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DEVELOPMENT DESIGN SPECIFICATION

D1

GEOMETRIC ROAD DESIGN (Urban and Rural)

AMENDMENT RECORD FOR THIS SPECIFICATION PART

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part. The clause numbering and context of each clause are preserved. New clauses are added towards the rear of the specification part as special requirements clauses. Project specific additional script is shown in the specification as italic font.

The amendment code indicated below is 'A' for additional script 'M' for modification to script and 'O' for omission of script. An additional code 'P' is included when the amendment is project specific.

Amendment Sequence No.	Key Topic addressed in amendment	Clause No.	Amendment Code	Author Initials	Amendment Date
1	<i>Para (d) deletion of standards</i>	1.03	O	MB	21/01/08
1	<i>Item 9 - Footpath width included</i>	1.17	M	MB	21/01/08

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DEVELOPMENT DESIGN SPECIFICATION D1 - DESIGN (URBAN AND RURAL)**GENERAL****D1.01 SCOPE**

- 1 This section sets out design specifications to be used in the subdivision of land.
- 2 All relevant design principles must be integrated in the development of the road network. A careful balance is required between maximising amenity, safety considerations and those related to legibility and convenience.

D1.02 AIMS

- 1 The provision of a road system within a subdivision is to be designed so as to achieve the following aims:
 - Provide convenient and safe access to all allotments for pedestrians, vehicles and cyclists.
 - Provide safe, logical and hierarchical transport linkages with existing street system.
 - Provide appropriate access for buses, emergency and service vehicles.
 - Provide for a quality product that minimises maintenance costs.
 - Provide a convenient way for public utilities.
 - Provide an opportunity for street landscaping.
 - Provide convenient parking for visitors.
 - Have appropriate regard for the climate, geology and topography of the area.
 - To ensure the design of any proposed residential subdivision takes into account inherent site constraints and natural landform features.
 - To ensure that the design of any proposed residential subdivision takes into account any significant trees or other vegetation upon the subject site, including any endangered ecological community or threatened species.
 - To ensure residential lots are well designed to take into account aspect, orientation, slope issues and optimal solar access.
 - To provide residential lots which maximises solar access and energy efficiency opportunities for future dwellings and private open space areas.

D1.03 CONSULTATION

- 1 Designers are encouraged to consult with the Council and other relevant authorities prior to or during the preparation of design. Designers shall in addition to requirements of this Specification ascertain specific requirements of these authorities as they relate to the designs in hand.
- 2 Where there is inconsistency between the RTA Road Design Guide and AUSTROADS, the RTA Road Design Guide shall have primacy. The Designer should consult with Council for determination.

D1.04 PLANNING CONCEPTS

- 1 In new areas (as distinct from established areas with a pre-existing road pattern) each class of route should reflect its role in the road hierarchy by its visual appearance and related physical design standards. Routes should differ in alignment and design standard according to the volume of traffic they are intended to carry, the desirable traffic speed, and other factors. **Road Hierarchy**

- 2 The road pattern and width must be in conformity with that shown on any relevant area Development Control Plan. In areas not covered by these plans, the pattern and width(s) will be determined by Council on their merits.
- 3 The road network for residential developments shall have clear legibility.
- 4 The road network should reinforce legibility by providing sufficient differentiation between the road functions.
- 5 Wherever possible distinct landmark features such as watercourses, mature vegetation or ridge lines should be emphasised within the structural layout so as to enhance the legibility. **Legibility**
- 6 Whilst legibility can be enhanced by introduced physical features such as pavement and lighting details, the road network should by its inherent design and functional distinction provide the necessary legibility.
- 7 The maximum number of turning movements at intersections or junctions that a visitor should be required to undertake to reach a particular address within the development should be minimised.

URBAN DESIGN CRITERIA

D1.05 ROAD HIERARCHY

- 1 A hierarchical road network is essential to maximise road safety, residential amenity and legibility. Each class of road in the network serves a distinct set of functions and is designed accordingly. The design shall convey to motorists the predominant function of the road. For a typical hierarchy refer to Council's DCP's.

D1.06 ROAD NETWORK

- 1 The design features of each type of road convey to the motorist its primary functions and encourage appropriate driver behaviour.
- 2 Traffic volumes and speeds on any road shall be compatible with the residential functions of that road.
- 3 The maximum length of lower order roads shall ensure their status as a residential place is retained, where the traffic, in terms of speed and volume will enable the integration of pedestrian, cycle and vehicular movements. This length will also ensure that residential convenience is not unduly impaired as a result of speed restraints.
- 4 The length of higher order roads within a development shall be minimised.
- 5 The time required for motorists to travel on all streets within the development shall be minimised.
- 6 Where lower order roads form part of a pedestrian or cycle network, access links should provide suitable connectivity with adjoining roads or open space systems so as to ensure such pedestrian and cycle network are functionally efficient.
- 7 The road network should ensure that no road links with another road which is more than two levels higher or lower in the hierarchy. **Road Links**

D1.07 DESIGN SPEED

- 1 Design speed is generally used as the basic parameter in the specification of design standards, determining the minimum design value for other elements. Vehicular speeds are

also limited by road intersections as well as changes in horizontal and vertical alignment.

- 2 Adoption of a low design speed discourages speeding, however, where vertical or horizontal curves of low design speed are located in otherwise high speed sections, the result is a potentially dangerous section of road. It should be recognised that in low standard roads, operating speeds will tend to be in excess of arbitrary speed standards. Attention shall be given to ensuring that potentially hazardous features are visible to the driver and adopting traffic engineering measures which will help a driver avoid errors of judgement. **Low Speeds**
- 3 Design speeds shall be in accordance with Council's DCP. Where a development is not covered by the provisions of a DCP, the design speed shall be set by Council.

D1.08 LONGITUDINAL GRADIENT

- 1 Other than at sags and crests, the minimum permissible gradient is 0.5%. Variable crossfall may be necessary to produce the required grade in the gutter. Maximum recommended grades are shown in Table D1.1.

Table D1.1

Road Carriageway Type	Maximum Desirable Grade	Absolute Maximum Grade
Residential	15%	Greater than 15% up to and equal to 20% for distances not exceeding 100 m and do not require movements of Heavy Vehicle
Industrial / Commercial	12%	Greater than 12 % up to and equal to 15% for distances not exceeding 100 m

- 2 Design of the road alignment and the grades used are interrelated. A steep grade on a side street is undesirable if vehicles on the side road have to stand waiting for traffic in the priority road.
- 3 The maximum grade in any direction within a cul-de-sac turning circle or T-Head shall not exceed 8%.

D1.09 HORIZONTAL CURVES AND TURNING MOVEMENTS

1. The Horizontal Alignment of a road is normally a series of tangents and curves which may be connected by transition curves. For design speeds up to 60 km/h the use of transition curves is not considered necessary. In practice, curve radii on urban roads range from right angled bends to large radius curves. **Transition Curves**
2. The radius of horizontal curves in urban areas shall meet the following objectives:
 - a. turning movements of a large rigid vehicle to enter and leave each street travelling in a forward direction.
 - b. sight distance criteria in accordance with AUSTROADS requirements taking account of building setbacks and landscape features.
 - c. desired speed environment to cater for pedestrian, cyclists be the largest attainable.

D1.10 VERTICAL CURVES

- 1 Vertical curves will be simple parabolas and shall be used on all changes of grade exceeding 1 %. The desirable minimum design speed is 40 km/h. The length of the crest vertical curve for stopping sight distance shall conform with AUSTROADS requirements.

- 2 For adequate riding comfort, lengths of sag vertical curves shall conform with the RTA Road **Riding**

Design Guide. As residential roads are usually lit at night, the criterion for designing sag vertical curves is a vertical acceleration of 0.05 g for desirable riding comfort, and 0.10 g for minimum riding comfort. The minimum length for vertical curves are shown in Table D1.2. **Comfort**

Table D1.2

	Local access (m)	Collector (m)	Distributor (m)
Minimum vertical curve	25	35	50
Absolute minimum vertical curve (to be applied at road junctions only)	8	12	20

- 3 Sight distance requirements at all intersections shall be provided in accordance with AUSTROADS 'Intersections at Grade'. **Side Road**
- 4 Drainage poses a practical limit to the length of sag curve. A minimum grade of 0.5 per cent should be maintained in the kerb and gutter. **Sag Curves**
- 5 The three dimensional coordination of the horizontal and vertical alignment of a road should be aimed at improved traffic safety and aesthetics. Economic considerations often require a compromise with aesthetic considerations. The following principles should be applied:
 - The design speed of the road in both horizontal and vertical planes should be of the same order.
 - Combined horizontal and vertical stopping sight distance and minimum sight distance should be considered three dimensionally.
 - Sharp horizontal curves should not be introduced at or near the crest of a vertical curve. A horizontal curve should leave the vertical curve and be longer than the vertical curve.
 - A short vertical curve on a long horizontal curve or a short tangent in the gradeline between sag curves may adversely affect the road's symmetry and appearance.

D1.11 CARRIAGEWAY WIDTH

- 1 The cross section of the road reserve must cater for all functions that the road is expected to fulfil, including the safe and efficient movement of all users, provision for parked vehicles, acting as a buffer from traffic nuisance for residents, the provision of public utilities and streetscaping. Carriageway width, footway width and road reserve width shall comply with the relevant Council DCP. **Functions**
- 2 Where a development is not covered by the provisions of a DCP, carriageway width footway width and road reserve width shall be determined by Council.

D1.12 CROSSFALLS

- 1 Desirably, roads should be crowned in the centre. Typical pavement crossfalls on straight roads are:

<i>Pavement Type</i>	<i>Crossfall</i>
Bituminous seal coat	3 %
AC pavement	3 %
Cement concrete pavement	2 %

(Source: NAASRA (Now AUSTROADS), Guide policy for geometric design of major urban roads)

2. There are many factors affecting levels in urban areas which force departures from these crossfalls. Differences in level between road alignments can be taken up by offsetting crown **Offset Crown Changes**

lines or adopting one way cross falls. Sustained crossfalls should not exceed 4 per cent, although up to 6 per cent may be used where unavoidable.

