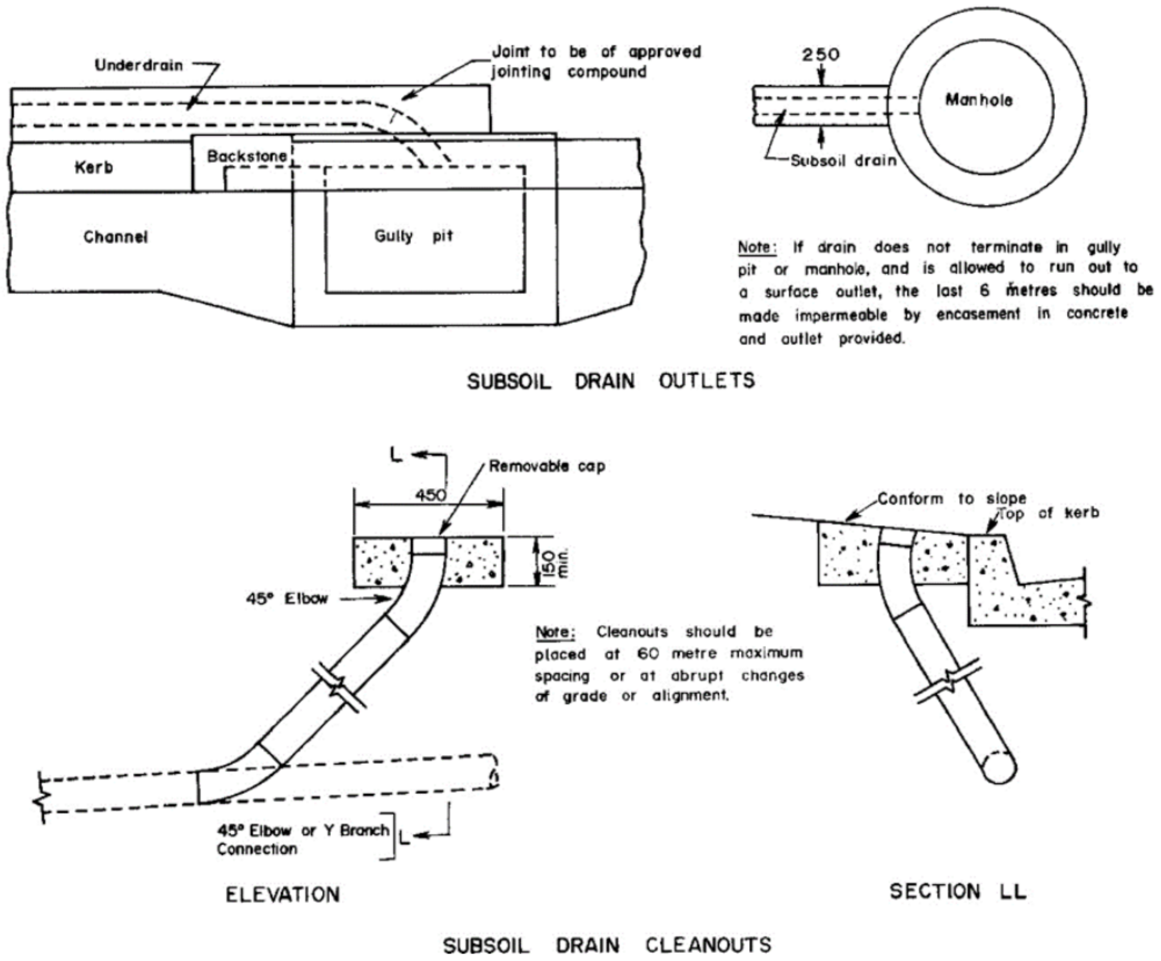
Figure 8.5(g) – Standard subsoil drains



Notes:

1. Minimum cover for various compactors unless approved otherwise:
   Hand held compactors –100 mm
   Compactors < 15 tonnes – 200 mm
   Compactors > 15 tonnes – 200 mm
2. All dimensions are in millimetres.