- 3 The rate of change of crossfall should not exceed: **Rate of Rotation**
 - a. 6 per cent per 30 m for through traffic;
 - b. 8 per cent per 30 m for free flowing turning movements; or
 - c. 12 per cent per 30 m for turning movements for which all vehicles are required to stop.
- 4 The crossfall on a through road shall take precedence over the grade in side streets. **Priority Road**
Standard practice is to maintain the crossfall on the priority road and adjust the side road levels to suit. The crossfall in side streets should be warped quickly either to a crown or a uniform crossfall depending on the configuration of the side street.



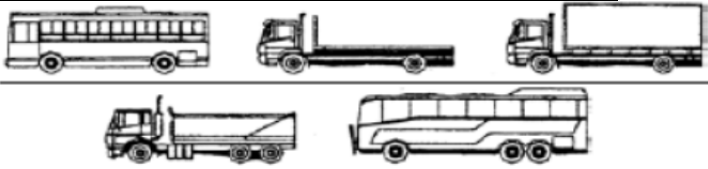

D1.13 FOOTWAY AREAS

1. A suitable design for the footpath will depend on utility services, the width of pathways, access to adjoining properties, likely pedestrian usage and preservation of trees. Crossfalls in footpath areas shall generally be 4%. Where this is not practical footpath crossfalls shall not be less than 2% nor exceed 6%. The footpath shall be graded to fall toward the kerb other than at locations specifically designed to cater for overland flow of stormwater. **Utility Services**

D1.14 INTERSECTIONS

1. The design of intersections or junctions shall allow all movements to occur safely without undue delay. Projected traffic volumes should be used in designing all intersections or junctions on local distributor roads. **Traffic Volumes**
2. Intersection design for the junction of subdivision roads with existing main rural, main urban and state highways should generally be designed in accordance with the publication AUSTROADS Guide to Road Design Part 4, Intersections and Crossings" **Main Roads**
3. Intersections with main roads, tourist roads or state highways are to be designed and constructed in accordance with the requirements of the Roads and Traffic Authority and Council. **Tourist Roads State Highways**
4. Where major intersections are required to serve a development complete reconstruction of the existing road pavements will be necessary where the speed environment and irregularity of the existing road pavement may endanger the safety of traffic in the locality.
5. Intersections should be generally located in such a way that: **Criteria**
 - a. The streets intersect preferably at right-angles and not less than 70°.
 - b. The landform allows clear sight distance on each of the approach legs of the intersection.
 - c. The minor street intersects the convex side of the major street.
 - d. The vertical grade lines at the intersection do not impose undue driving difficulties.
 - e. The vertical grade lines at the intersection will allow for any direct surface drainage.
 - f. Two side streets intersecting a major street in a staggered pattern should have a minimum centre-line spacing of 40 m.
6. Stopping and sight distances are to be provided for horizontal and vertical curves at all intersections in accordance with AUSTROADS requirements.
7. In cul-de-sac streets adequate provision should be made at the end of the road for vehicle types which frequently use the streets to turn around. The likelihood of parked vehicles obstructing turns must be catered for.
8. The drainage function of the carriageway and/or road reserve must be satisfied by the road reserve cross-section profile.

9. Footpath (footway/nature strip/verge) area width shall be in accordance with Council's DCP or a minimum of 3.5 metres wide unless otherwise approved by Council. **Verge Widths**
10. All vehicle turning movements are accommodated utilising AUSTROADS Design Vehicles and Turning Templates. **Turning Movements**
- For turning movements involving local distributor roads, the "design semi-trailer" with turning path radius 15.0 m.
 - For turning movements involving local streets or collector streets, but not distributor roads, the "design bus/truck" with turning path radius 12.5 m.
 - For turning movements on access streets but not involving distributor roads, collector streets or local streets, the garbage collection vehicle used by the local authority.
 - For turning movements at the head of cul-de-sac streets sufficient area is provided for the "design bus/truck" to make a three-point turn.. Where driveway enhances are to be used for turning movements, the required area is constructed and design to withstand the relevant loads.

AUSTROADS	Australian Standard	Design Length (m)	
	B85 Vehicle	4.91	
	B99 Vehicle	5.2	
	Small Rigid Vehicle	6.4	
Service Vehicle	Medium Rigid Vehicle	8.8	
Single Unit truck/bus	Heavy Rigid Vehicle	12.5	
Single Articulated	Articulated Vehicle	19	

D1.15 ROUNDABOUTS

- Roundabouts are to be approved by the Council.
- Roundabouts shall be designed in accordance with the requirements of the publication AUSTROADS Guide to Road Design Part 4B : Roundabouts and current RMS Guidelines. Roundabout design should generally comply with the following:
 - entry width to provide adequate capacity.
 - adequate circulation width, compatible with the entry widths and design vehicles e.g. buses, trucks, cars.
 - central islands of diameter sufficient only to give drivers guidance on the manoeuvres expected.
 - deflection of the traffic to the left on entry to promote gyratory movement.
 - adequate deflection of crossing movements to ensure low traffic speeds.
 - a simple, clear and conspicuous layout.
 - design to ensure that the speed of all vehicles approaching the intersection will be less than 50 km/h. **Approach Speed**

D1.16 TRAFFIC CALMING

1. Calming devices such as thresholds, slowpoints, speed humps, chicanes and splitter islands should be designed in accordance with the requirements of the publication AUSTROADS Guide to Traffic Management part 8: Local Area Traffic Management and are to be approved by Council. Designs should generally comply with the Council LATM plans and the following:

(a) Streetscape

- i. reduce the linearity of the street by segmentation
- ii. avoid continuous long straight lines (e.g. kerb lines)
- iii. enhance existing landscape character
- iv. maximise continuity between existing and new landscape areas.

(b) Location of Devices/Changes

- i. devices other than at intersections should be located to be generally consistent with streetscape requirements
- ii. existing street lighting, drainage pits, driveways, and services may decide the exact location of devices
- iii. slowing devices are located at spacings of 100-150m.

(c) Design Vehicles

- i. emergency vehicles must be able to reach all residences and properties.
- ii. where bus routes are involved, buses should be able to pass without mounting kerbs.
- iii. in newly developing areas where street systems are being developed in line with LATM principles, building construction traffic must be catered for.

Design Vehicles**(d) Control of Vehicle Speeds**

- i. maximum vehicle speeds can only be reduced by deviation of the travelled path. Pavement narrowings have only minor effects on average speeds, and usually little or no effect on maximum speeds
- ii. speed reduction can be achieved using devices which shift vehicle paths laterally (slow points, roundabouts, corners) or vertically (humps, platform intersections, platform pedestrian/school/bicycle crossings)
- iii. speed reduction can be helped by creating a visual environment conducive to lower speeds. This can be achieved by 'segmenting' streets into relatively short lengths (less than 300m), using appropriate devices, streetscapes, or street alignment to create short sight lines

Vehicle Speeds**(e) Visibility Requirements (sight distance)**

- i. adequate critical sight distances should be provided such that evasive action may be taken by either party in a potential conflict situation. Sight distances should relate to likely operating speeds
- ii. sight distance to be considered include those of and for pedestrians and cyclists, as well as for drivers
- iii. night time visibility of street features must be adequate. Speed control devices particularly should be located near existing street lighting if practicable, and all street features/furniture should be delineated for night time operation.

Visibility**(f) Critical Dimensions**

Many devices will be designed for their normal use by motor cars, but with provision (such as mountable kerbs) for larger vehicles. Some typical dimensions include:

- i. pavement narrowings
 - single lane 3.50 m between kerbs 3.75 m between obstructions

- two lane 5.50 m minimum between kerbs
- ii. bicycle lanes (including adjacent to pavement narrowings)
 - 1.35m minimum
- iii. plateau or platform areas
 - 75 mm to 150 mm height maximum, with 1 in 15 ramp slope
- iv. width of clear sight path through slowing devices
 - 1.0 m maximum

(i.e. the width of the portion of carriageway which does not have its line of sight through the device blocked by streetscape materials, usually vegetation)
- v. dimensions of mountable areas required for the passage of large vehicles to be determined by appropriate turning templates.

**Bicycle
Lanes****D1.17 PARKING**

1. The parking requirements are outlined in Council's DCP.

D1.18 BUS ROUTES

1. Bus routes will normally be identified by Council. It is important that the road hierarchy adequately caters for buses. The main criteria in determining the location of bus routes is that *no more than 5% of residents should have to walk in excess of 400 metres* to catch a bus. Normally roads above the local street in the hierarchy are designed as bus routes.

Buses**RURAL DESIGN CRITERIA****D1.19 GENERAL**

1. In addition to the foregoing sections this section specifically applies to all those sites identified as being suited to rural subdivisions inclusive of rural home-sites and hobby farms types of developments.
2. Design speed is to be generally used as the basic parameter of design standards and the determination of the minimum design value for other elements in rural subdivisions is to be based on the concept of a "speed environment" as outlined in AUSTROADS Guide to Road Design Part 3: Geometric Design
3. Reserved.
4. Where the table drain is likely to scour, a RTA Type SH dish drain, or similar structure is to be constructed along the invert. For grades of less than 0.5%, the inverts of the drain are to be lined to prevent siltation.

**Design
Speed****Table
Drain****D1.20 SIGHT DISTANCES**

1. Sight distances shall be in accordance with AUSTROADS requirements
2. Deleted

**Sight
Distance****D1.21 HORIZONTAL AND VERTICAL ALIGNMENT**

1. Horizontal and vertical curves are to be designed generally to the requirements of AUSTROADS Guide to Road Design Part 3: Geometric Design. These requirements are essential to satisfy the safety and performance of proper road design. Roads having both

horizontal and vertical curvature should be designed to conform with the terrain to achieve desirable aesthetic quality and being in harmony with the landform.

D1.22 INTERSECTIONS

1. Intersections shall be designed in accordance with the publication AUSTROADS Guide to Road Design Part 4, Intersections and Crossings. The type of intersection required will depend on existing and planned connecting roads.
2. Adequate sight distance in accordance with AUSTROADS requirements shall be provided at intersections and junctions.
3. An absolute minimum spacing of 40 m shall be adopted for staggered junctions. The intersection angle between two roads shall not be less than 70 degrees. ***Staggered Junctions***

D1.23 CARRIAGEWAYS

1. Carriageway width shall be in accordance with Council's DCP. Where a development is not covered by the provisions of a DCP, carriageway width shall be determined by Council.

Table 2: Characteristics of roads in residential road networks

Street Type	Traffic Volume (vpd) ⁽¹⁾	Target Speed Environment (km/h)	Minimum Carriageway Width ⁽²⁾ (m)	Parking Provision	Kerb Type	Concrete Footpath	Shared Path	Verge Width (m)	Street Pavement Type	Road Reservation Width (m)
Access Place ⁽⁴⁾ (Adjacent to Public open Space)	< 100	25	3.5 One Way	1 verge bays per 2 lots ⁽⁵⁾	Barrier kerb (open space) Roll kerb (lots)	No ⁽⁶⁾	No ⁽⁷⁾	1.5 adj to open space 3.5 m adj to lots	Reinforced Concrete	8.5
Access Place ⁽⁴⁾	< 100	25	3.7 One Way	1 verge bays per 2 lots ⁽⁵⁾	Barrier kerb	No ⁽⁶⁾	No ⁽⁷⁾	3.5	Reinforced Concrete	10.7
Access Street ⁽⁴⁾	< 300	25	6.5 Two Way	Carriage way ⁽⁸⁾	Barrier kerb	No ⁽⁶⁾	No ⁽⁷⁾	3.5 ⁽⁹⁾	Asphalt	13.5
Local Street (minor)	300 - 1,000	40	7.5 ⁽¹⁰⁾	Carriage way	Barrier kerb	Yes 1.5 m one side	No ⁽⁷⁾	3.5 ⁽⁹⁾	Asphalt	14.5

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Part B – Land Use Based Planning Controls

Chapter B2: Residential Subdivision

Street Type	Traffic Volume (vpd) ⁽¹⁾	Target Speed Environment (km/h)	Minimum Carriageway Width ⁽²⁾ (m)	Parking Provision	Kerb Type	Concrete Footpath	Shared Path	Verge Width (m)	Street Pavement Type	Road Reservation Width (m)
Local Street (major) ⁽¹¹⁾	1,000 - 3,000	40	9.5	Carriage way	Barrier kerb	Yes 1.5 m one side	No ⁽⁷⁾	3.5 ⁽⁹⁾	Asphalt	16.5
Collector ⁽¹¹⁾	3,000 - 6,000	50 ⁽¹²⁾	Min. 11.5	Carriage way	Barrier kerb	Yes 1.5 m one side	2.5 m shared path one side	Min. 3.5	Asphalt	Min. 18.5
Major Collector / Sub Arterial ⁽¹¹⁾ ⁽¹³⁾	> 6,000	60 ⁽¹²⁾	Min. 13.5 ⁽¹⁴⁾	Carriage way	Barrier kerb	Yes 1.5m one side	2.5 m shared path one side	Min. 3.5 ⁽¹⁵⁾	Asphalt	Min. 20.5

D1.24 SCOUR PROTECTION

1. Scour protection of roadside drainage and table drains is required. The level of protection will depend on the nature of the soils, road gradients and volume of stormwater runoff.
2. Protection works may involve concrete lined channels, turfing, rock pitching, grass seeding, individually or any combination of these. Geotechnical investigations should be carried out to determine the level and extent of any protection works prior to proceeding to final design stage.

DEVELOPMENT DESIGN SPECIFICATION

D2

PAVEMENT DESIGN

AMENDMENT RECORD FOR THIS SPECIFICATION PART

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part. The clause numbering and context of each clause are preserved. New clauses are added towards the rear of the specification part as special requirements clauses. Project specific additional script is shown in the specification as italic font.

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Amendment Sequence No.	Key Topic addressed in amendment	Clause No.	Amendment Code	Author Initials	Amendment Date
1	<i>Pavement thicknesses and construction staging</i>	2.16	M	MB	21/01/08
1	<i>Deletion of sprayed bituminous seal</i>	2.08	O	MB	21/01/08

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PAVEMENT DESIGN

GENERAL

D2.01 SCOPE

1. The work to be executed under this Specification consists of the design of the road pavement to meet the required design life, based on the subgrade strength, traffic loading and environmental factors, and including the selection of appropriate materials for select subgrade, sub-base, base and wearing surface. *Design Criteria*
2. The Specification contains procedures for the design of the following forms of surfaced road pavement construction: *Surfaced Pavement Types*
 - (a) flexible pavements consisting of unbound granular materials;
 - (b) flexible pavements that contain one or more bound layers, including pavements containing asphalt layers other than thin asphalt wearing surfaces;
 - (c) rigid pavements (ie. cement concrete pavements);
 - (d) concrete segmental block pavements.

D2.02 OBJECTIVES

1. The objective in the design of the road pavement is to select appropriate pavement and surfacing materials, types, layer thicknesses and configurations to ensure that the pavement performs adequately and requires minimal maintenance under the anticipated traffic loading for the design life adopted. *Pavement Performance*

PAVEMENT DESIGN CRITERIA

D2.03 DESIGN VARIABLES

1. Regardless of the type of road pavement proposed, the design of the pavement shall involve consideration of the following five input variables: *Design Variables*
 - (a) Design Traffic
 - (b) Subgrade Evaluation
 - (c) Environment
 - (d) Pavement and Surfacing Materials
 - (e) Construction and Maintenance Considerations

D2.04 DESIGN TRAFFIC

1. The design traffic shall be calculated based on the following minimum design lives of pavement:- *Minimum Pavement Design Life*
 - (a) Flexible, Unbound Granular - 50 years
 - (b) Flexible, Containing one or more bound layers - 50 years
 - (c) Rigid (Concrete) - 50 years
 - (d) Segmental Block - 50 years
2. Design traffic shall be calculated in equivalent standard axles (ESAs) for the applicable design life of the pavement, taking into account present and predicted commercial traffic volumes, axle loadings and configurations, commercial traffic growth and street capacity. *Design Traffic*
3. For new subdivisions, the design traffic shall take account of both the construction traffic associated with the subdivision development and the in-service traffic. For interlocking

concrete segmental pavements, the simplification of replacing ESA's with the number of commercial vehicles exceeding 3 tonne gross contained in CACA - Interlocking Concrete Road Pavements is acceptable up to a design traffic of 10^6 . Beyond this ESAs should be calculated.

4. The pavement design shall include all traffic data and/or assumptions made in the calculation of the design traffic. **Traffic Data**
6. In the absence of other traffic data, the following traffic values (in ESAs) may be taken as a guide to the design traffic, but shall be subject to variation depending on the circumstances for the particular development. **Design ESAs**

<u>Street Type:</u>	<u>Design ESA's - 50 year design life</u>
Urban Residential	<ul style="list-style-type: none"> - Cul-de-sac 2×10^4 - Minor 6×10^4 - Local Access 3×10^5 - Collector 1×10^6 - Distributor 2×10^6
Rural Residential	<ul style="list-style-type: none"> - Cul-de-sac 2×10^4 - Other 3×10^5 - Private Road 3×10^4
Commercial and Industrial	5×10^6

D2.05 SUBGRADE EVALUATION

1. Except where a mechanistic design approach is employed using AUSTROADS Pavement Technology, the measure of subgrade support shall be the California Bearing Ratio (CBR). Where a mechanistic design approach using linear elastic theory is employed for flexible pavements, the measure of subgrade support shall be in terms of the elastic parameters (modulus, Poisson's ratio). **California Bearing Ratio**
2. The following factors must be considered in determining the design strength/stiffness of the subgrade: **Design Considerations**
 - (a) Sequence of earthworks construction
 - (b) The compaction moisture content and field density specified for construction
 - (c) Moisture changes during service life
 - (d) Subgrade variability
 - (e) The presence or otherwise of weak layers below the design subgrade level.
3. The subgrade Design CBR adopted for the pavement design must consider the effect of moisture changes in the pavement and subgrade during the service life, and hence consideration must be given to the provision of subsurface drainage in the estimation of equilibrium in-situ CBRs, and hence in the design of the pavement structure. If subsurface drainage is not provided, then the Design CBR adopted must allow for a greater variability in subgrade moisture content during the service life of the pavement, and hence a Design Moisture Content above the Optimum Moisture Content. **Design CBR**
4. The calculation of the Design CBR shall be based on a minimum of three 4 day soaked CBR laboratory samples for each subgrade area, compacted to the relative density specified for construction, and corrected to allow for the effects of subsurface drainage (or lack of), climatic zone, and soil type if appropriate (as per the guidelines in APRG No 21) to give an estimated equilibrium in-situ CBR. The Design CBR for each subgrade area is computed by using the appropriate formulae as follows: **Calculation of Design CBR**

Design CBR = Least of estimated equilibrium CBRs, for less than five results

Design CBR = 10th percentile of all estimated equilibrium CBRs, for five or more results

= $C - 1.3S$

Where C is the mean of all estimated equilibrium CBRs, and
S is the standard deviation of all values.

5. The pavement design shall include a summary of all laboratory and field test results and assumptions and/or calculations made in the assessment of Design CBR.

**Summary
of Results**

D2.06 ENVIRONMENT

1. The environmental factors which significantly affect pavement performance are moisture and temperature. Both of these factors must be considered at the design stage of the pavement. Reference should be made to AUSTROADS Pavement Technology, APRG NO 21,
2. The following factors relating to moisture environment must be considered in determining the design subgrade strength/stiffness and in the choice of pavement and surfacing materials:
 - (a) Rainfall/evaporation pattern
 - (b) Permeability of wearing surface
 - (c) Depth of water table
 - (d) Relative permeability of pavement layers
 - (e) Whether shoulders are sealed or not
 - (f) Pavement type (boxed or full width)
3. The effect of changes in moisture content on the strength/stiffness of the subgrade shall be taken into account by evaluating the design subgrade strength parameters (ie. CBR or modulus) at the highest moisture content likely to occur during the design life, ie the Design Moisture Content. The provision of subsurface drainage may, under certain circumstances, allow a lower Design Moisture Content, and hence generally higher Design CBR.
4. The pavement design shall include all considerations for environmental factors, and any assumptions made that would reduce or increase design subgrade strength, or affect the choice of pavement and surfacing materials.

Reference

**Evaluate
Design CBR**

D2.07 PAVEMENT AND SURFACING MATERIALS

1. Pavement materials can be classified into essentially four categories according to their fundamental behaviour under the effects of applied loadings:
 - (a) Unbound granular materials, including modified granular materials
 - (b) Bound (cemented) granular materials
 - (c) Asphaltic Concrete
 - (d) Cement Concrete
2. Surfacing materials can also be classified into essentially three categories or types:-
 - (a) Asphaltic concrete (residential, rural, industrial and commercial),
 - (b) Cement Concrete (in public roads only where approved by Council in the Development Consent),
 - (c) Concrete Segmental Pavers (in public roads only where approved by Council in the Development Consent)
3. Unbound granular materials, including modified granular materials, shall satisfy the

**Pavement
Classification**

**Surfacing
Classification**

requirements of the Construction Specification for FLEXIBLE PAVEMENTS.