Figure 8.5(h) – Subsoil drains outlets and cleanouts



Notes:

The pavement base course may be more permeable than the sub-base.

Relative permeabilities should be considered in locating the drains.

8.6 Locations of Subsurface Drains

Addition

Figure 8.6(a) shows typical locations of subsoil drains in a divided road in a cutting. The width and nature of the median determines the number of subsoil drains required.

Grassed medians can provide a means by which water can enter the pavement or subgrade. Medians should therefore be constructed of a material of low permeability (for example, a compacted soil aggregate as recommended for shoulders), except for 100 mm of topsoil to grow grass. Provision of an impermeable membrane under the median should also be considered.

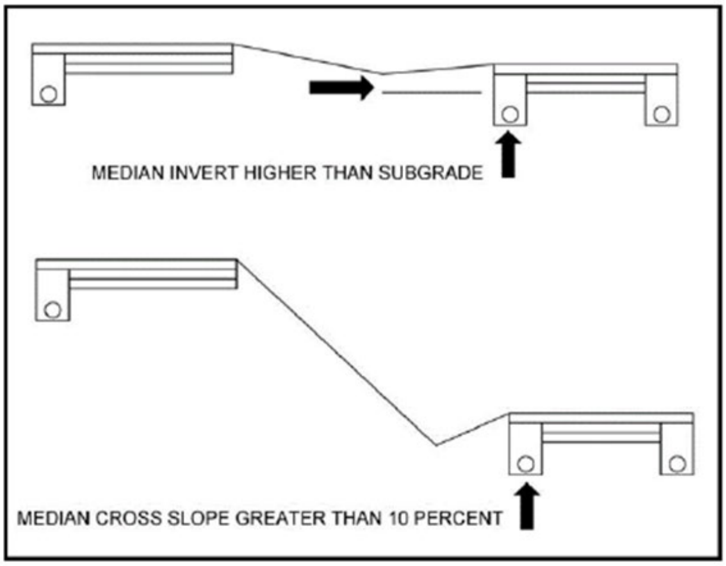
However, where median planting other than grass is required for aesthetic or headlight screening reasons, the low permeability material or impermeable membrane will inhibit growth and should not be used.

Longitudinal subsoil drainage should be provided where there is a possibility of entry of water from grassed medians, or where there is a significant difference in level between roadways, or where permeable subsoil surface strata exists.

Figure 8.6(b) shows typical locations of subsoil drains in a low embankment or transition zone from embankment to cut.

Figure 8.6(c) shows a typical example in a cutting where subsoil drains are often required.

Figure 8.6(a) – Location of subsoil drains (divided road)



Note:

If invert of median drain is not much lower than pavement layers and/or the possibility of seepage from median back under pavement exists, a subsoil drain should be considered here.

Figure 8.6(b) – Subsoil drains – Low embankment or transition from embankment to cut