4. Bound (cemented) granular materials shall satisfy the requirements of the Construction Specification for FLEXIBLE PAVEMENTS.
5. Asphaltic concrete shall satisfy the requirements of the Construction Specification for ASPHALTIC CONCRETE.
6. Cement concrete shall satisfy the requirements of the Construction Specifications for MASS CONCRETE SUBBASE, PLAIN OR REINFORCED CONCRETE BASE, or FIBRE REINFORCED CONCRETE, as appropriate.
7. Sprayed bituminous seals shall satisfy the requirements of the Construction Specification for SPRAYED BITUMINOUS SURFACING.
8. Concrete segmental pavers shall satisfy the requirements of the Construction Specification for SEGMENTAL PAVING.

D2.08 CONSTRUCTION AND MAINTENANCE CONSIDERATIONS

1. The type of pavement, choice of base and subbase materials, and the type of surfacing adopted should involve consideration of various construction and maintenance factors as follows:
 - (a) Extent and type of drainage
 - (b) Use of boxed or full width construction
 - (c) Available equipment of the Contractor
 - (d) Use of stabilisation
 - (e) Aesthetic, environmental and safety requirements
 - (f) Social considerations
 - (g) Construction under traffic
 - (h) Use of staged construction
 - (i) Ongoing and long-term maintenance costs

These factors are further discussed in AUSTROADS Pavement Design.

PAVEMENT THICKNESS DESIGN

D2.09 PAVEMENT STRUCTURE - GENERAL

1. Notwithstanding subgrade testing and subsequent pavement thickness design, the thickness of subbase and base layers shall not be less than the following:-

<ol style="list-style-type: none"> (a) Flexible pavement: (b) Rigid pavement: 	<ol style="list-style-type: none"> Subbase 100mm, Base 100mm, Subbase 100mm, Base 150mm 	Minimum Pavement Thickness
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2. The subbase layer shall extend a minimum of 150mm behind the rear face of any kerbing and/or guttering.

**Subbase
Extent**
3. The base and surfacing shall extend to the face of any kerbing and/or guttering. Where the top surface of the subbase layer is below the level of the underside of the kerbing and/or guttering, the base layer shall also extend a minimum of 150mm behind the rear face of the kerbing and/or guttering.

Base Extent
4. For unkerbed roads, the subbase and base layers shall extend at least to the outer edge of the nominated width of shoulder.

D2.10 UNBOUND GRANULAR FLEXIBLE PAVEMENTS (BITUMINOUS SURFACED)

1. Unbound granular flexible pavements with thin bituminous surfacings, including those with cement or lime modified granular materials, with design traffic up to 10^6 ESAs shall be designed in accordance with APRG NO 21, using Figure 13.8.2 (A) (95% confidence limit curves).
2. For design traffic above 10^6 ESAs, the design shall be in accordance with AUSTROADS Pavement Technology.

D2.11 FLEXIBLE PAVEMENTS CONTAINING BOUND LAYERS (BITUMINOUS SURFACED)

1. Flexible pavements containing one or more bound layers, including cement stabilised layers or asphaltic concrete layers other than thin asphalt surfacings, shall be designed in accordance with AUSTROADS Pavement Design.
2. As an alternative to AUSTROADS Pavement Design for design traffic up to 10^6 ESAs, bound layers may be assumed to be equivalent to unbound layers of the same thickness, and the pavement designed in accordance with APRG NO 21, using Figure 13.8.2 (A) (95% confidence limit curves).

D2.12 RIGID PAVEMENTS

1. Rigid (concrete) pavements, with design traffic up to 10^6 ESAs shall be designed in accordance AUSTROADS Technology . ***Rigid (Concrete)***
2. Rigid (concrete) pavements for design traffic above 10^6 ESAs, the design shall be in accordance with AUSTROADS Pavement Technology .
3. Single lane concrete bus bays adjacent to a flexible pavement shall be designed in accordance with AUSTROADS Pavement Technology.

D2.13 CONCRETE SEGMENTAL BLOCK PAVEMENTS

1. Concrete segmental block pavements with design traffic up to 10^6 estimated commercial vehicles exceeding 3T gross shall be designed in accordance with AUSTROADS Pavement Technology ***Concrete Segmental Block***
2. For design traffic above 10^6 estimated commercial vehicles exceeding 3T gross the design shall be in accordance with AUSTROADS Pavement Technology , with the calculation of design traffic in terms of ESAs.

SURFACING DESIGN

D2.14 CHOICE OF SURFACE TYPE

1. Except where the pavement is designed for concrete or segmental block surfacing, the wearing surface shall be a bituminous wearing surface as follows:- ***Bitumen Wearing Surface***
 - (a) Urban Residential Streets :
One layer of 40mm ARRB gap graded AC 14
 - (b) Rural and Rural Residential Roads :
One layer of 40mm ARRB gap graded AC14

- (c) Commercial and Industrial streets:
One layer of 50 mm ARRB gap graded AC 14
 - (d) Sub-arterial, Arterial roads and Roundabouts:
One layer of 50 mm ARRB gap graded AC 14
- 2. Concrete segmental pavers shall be 80mm thick, shape Type A, and designed to be paved in a herringbone pattern. ***Size and Shape***
 - 3. The edges of all paving shall be designed to be constrained by kerbing and/or guttering ***Edge Constraint***

DOCUMENTATION

D2.15 DESIGN CRITERIA AND CALCULATIONS

- 1. All considerations, assumptions, subgrade test results, and calculations shall be submitted with the pavement design. ***Submission Details***
- 2. The Drawings shall clearly indicate the structure, material types and layer thicknesses of the proposed pavement and surfacing. ***Drawings***

DEVELOPMENT DESIGN SPECIFICATION

D3

STRUCTURES BRIDGE DESIGN

AMENDMENT RECORD FOR THIS SPECIFICATION PART

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part. The clause numbering and context of each clause are preserved. New clauses are added towards the rear of the specification part as special requirements clauses. Project specific additional script is shown in the specification as italic font.

The amendment code indicated below is 'A' for additional script 'M' for modification to script and 'O' for omission of script. An additional code 'P' is included when the amendment is project specific.

Amendment Sequence No.	Key Topic addressed in amendment	Clause No.	Amendment Code	Author Initials	Amendment Date

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DEVELOPMENT DESIGN SPECIFICATION D3 STRUCTURES/BRIDGE DESIGN

GENERAL

D3.01 SCOPE

1. This section sets out design considerations to be adopted in the design of structural engineering elements for land subdivisions. Such activities will include:

- Road traffic bridges
- Pedestrian bridges
- Structures other than bridges, but associated with roads (eg retaining walls)
- Small earth dams, detention basins
- Structures used for public safety (traffic barriers, pedestrian barriers, street lighting)
- Major sign support structures
- Temporary works
- Noise barriers and fencing adjacent to public land.

Such structures may be of concrete, timber or steel constructions, but with emphasis placed on low maintenance and longevity.

D3.02 OBJECTIVE

1. The aim of design shall be the achievement of acceptable probabilities that the structure being designed will not become unfit for use during its design life, having regard to economic, physical, aesthetic and other relevant constraints. ***Design Life***

D3.03 BASIS OF DESIGN

1. The design shall be based on scientific theories, experimental data and experience, interpreted statistically as far as possible. The safety and service performance of a structure depends also on the quality control exercised in fabrication, supervision on site, the control of unavoidable imperfections and the qualifications, experience and skill of all personnel involved. Adequate attention shall therefore be given to these factors. In addition, adequate management control and supervision by experienced engineers shall be required at all stages of design and construction to prevent the occurrence of gross errors. ***Safety Quality Qualifications***
2. Specifications shall be notated on the design plans with sufficient detail to ensure that the above described strategies are able to be effectively implemented at the construction stage.

D3.04 ROAD TRAFFIC BRIDGES

1. Structural design of bridges is a specialised field, generally falling outside the scope of most civil engineering consultancies ***NPER3***
2. Council will not accept bridge designs from persons who are not qualified as Chartered Professional Engineer and registered on NPER.
3. The Australian Standard AS 5100 Bridge design is the appropriate general reference for bridge proposals.
4. Council normally requires bridges to have low maintenance finishes; therefore timber and steel are not usually acceptable construction materials, unless suitable precautions are adopted. Heavy debris and bed loads may be characteristic of some streams so that large spans with slender piers are encouraged. If overtopping is permitted, handrails and guardrails shall be designed to withstand the hydraulic and impact forces. Flood depth indicators shall be provided in such cases. ***Debris Overtopping***
5. The design life for bridges shall be 100 years. The ultimate limit state shall withstand, without collapse, a flood of up to and including a 1:2000 year ARI Maintenance is a key issue affecting ***Design Life Maintenance***

the design life of the structure. The design plans shall specify the design life of the structure together with the relevant maintenance programs to be adopted upon which the design life is based. Parameters used in the design shall also be shown on the design plans.

6. Unless otherwise indicated in the Notification of Determination of Development Application, small bridges within allotments shall be designed with appropriate afflux to convey the 5 year ARI flood event and be able to withstand the inundation loadings for up to the 100 year ARI flood event. ***Small Bridges
Design Storm Event***
7. Where structures are designed to be inundated, the effect of the backwater gradient on upstream property shall be investigated and clearly shown on the design plans.
8. Bridges located in roadways which are to be dedicated as public roads shall be designed to convey the flood event identified in the Notification of Determination of Development Application. Where no inundation is permitted, appropriate afflux shall be adopted together with a 500mm freeboard to the underside of the bridge deck. ***Freeboard***
9. Designers shall consult with service authorities regarding current of likely provision for public utilities in bridges. Written advice from the service authorities shall be submitted with the Construction Certificate application. ***Public Utilities***

D3.05 PEDESTRIAN BRIDGES

1. Provision for pedestrians on bridges is required in rural residential and urban areas. The minimum provision is a 1.5m footpath with kerb at the road traffic edge and handrail for pedestrians and 2.5m width for shared pedestrian and cycleway. Pedestrian paths & cycleways shall be designed in accordance with Austroads – 'Guide to Traffic Engineering Practice Part 13 & 14, and the RMS NSW Bicycle Guidelines. ***Pedestrians***
2. Council may require the provision of separate pedestrian carriageways in other situations should the anticipated traffic warrant it. Urban bridge approaches shall be lit. Designers should consult with the service authorities regarding the current and future utility services which the bridge may be required to carry. These shall be concealed. Disabled access shall be considered and provided for in the design. ***Carriage of Utilities***
3. Council will not accept bridge designs from persons who are not qualified as a Chartered Professional Engineer and registered on NPER.

D3.06 STRUCTURES OTHER THAN BRIDGES, ASSOCIATED WITH ROADS

1. Public utility structures, retaining walls, and the like shall be designed by a Chartered Professional Engineer, competent in the design of such structures. The designer shall refer to any other Australian standards to execute the design. Retaining Walls, reinforced soil structures & Reinforced rock structures are to be designed in accordance with AS 4678 Earth Retaining Structures, Austroads and other relevant Australian Standards.
2. Retaining walls and reinforced soil walls have a design life of 100 years.

D3.07 SMALL EARTH DAMS/DETENTION BASINS

1. Small earth dams may be designed following the guidelines in "Design and Construction of Small Earth Dams" by K D Nelson together with relevant geotechnical recommendations. The structural design of weir outlets to resist failure shall be considered in design.
2. Childproof fencing shall be nominated where unacceptable risk exists due to the location of the dam/basin in relation to the urban nature of the area. This requirement shall be determined by Council. ***Fencing***
3. The consultant shall carry out the design with recognition of the potential risk on existing and planned infrastructure downstream, assuming the probability of dam/basin failure.

4. The consultant shall be a Chartered Professional Engineer having accreditation in the design of such structures. **Qualification**
5. The consultant shall be required to certify the design and ultimately certify the work-as-executed plans for compliance with the design. All relevant details shall be shown on the design plans.

D3.08 STRUCTURES USED FOR PUBLIC SAFETY

1. Since the requirement of traffic barriers and pedestrian safety rails on bridges are different, the design engineer shall consider whether separate traffic and pedestrian barriers can be detailed to satisfy the major functional requirements. **Barriers**
2. The AS 5100 Bridge Design is the recommended reference in this regard.
3. It is essential that all barriers have been fully tested and accredited for the intended use under quality assurance provisions.
4. Urban and rural residential bridge crossings shall be provided with adequate street lighting that conforms with the relevant Australian Standards. Such requirements will be noted accordingly on the design plans. **Lighting**

D3.09 TEMPORARY WORKS

1. Structures which are proposed for the temporary support of roads, services and the like shall be designed by a qualified Chartered Professional Engineer experienced and accredited in the design of such structures. A construction programme, indicating the sequence of events leading to the implementation and removal of the temporary structures shall be specified on the design plans. **Programme of Temporary Provisions**

D3.10 NOISE BARRIERS AND FENCING

1. The footings and structural members for noise barriers and fencing adjacent to public land shall be designed to withstand all forces generated by Wind Classification N3.
2. The design of noise barriers and fencing adjacent to public land shall be certified by a Chartered Professional Engineer. The design and certification must be submitted with the Construction Certificate application.

D3.11 DESIGN LIFE

Table 2. Design Life Requirements

Asset	Item	Design Life
Bridges	Piles	100 years
	Pile caps	100 years
	Headstocks	100 years
	Piers	100 years
	Abutments	100 years
	Deck	100 years
	Approach slabs	100 years
Drainage Structures	Drainage structures - accessible	50 years
	Drainage structures – inaccessible	100 years
	Box culvert (crown units and link slabs)	100 years
	Box culvert base slab	100 years
	Pipe	100 years
Fencing	Fencing and Gates	20
Roadscape	Signs - Posts	10
	- Sign Faces	10
	- Surface coating systems	20
	- Fixings and Brackets	40
Road Furniture	Guideposts:- wood, plastic, metal corner cube / other reflectors	8
	Safety Fencing:-corner cube / other reflectors	8
	Guard Rail-steel / timber posts, single / double sided	40
	Wire Barrier	40
	Guardrail Breakaway Terminals (BCT's)	40
	Other Guardrail Terminals	20
	Pedestrian Bollards – Bollards, Refuges	20
	Pedestrian Grab Rails	20

Retaining walls and reinforced soil walls have a design life of 100 years.

DEVELOPMENT DESIGN SPECIFICATION

D4

SUBSURFACE DRAINAGE DESIGN

AMENDMENT RECORD FOR THIS SPECIFICATION PART

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part. The clause numbering and context of each clause are preserved. New clauses are added towards the rear of the specification part as special requirements clauses. Project specific additional script is shown in the specification as italic font.

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Amendment Sequence No.	Key Topic addressed in amendment	Clause No.	Amendment Code	Author Initials	Amendment Date

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DEVELOPMENT DESIGN SPECIFICATION D4 SUBSURFACE DRAINAGE DESIGN

GENERAL

D4.01 SCOPE

1. The work to be executed under this Specification consists of the design of the subsurface drainage system for the road pavement and/or subgrade.
2. This specification contains procedures for the design of subsurface drainage, including:
 - (a) Subsoil and Foundation Drains
 - (b) Sub-Pavement Drains
 - (c) Drainage Mats, including Type A and Type B Mats

D4.02 OBJECTIVES

1. The objective in the design of the subsurface drainage system is to control moisture content fluctuations in the pavement and/or subgrade to within the limits assumed in the pavement design. *Control Moisture Content*

D4.03 TERMINOLOGY

1. Subsoil drains are intended for the drainage of ground water or seepage from the subgrade and/or the subbase in cuttings. *Subsoil Drains*
2. Foundation drains are designed to drain excessive ground water areas within the foundation of an embankment or the base of cutting, or to intercept water from entering these areas. *Foundation Drains*
3. Sub-pavement drains are intended for the drainage of the base and subbase pavement layers in flexible pavements. They may also function to drain seepage or groundwater from the subgrade. *Sub-pavement Drains*
4. Type A drainage mats are intended to ensure continuity of a sheet flow of water under fills, to collect seepage from a wet seepage area, or for protection of vegetation or habitat downstream of the road reserve where a fill would otherwise cut the flow of water. *Type A Drainage Mats*
5. Type B drainage mats are constructed to intercept water which would otherwise enter pavements by capillary action or by other means on fills and to intercept and control seepage water and springs in the floors of cuttings. *Type B Drainage Mats*

SUBSOIL AND SUB-PAVEMENT DRAINS

D4.04 APPLICATION

1. Subsoil or sub-pavement drains shall be provided on both sides of the formation in the following locations, unless otherwise justified by a geotechnical report: *Geotechnical Survey*
 - (a) Formations where the depth to finished subgrade level is equal to or greater than 400mm below the natural surface level. *Locations*
 - (b) Locations of known and/or potential hillside seepage, high water table or isolated springs.
 - (c) Irrigated, flood-prone or other poorly drained areas.
 - (d) Highly moisture susceptible subgrades, ie. commonly displaying high plasticity or low soaked CBRs.
 - (e) Use of moisture susceptible pavement materials.

- (f) Existing pavements with similar subgrade conditions displaying distress due to excess subsurface moisture.
- (g) At cut to fill transitions.

Where only one side of the formation is in cut, and the other side in fill, it may be sufficient to provide subsoil or sub-pavement drains only along the edge of the formation in cut.

2. The need for subsoil and sub-pavement drains may otherwise become apparent during the construction process, due to changes in site moisture conditions or to areas of poorer subgrade being uncovered that were not identified in the geotechnical investigation. The Design Drawings shall be suitably annotated to the effect that subsoil or sub-pavement drains in addition to those shown on the Drawings shall be installed where and as directed by Council.

During Construction

D4.05 LAYOUT, ALIGNMENT AND GRADE

1. Typical cross sections of subsoil and sub-pavement drains are shown below in Figure D4.1. As indicated, subsoil drain trenches are excavated to below subgrade level, while sub-pavement drains extend into or adjacent to the pavement layers to facilitate drainage of the pavement layers in addition to the subgrade.

Typical Cross Sections

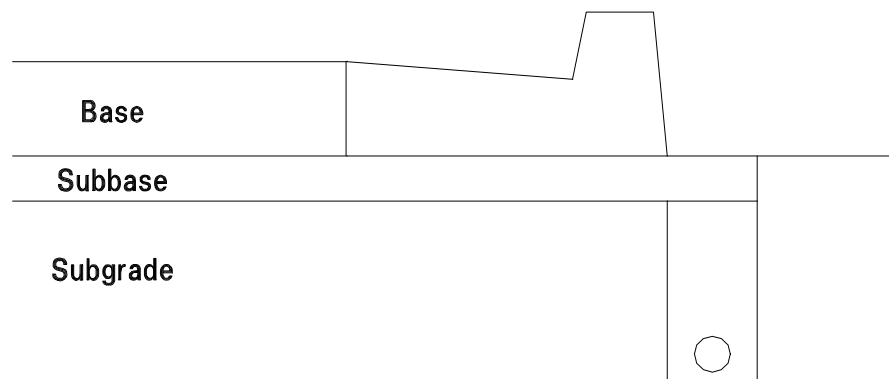


Figure D4.1 - Typical Subsoil Drain

2. In kerbed roads, the acceptable location for the trench is directly behind the rear of kerb as indicated in Figure D4.1. Pavement layers must extend to at least the line of the rear of the trench.
3. In unkerbed roads, subsoil and sub-pavement drains shall be located within the shoulder, preferably at the edge of the pavement layers.
4. The minimum longitudinal design grade shall be 0.5%.
5. Trench widths shall be a minimum of 300mm, with a minimum depth below finished subgrade level of 300mm in rock, 600mm in Other Than Rock and in all cases shall be below the invert level of any service crossings.
6. Outlets shall be spaced at maximum intervals of 80 metres. Where possible, subsoil and sub-pavement drainage pipes shall discharge into stormwater pits or other stormwater drainage structures.

Kerbed Roads

Unkerbed Roads

Grade

Trench Dimensions

Outlets

FOUNDATION DRAINS

D4.06 APPLICATION

1. The need to provide foundation drains may be apparent from the results of the geotechnical survey along the proposed road formation alignment, and in this case the location shall be

Geotechnical Survey During

shown on the plans. However, more commonly, the need to provide foundation drains is determined during construction, and hence in this situation requirements and locations cannot be ascertained at the design stage. **Construction**

- The Design Drawings shall be suitably annotated to the effect that foundation drains in addition to those shown on the Drawings shall be installed where and as directed by Council.