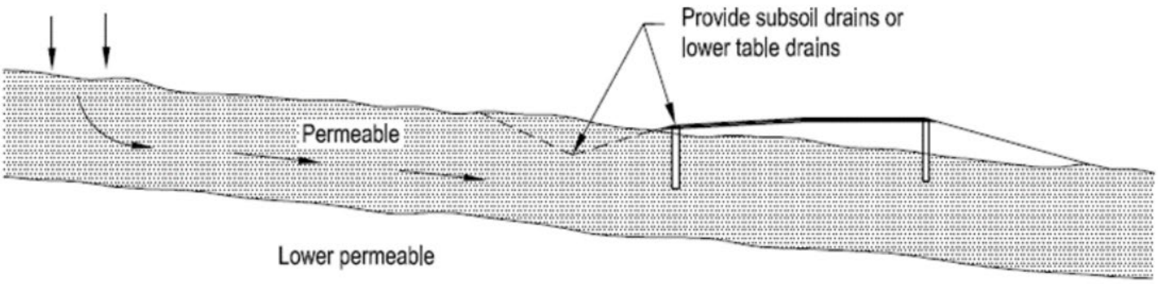
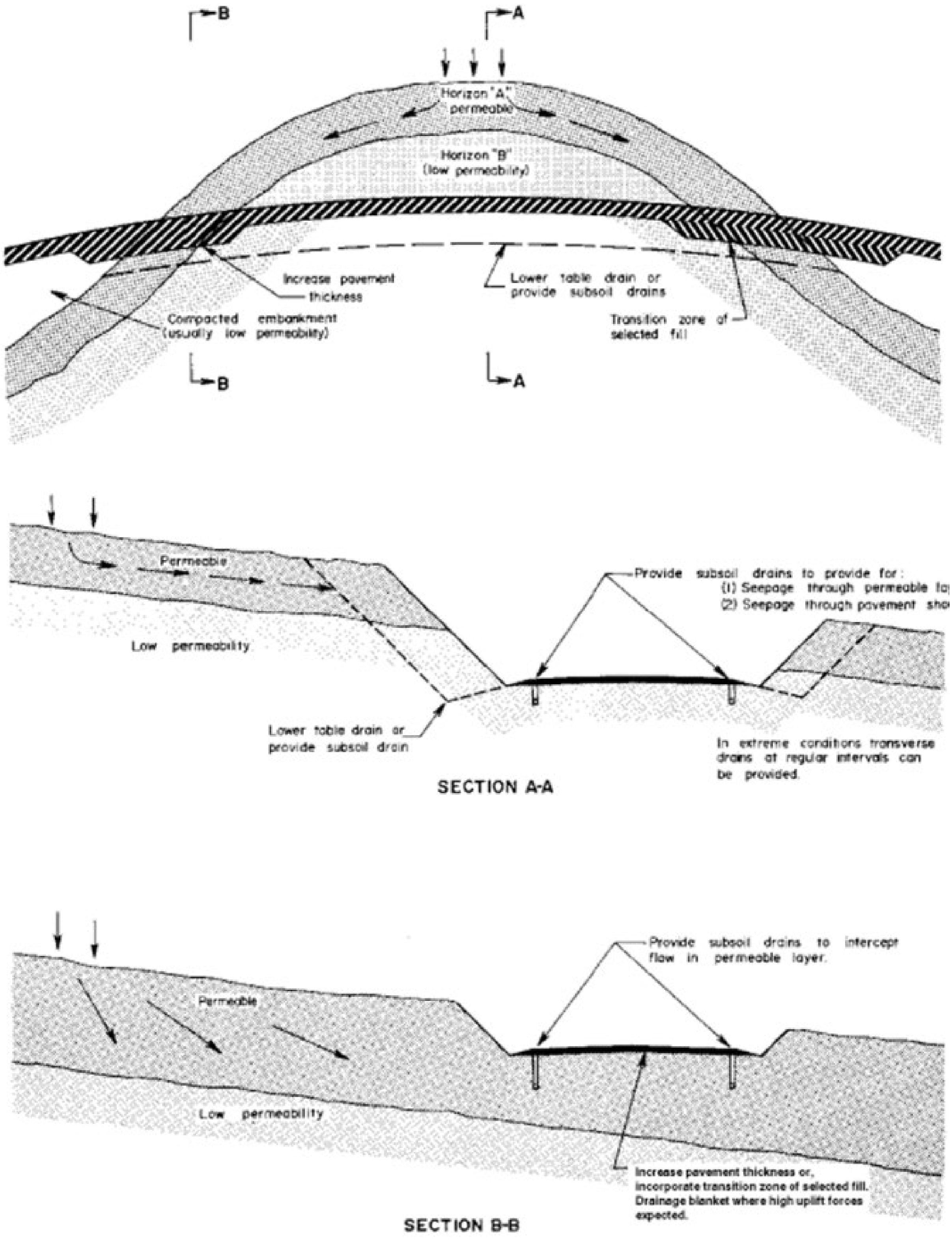


Figure 8.6(c) – Subsoil drains in cuttings



8.6.1 Longitudinal Subsurface Drains

Addition

Accepted as per Addition in Section 8.6 of this supplement.