D4.07 LAYOUT, ALIGNMENT AND GRADE

- Typical cross-sections of foundation drains are shown below in Figure D4.3.

Typical Cross Section

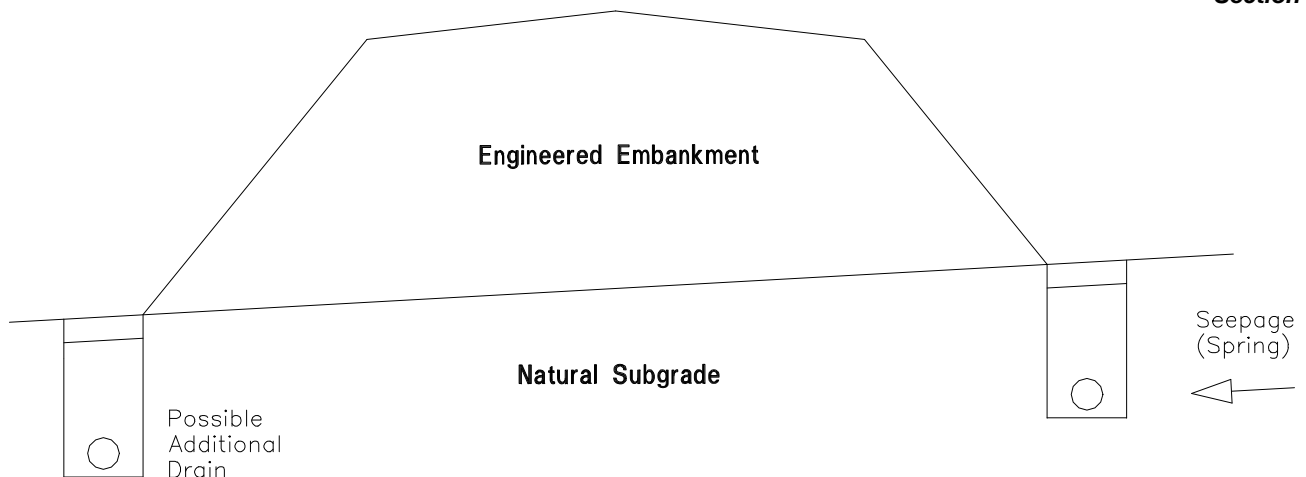


Figure D4.3 - Foundation Drains

- The minimum acceptable design grade shall be 0.5%. **Grade**
- Foundation drains shall be a minimum trench width of 300mm, with a variable trench depth to suit the application and ground conditions on site. **Trench Dimensions**
- Outlets shall be spaced at maximum intervals of 80 metres. **Outlets**

DRAINAGE MATS (BLANKETS)

D4.08 APPLICATION

- Type A drainage mats are required where there is a need to ensure continuity of a sheet flow of water under fills, to collect surface seepage from a wet seepage area, or for protection of vegetation or habitat downstream of the road reserve where a fill would otherwise cut the flow of water. Type A drainage mats are constructed after the site has been cleared and grubbed and before commencement of embankment construction. **Type A Mats**
- Type B drainage mats are required where there is a need to intercept water which would otherwise enter pavements by capillary action or by other means on fills and to intercept and control seepage water and springs in the floors of cuttings. Type B drainage mats shall be constructed after completion of the subgrade construction and before construction of the pavement. **Type B Mats**
- The need to design for the provision of drainage mats should be apparent from the result of the geotechnical survey along the proposed road formation alignment. **Geotechnical Survey**

MATERIALS

D4.09 SUBSOIL AND SUB-PAVEMENT DRAIN PIPE

1. Pipes designated for subsoil, foundation and sub-pavement drains shall be minimum 100mm dia. slotted pipe.
2. Corrugated plastic pipe shall be Class 1000 conforming with the requirements of AS2439.1. Joints, couplings, elbows, tees and caps shall also comply with AS2439.1..
3. Slotted rigid UPVC pipe shall be of a type and class approved by Council.
4. All pipe shall be slotted, and fitted with seamless tubular filter fabric complying with MR Form 1160. Outlets through fill batters shall be unslotted pipe.

D4.10 INTRA PAVEMENT DRAIN PIPE

1. Pipes for use in Type B Drainage Mats shall be designated 100mm diameter slotted fibre reinforced cement pipe, (designated type 100 DMR pipe) meeting the requirements of RTA Specification 3555. These pipes shall be designated for:
 - intra pavement drains where crushed rock subbase layer thicknesses are greater than 200mm,
 - for edge drains where any part of the shoulder consists of material other than concrete, and
 - for use in Type B Drainage Mats.

D4.11 FILTER MATERIAL

1. Reserved
2. Material requirements and gradings for the filter material are included in the Construction Specification, SUBSURFACE DRAINAGE GENERAL.
3. The type of filter material specified to backfill the sub-surface drainage trenches (subsoil, foundation and sub-pavement drains) may depend on the permeability of the pavement layers and/or subgrade and the expected flow rate. Guidance to the selection of appropriate filter material is contained in ARRB Special Report 35.

D4.12 GEOTEXTILE

1. Where necessary to provide separation (ie. prevent infiltration of fines) between the filter material in the trench and the subgrade or pavement material, geotextile shall be specified to encapsulate the filter material. The geotextile shall comply with the requirements included in the Construction Specification, SUBSURFACE DRAINAGE GENERAL.
2. Geotextile shall also be specified for both Type A and Type B Drainage Mats.

DEVELOPMENT DESIGN SPECIFICATION

D5

STORMWATER DRAINAGE DESIGN

Refer to the following documents (or any subsequent amendments):

- Wollongong Development Control Plan 2009 – Chapter E13 – Floodplain Management
- Wollongong Development Control Plan 2009 - Chapter E14 – Stormwater Management
- NSW Government – Floodplain Development Manual , April 2005

AMENDMENT RECORD FOR THIS SPECIFICATION PART

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Amendment Sequence No.	Key Topic addressed in amendment	Clause No.	Amendment Code	Author Initials	Amendment Date
1	<i>Revision of OSD Policy</i>		M	MB	21/01/08
1	<i>Inclusion of DCP 54</i>		A	MB	21/01/08

DEVELOPMENT DESIGN SPECIFICATION

D6

SITE REGRADING

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DEVELOPMENT DESIGN SPECIFICATION D6 - SITE REGRADING

GENERAL

D6.01 SCOPE

1. This design specification sets out requirements for the site regrading involved in land development and subdivision. Conceptual requirements are presented as necessary considerations when preparing designs for site regrading.
2. The scope of this specification assumes that the Designer is familiar with requirements cited in the various construction specifications, specifically those related to earthworks, clearing and grubbing, erosion and sedimentation. Additionally the Designer needs to make reference to the associated design specifications related to drainage design, geometric road design and stormwater management and erosion design. *Familiarity with other Specifications Required*

D6.02 OBJECTIVES

1. This specification aims to assist the Designer in achieving:
 - enhancement of the environmental character of the site whilst maintaining the natural features of the site *Environmentally Sound*
 - a minimal impact on adjoining properties and developments. *Impact on Adjoining Properties*

D6.03 SITE REGRADING CONCEPT

1. Subject to geotechnical, environmental and other constraints (such as but not limited to watercourses, remnant vegetation, heritage items, retention of flood storage) the Designer shall review the natural surface contours and where necessary shall design finished surface levels that ensure the land is suitably contoured to provide lots or building envelopes which are above the flood planning level in accordance with Council's DCPs.
2. Site regrading shall not create localised or trapped low points and shall ensure that surface water flows naturally to roads or drainage reserves without concentration of flow which may cause hazardous situations or scour. *Drainage*
3. The Designer shall consider the implications of site regrading in relation to the existing natural environment. Generally site regrading shall not be permitted in heavily treed areas or in floodplains. *Natural Environment*
4. Care shall be taken to provide overland flow routes from low points and over major drainage lines, to direct runoff for floods up to a 100 year average recurrence interval (ARI). *Overland Flow*
5. The design of site regrading areas in conjunction with the design of roadworks shall be considered with the objective of balancing cut to fill and achieving both an economical development and minimising haulage of imported fill or spoil to and from the development site. *Minimal Road Haulage*

D6.04 SPECIAL TREATMENT OF PARTICULAR AREAS

1. The extent of the 100 year ARI flood inundation line shall be clearly shown on the design plans. *Flooding*
2. Proposals to alter surface levels in an area affected by flooding or subject to inundation shall be supported by a detailed flood study which shall be lodged with the Development Application. *Inundation Areas*

3. Site constraints may be required to be identified as a burden on developed property. It is recommended that the designer take this into account when preparing the design. The property may ultimately be affected by a "restriction as to user", which may be controlled by a legal 88B Instrument placed on title to the land and/or by a Section 149 message advising prospective purchasers of any restrictions affecting the land. ***Restrictions on Land Use***
4. The finished surface of filled areas shall be designed to levels allowing an adequate cover depth over pipelines and permitting surface stormwater flow to be guided to inlet pits. ***Piped Gullies or Depressions***
5. The location of natural and artificial features shall be clearly defined on the site regrading plans and defined by distance to corner boundaries, monuments, etc for purposes of relocation at the geotechnical testing stage for work as executed plans. A geotechnical report specifying the site preparation and compaction requirements shall be part of the site regrading plan. Any proposal for fill shall be supported by a geotechnical report justifying the type of material and physical and chemical characteristics including an assessment of the environmental impact.
6. The finished level of any building area shall be designed to ensure a desirable surface grading is 1%, with a absolute minimum of grade 0.5% in the direction of the drainage system designed to cater for its catchment. ***Flat Ground***
7. For building areas on slopes greater than 15% refer to Council's DCP. For developments not covered by the provisions of a DCP, Council should be consulted. ***Steep Slopes***

D6.05 TEMPORARY DIVERSION DRAINS

1. Temporary drains shall be installed to divert surface flows away from the site regrading area. The location and silt/erosion control treatment shall be clearly identified on the engineering plans. ***Erosion***
The objective will be to ensure minimal soil disturbances and material loss off the site.