8.6.2 Transverse Subsurface Drains

Addition

Accepted as per Addition in Section 8.6 of this supplement.

8.6.4 Combined Stormwater and Groundwater Drains

Addition

Accepted as per Addition in Section 8.6 of this supplement.

8.6.5 Locations of Subsurface Drains on Rural Roads

Addition

Accepted as per Addition in Section 8.6 of this supplement.

8.6.6 Access to Subsurface Drains

Addition

Figure 8.5(h) shows typical subsoil drain outlets and cleanouts in an urban environment. Transport and Main Roads Standard Drawing SD1116 provides further details, including treatments for rural environments.

Pits for subsurface drainage should be spaced not further than 150 m apart for ease of inspection and cleaning of the pipes. Maximum spacing between a cleanout and an outlet should generally not exceed 120 m to facilitate inspection and flushing. In cuttings where groundwater is not present, the distance to the outlet of a pavement drain may be much greater, but intermediate pits should generally be placed at a maximum spacing of 120 m.

Where groundwater occurs in a cutting, the seepage should be conveyed from the subsurface drain into an impervious collector pipe to minimise water penetration of pavement remote from the problem area.

Outlets should be in areas that are easily accessible and, where possible, visible to personnel standing on the road surface. An outlet should not hinder road maintenance activities, such as cleaning unlined table drains or grass cutting.

Outlets should be provided with some form of erosion protection commonly referred to as a splash zone. Typically, this consists of either:

- a masonry or concrete apron, or
- an area of large aggregate to dissipate the outflow energy.

8.7.3 Filters

Difference

This section contains extracts from the *Guide to the Control of Moisture in Roads* (NAASRA 1983) and applies to most drains.

A filter material is required in any permanent subsurface drainage system to prevent fine soil particles from washing into the system. For satisfactory performance, a filter material must be more permeable than the surrounding material but, at the same time, fine enough to keep that material in place.

In addition, the filter should be stable under flow situations and should itself be prevented from washing into perforations or joints in drainage pipes.

These requirements can be satisfied in various ways, usually by either granular materials or synthetic filter fabrics (geotextiles).

Filter materials are not usually necessary in temporary drainage systems or where the surrounding soil is known to be very stable. Examples of stable material are fractured rock, fissured or jointed heavy clays or other weathered materials, and naturally or artificially cemented materials. Care should be taken to determine whether fissured or jointed materials are sufficiently stable under adverse conditions to warrant dispensing with a filter material. Water flowing from joints should be examined for suspended particles and the susceptibility of the material to erosion in the disturbed or undisturbed state determined.

Transport and Main Roads Technical Specification MRTS27 *Geotextiles (Separation and Filtration)* describes the material requirements and work to be carried out for the relevant geotextiles in drains and trenches and drainage blankets, and geotextiles under or within embankments.

The design of granular filter material is described in *Subsurface Drainage of Road Structures* (ARRB 1987).

8.7.5 Minimum Cover

Difference

Figure 8.5(h) shows typical subsoil drain outlets and cleanouts in an urban environment. Transport and Main Roads Standard Drawing SD1116 provides further details including treatments for rural environments.

Notes:

1. Minimum cover for various compactors unless approved otherwise:
   - Hand held compactors – 100 mm
   - Compactors < 15 tonnes – 200 mm, and
   - Compactors > 15 tonnes – 200 mm
2. All dimensions are in millimetres.

References

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Addition

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Appendix A – Pit Performance Curves used in Victoria

A.1 Side Entry Pits – 1 Metre Inlet

Addition

Refer to Section 5.3.3 of this supplement.

A.2 Side Entry Pits – 1.5 Metre Inlet

Addition

Refer to Section 5.3.3 of this supplement.