DEVELOPMENT DESIGN SPECIFICATION

D7

SOIL AND WATER MANAGEMENT

Refer to the following document (or any subsequent amendment):

- Managing Urban Stormwater - Soils & Construction – Volume 1 - 4th Edition
March 2004

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1	<i>Standard modified to reflect 4th Edition</i>		M	MB	21/01/08

DEVELOPMENT DESIGN SPECIFICATION

D9

CYCLEWAY AND PATHWAY DESIGN

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DEVELOPMENT DESIGN SPECIFICATION D9 CYCLEWAY AND PATHWAY DESIGN

GENERAL

D9.01 SCOPE

1. This specification sets out requirements to be used in the design of various types of cycleways and pathways and shared use pathways.
2. All relevant design principles contained in the Austroads Guide referenced below must be integrated in the design of cycleways and associated infrastructure. This specification serves as a companion document to the Austroads Guide extended to incorporate basic requirements for pathways. **AUSTROADS**

D9.02 OBJECTIVES

1. This specification aims to set standards and document requirements related to the provision of cycleways and pathways which encourage pedestrian activities and cycling for transportation and recreational purposes. Cycleways and pathways are to be safe and convenient and shall maintain a satisfactory level of service for all pathway users. **Safety Level of Service**

D9.03 CONSULTATION

1. The Designer is encouraged to consult with Council, the Developer's Landscape Architects/Designers and relevant authorities prior to and during the preparation of cycleway and pathway and shared use pathway design. **Landscape Designers Public Authorities**

D9.04 PLANNING CONCEPTS

1. Council will provide specific requirements for cycleways and pathways in Council's Subdivision Policy and DCP's as well as in a regional or local strategic bicycle plan. The Designer will need to enquire about such documents and comply with requirements defined. **Subdivision Policy and Bicycle Plan**
2. The Designer should be familiar with cycleway geometric design requirements in terms of: **Geometric Design**
 - width
 - grade
 - stopping sight distance
 - change in grade
 - horizontal curvature
 - crossfall and drainage
 - superelevation
 - sight distance on horizontal curves

These requirements are discussed in the AUSTROADS Guide.

AUSTROADS Guide

D9.05 CYCLEWAY AND PATHWAY TYPES

1. Cycleways can be provided on road and off road. The Austroads Guide provides detailed descriptions, warrants, widths, pavement marking etc for the majority of these cycleways. **On Road Off Road**
2. Common alternative cycleway types include:

On Road

Shared Parking/Bicycle Lanes
 Wide Kerbside Lanes
 Shared Traffic Lanes
 Exclusive Bicycle Lane
 Sealed Shoulder

Off Road

Shared Bicycle/Pedestrian Pathway
 Segregated Pathway
 Exclusive Cycleway

The AUSTROADS Guide provides advice on the suitability of pavement conditions; drainage pit grates etc for on road cycleways. **AUSTROADS Guide**

3. Common pathway types include:
 Exclusive Pedestrian Pathways
 Shared Bicycle/Pedestrian Pathways

By definition pedestrian pathways are "off road" in that pedestrian facilities routinely designed adjacent to **roadways** are termed footpaths and are designed to meet criteria outlined in Council's Subdivision Policy and typically related to road cross section detailing. **Footpaths**

4. Pathways by comparison diverge from the road alignment either within the road reserve or across **land reserves**. Pathways can be provided in conjunction with overland floodways or retention basins. **Land Reserves**

D9.06 PROVISIONS FOR CYCLEWAYS AND PATHWAYS AT STRUCTURES

1. Designers shall consider the best way to cater for the uninterrupted movement of cyclists and pedestrians at proposed and existing structures wherever possible. Structures include bridges and underpasses over rivers, roads or railways. The Austroads Guide provides information on: **Bridges Underpasses**
 - acceptable widths and clearances
 - types of cycleways and pathways
 - handrails
 - bicycle bridges
 - approach ramps
 - etc

D9.07 SIGNAGE AND PAVEMENT MARKING

1. The Designer shall provide adequate signposting design for cycleways and pathways.
2. Signs and pavement marking will provide for the safe and convenient use of the facility. The signs and pavement marking will comply with AS 1742. **Signs Pavement Marking**

D9.08 END OF JOURNEY FACILITIES

1. Consideration must be given to the design of adequate facilities at common destinations of bicyclists and pedestrians so as to encourage cycleway and pathway usage.
2. Such facilities could include: **Facilities**

- seats
- standby areas
- secure bicycle parking
- picnic facilities

3. Bicycle parking installation design should meet appropriate criteria discussed in the Austroads *Parking* Guide and be fabricated to meet AS 2890-3.

D9.09 MINIMUM DESIGN STANDARDS

1. Notwithstanding the guidelines provided in this specification and referenced documents the following minimum standards have been determined as shown in Table D9.1. Where a disabled access path is being provided, the cross fall should comply with AS 1428 Design for Access and Mobility.

Table D9.1

	Cycleway	Pathway	Shared Use Pathway	Remarks
Path Width	2.0	1.2m	2.5m	
Formation Width	3.0m	2.0m	3.5m*	Width to be 4.0m through a Major Recreational Park
Crossfall min. max.	2.5 % 5 %	2.5 % 5 %	2.5 % 5 %	
Clearance Horiz.	2.5m	1.2m	2.5m	
Thickness	100 mm reinforced	100 mm reinforced	100 mm reinforced	SL72 mesh at vehicle crossing points or designated vehicle access
Joint Spacing	6.0m	3.6 m	6.0 m	'Conolly Key Joint' or equivalent
Concrete Grade	25 MPa	25 MPa	25 MPa	

DEVELOPMENT DESIGN SPECIFICATION

D13

LANDSCAPING

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1	<i>Landscape standard updated</i>		M	MB	21/01/08

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13.01 CONSULTATION

The Developer is encouraged to consult with Council prior to the preparation of landscape design plans.

13.02 PLANNING CONCEPTS

Council provides specific requirements for Landscaping in Council's Development Control Plan B2 and E6. The Developer will need to comply with the requirements defined in these documents

13.03 STREET TREES

The developer must address the street frontage by installing street tree planting and protective bollards. The street trees shall be 100 litre pot 2.5 m minimum height, 1.2m wide and 40mm minimum calliper. Trees are to be installed in accordance with Wollongong Development Control Plan 2009 – Chapter E6: Landscaping.

Location of street tree plantings to be sited to ensure no conflict occurs with street light poles.

Bollards to consist of minimum two (2 No.) 1800mm x 90 x 90mm ACQ treated/ hardwood posts with weathered top, decorative rebate and set min one third into firm ground (or approved similar) . Brick edging to consist of 110mm wide paver on 150mm thick reinforced concrete footing (or approved similar).

Tree pits must be provided with a root barrier to protect the kerb and footpath. The nature, extent and depth of the root barrier shall be determined on site by a qualified arborist in consideration of the on-site conditions and tree species. Tree pits must be adequately mulched, plants installed and bollards/edging installed to the satisfaction of WCC Manager of Works. These requirements shall be reflected on the Subdivision Certificate plans and any supporting documentation

13.04 PLAYGROUNDS

Developers are to consult with the Council prior to and during the design and specification of playgrounds and associated equipment. The design of these spaces must consider the relevant Australia Standards for playgrounds.

DEVELOPMENT CONSTRUCTION SPECIFICATION

C101

GENERAL

AMENDMENT RECORD FOR THIS SPECIFICATION PART

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SPECIFICATION C101: DEVELOPMENT CONSTRUCTION - GENERAL

GENERAL REQUIREMENTS

C101.01 CONFLICT BETWEEN APPROVED DRAWINGS AND SPECIFICATIONS

1. Where conflict or inconsistency arises between the Approved Plans, Standard Drawings and/or the Specification, the Contractor shall notify the Principal Certifying Authority and consult the Principal Certifier for a determination.

C101.04 DRAWINGS

1. A set of approved plans as issued with the Construction Certificate shall be kept on site at all times during the work.
2. A copy of the Notification Determination of Development Application (Development Consent) shall be kept on site at all times during the work.
3. A current set of WCC standard drawings shall be kept on site at all times. Unless otherwise approved by the Principal Certifying Authority the following Department of Housing Standard Drawings shall apply to the works:
 - a. RM 01 - Standard Kerb and Gutter
 - b. RM 07 - Standard Grated Gully Pit to Concrete Accessway
 - c. RM 10 - Standard Grated Kerb Inlet Pit
 - d. RM 11 - Standard Surcharge Pit
 - e. RM 15 - Standard Concrete Headwall (300 to 900 dia)
 - f. RM 16 - Standard Concrete Headwall (1050 to 1350 dia)
 - g. RM 17 - Standard Concrete Headwall (1500 to 1800 dia)

C101.05 STANDARDS AND TEST METHODS

1. Unless otherwise specified, materials and workmanship shall be in accordance with the relevant standard of the Standards Association of Australia. **Australian Standards**
2. The AS standards applicable to the Works shall be the edition current as at 14 days prior to the commencement of work.
3. Overseas standards and other standard documents named in the Specification shall be applicable in the same manner as Australian Standards to relevant materials and workmanship. **Overseas Standards**
4. Copies of any standards quoted or referred to in the Specification shall be kept on the site if so specified. **Copies to be kept on Site**
5. Where no suitable AS test methods are available, those of the relevant RMS testing shall be used. **Other Test Methods**

C101.06 TESTING AND SURVEY

1. The minimum frequency of testing and survey shall be in accordance with either the Specification for QUALITY CONTROL REQUIREMENTS. **Minimum Frequency**

C101.07 WORKING AREAS

1. If existing fencing is cut or altered by the Contractor, the Contractor shall provide and maintain temporary fencing to the satisfaction of the Principal Certifying Authority during the Contract to **Temporary Fencing**

prevent unauthorised entry into the property, and shall reinstate the fencing and remove temporary fencing on completion of the work.

C101.08 SMOOTH JUNCTIONS

1. Construction shall make smooth junctions with the existing work.

C101.10 SITE MEETINGS

1. Regular site meetings will be held for the purpose of discussion of the progress and co-ordination of the work and any matters of doubt regarding the intent or interpretation of the Drawings or the Specification. The Contractor shall arrange for relevant sub-contractors or their responsible representatives to be present at these meetings. The meetings will be held at a time agreed by the Principal Certifying Authority and the Contractor. **Representation**
2. The Contractor shall give the Principal Certifying Authority 48 hours' notice of the date, time and location of the meetings. **Advice to Council**
3. The Developer or the Developer's Representative shall chair site meetings, keep minutes of the proceedings and shall provide copies of the minutes for the Contractor, all present at the meeting and others concerned with the matters discussed. **Responsibility for Minutes**
4. No action shall be taken as a result of a meeting until the minutes have been accepted in writing as a true record of the meeting by the Principal Certifying Authority.

C101.11 WORK-AS-EXECUTED DRAWINGS

1. Certified Work-as-Executed Drawings for the work shall be submitted to the Principal Certifying Authority prior to release of the Subdivision Certificate. The Work-as-Executed Drawings shall comply with the Notification of Determination of Development Application (Development Consent). **Submission**
2. Work-as-Executed Drawings shall show in red ink all changes to the Approved Drawings and actual values of all levels shown on the Drawings. The Drawings shall be signed by a Registered Surveyor and certified by the Designer that the work as completed, including variations and meet the design intent. **Certification**

ENVIRONMENTAL REQUIREMENTS

C101.14 PROTECTION OF THE ENVIRONMENT

1. All work shall be carried out in such a manner as to avoid nuisance and/or damage to the environment. The Contractor shall comply with the requirements of the conditions of the Notification of Determination of Development Application (Development Consent), the Approved Soil & Water Management Plan, Protection Of The Environment Operations (POEO) Act and all other relevant Acts. **Conformance to Acts**
2. The Contractor shall plan and carry out the Works to avoid erosion, contamination and sedimentation of the site and its surroundings. **Erosion Control**
3. Herbicides and other toxic chemicals shall not be used on the site without the prior written approval of the Principal Certifying Authority. **Herbicides and Toxic Chemicals**
4. No noise or smoke or other nuisance, which in the opinion of the Principal Certifying Authority is unnecessary or excessive shall be permitted by the Contractor in the performance of the Works. Should work outside customary working hours be approved, the Contractor shall not use, during such period, any plant, machinery or equipment which in the opinion of the Principal Certifying Authority is causing or is likely to cause a nuisance to the public. No noisy works **Noise, Smoke or Other Nuisances**

and/or works likely to disturb nearby residents shall be undertaken during the hours precluding such activity as specified by Council in accordance with the requirements for development consent and building approval made under the Local Government Act and the POEO Act.

5. The Contractor shall ensure that dust from the site is minimised by a method approved by the Principal Certifying Authority. **Dust Control**

C101.16 BLASTING

1. Blasting will not be permitted.

C101.17 LIMITS ON NOISE

1. The Contractor shall only use plant that have effective residential class silencers fitted to all engine exhaust, have engine covers fitted, are maintained in good order, and in addition meet the following requirements. **Plant with Silencers**
 - (a) On purchase have met the NAASRA Specification for Noise levels of plant and equipment, or
 - (b) Have a Maximum Noise level (L_{AMAX}) less than 80 dB(A) when measured at a distance of 7 metres.
2. Operational hours of plant or other noise generating equipment shall be restricted to between the prescribed working hours nominated in the development consent. Work outside of the hours specified shall not be undertaken without the prior approval of the Principal Certifying Authority. **Working Hours**
3. Notwithstanding noise emission limits on plant, noise emanating from the construction site when measured at any noise sensitive location (such as a residential premise), as determined by the Environment Protection Authority shall not exceed an L10 sound pressure level (noise level exceeded for 10% of the sample time) the greater of: **Maximum Noise Levels**
 - (a) Short term (period of up to 1 month) 65dBA or 20dBA above ambient
 - (b) Medium term (period of 1 month up to 6 months) 55dBA or 10dBA above ambient
 - (c) Long term (any period of more than 6 months) 50dBA or 5dBA above ambient
4. The monitoring positions and time period for monitoring purposes shall be set by the EPA with the time period generally based on a series of 10 to 15 minute measurements which shall be averaged over the entire daily working period for the activity concerned. **Monitoring**

C101.18 LIMITS ON GROUND VIBRATION

1. It is the intent of this Specification that ground vibration levels, transmitted from operating items of plant in the vicinity of residential premises shall not exceed levels that are close to the lower level of human perception inside the premise nor will cause structural damage to the building. **Levels**
2. Vibration (RMS Z-Axis) generated by construction works shall not exceed **Limits**

Curve 4 - for the period of 1 month or less

Curve 2 - for the period of more than 1 month

as defined in British Standard BS6472 "Evaluation of Human Exposure to Vibration in Buildings (1 HZ to 80 HZ)" when measured inside nearby residential premises.
3. Ground vibrations generated by construction works shall not exceed a peak particle velocity (V_R max) limit of 5 mm/sec when measured within one metre of any residential premise. **Peak Particle Velocity**

DEVELOPMENT CONSTRUCTION SPECIFICATION

C201

CONTROL OF TRAFFIC

AMENDMENT RECORD FOR THIS SPECIFICATION PART

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SPECIFICATION C201: CONTROL OF TRAFFIC

GENERAL

C201.01 SCOPE

1. The work to be executed under this Specification consists of all work necessary to provide for the safe movement of traffic and the protection of persons and property through and/or around the work site. **This traffic control specification may be superseded by a Traffic Control Code of Practice issued by WorkCover.**
2. The extent of work includes the design, construction, maintenance and removal of temporary roadways and detours, the provision of traffic controllers, signposting, road markings, raised pavement markers, lights, barriers and any other items required. **Works Included**
3. Control of traffic shall be in accordance with AS 1742.3, SAA HB81, this Specification, and the Drawings. **Standards**
4. Wherever the word 'should' occurs in AS 1742.3 the word 'shall' applies and the required action is the Contractor's responsibility. **Contractor's Responsibility**

C201.02 REFERENCE DOCUMENTS

1. Documents referenced in this specification are listed in full below whilst being cited in the text in the abbreviated form or code indicated. **Documents Standards Test Methods**

(a) Australian Standards

AS 1165	-	Traffic Hazard Warning Lamps
AS 1742.3	-	Traffic Control Devices for Works on Roads
AS 1743	-	Road Signs Specifications
AS 1744	-	Standard Alphabets for Road Signs
AS 1906	-	Retroreflective Materials & Devices for Road Traffic Control Purposes
SAA HB81	-	Field Guide for Traffic Control at Works on Roads

(b) AUSTROADS Publications

AUSTROADS	-	Guide to Traffic Engineering Practice - Intersections at Grade
AUSTROADS	-	Guide to the Geometric Design of Rural Roads

C201.03 TRAFFIC CONTROL PLAN

1. The Contractor shall construct the work with the least possible obstruction to traffic. **Minimise Obstruction**
2. The Contractor shall obtain all necessary approvals from Councils and other Authorities for temporary traffic arrangements except where specified otherwise. **Contractor's Responsibility**
3. The Traffic Control Plan shall include:- **Control Plan Contents**
 - (a) design drawings for any temporary roadways and detours in accordance with Clause C201.11 showing pavement, wearing surface and drainage details,
 - (b) details of arrangements for construction under traffic in accordance with SAA HB81, and
 - (c) a signpost layout plan showing:
 - (i) location, size and legend of all temporary signs
 - (ii) temporary regulatory signs and temporary speed zones, and
 - (iii) all traffic control devices such as temporary traffic signals, linemarking, pavement reflectors, guideposts, guardfence and barrier boards.

5. Where the Traffic Control Plan involves a temporary road closure, involves the use of Regulatory Traffic Control Signs or Devices and/or where in the opinion of the Council the disruption to local traffic is significant, the Contractor shall obtain the prior approval of the Local Traffic Committee. In such cases the period of notice shall be six weeks in accordance with Clause C201.24. **Notice**
6. Where the Traffic Control Plan is for works on State or Regional roads the Contractor shall obtain the prior approval of the Local Traffic Committee. In such cases the period of notice shall be six weeks in accordance with Clause C201.24.
7. The Traffic Control Plan shall be in accordance with the requirements of this specification and the Drawings.
8. Special consideration to the safety of pedestrians and workers shall be given in the preparation of the Traffic Control Plan. Particular care shall be taken when requiring reversal of traffic flows or the separation of unidirectional flow by medians or other physical separation. **Safety**

C201.04 SIDE ROADS AND PROPERTY ACCESSES

1. At all times, the Contractor shall provide safe and convenient passage for vehicles, pedestrians and stock to and from side roads and property accesses connecting to the roadway. Work which affects the use of side roads and existing accesses shall not be undertaken without providing adequate alternative provisions to the prior satisfaction of the Superintendent. **Access**

C201.05 TRAFFIC CONTROLLERS

1. The Contractor shall advise the Principal Certifying Authority of the names of proposed traffic controllers with a signed declaration that they are appropriately trained in the duties of traffic controllers in accordance with AS 1742.3 and SAA HB81. **Trained Traffic Controllers**

C201.06 APPROVED CLOTHING FOR WORK PERSONNEL

1. All personnel working in close proximity to traffic shall wear high visibility clothing to the requirements of AS 1742.3. **Safety Clothing**

C201.07 TEMPORARY SPEED ZONING

1. Where a temporary speed limit has been approved by the Local Traffic Committee or Road Authority, the Contractor shall arrange for the supply of appropriate temporary speed zoning signs, including posts and fittings, for erection. Where and when directed by the Principal Certifying Authority, the Contractor shall erect these signs, cover the signs when the speed zone is not in use and remove the signs when the speed zone is no longer required as part of the provision for traffic. A diary recording operation times of the speed zone shall be kept by the Contractor. **Speed Zone Signs**

C201.08 PLANT AND EQUIPMENT

1. During the day plant and equipment working in a position adjacent to traffic and having a projection beyond the normal width of the item, for example, a grader blade, shall have a fluorescent red flag attached to the outer end of the projection. During poor light conditions or at night, an additional traffic controller with an illuminated red wand shall direct traffic around such plant and equipment. **Plant Delineation**
2. At night, where traffic is permitted to use the whole or portion of the existing road, all plant items and similar obstructions shall be removed from the normal path of vehicles to provide a lateral clearance of at least 6 m where practicable, with a minimum clearance of 1.2 m. **Night Time Clearance**

3. Plant and equipment, within 6 m of the normal path of vehicles, shall be lit by not less than two yellow steady lamps suspended vertically from the point of the obstruction nearest to a traffic lane and one yellow steady lamp at each end of the obstruction on the side furthest away from the traffic lane. *Warning Lamps*

TEMPORARY ROADWAYS AND DETOURS

C201.09 APPROVAL

1. The Contractor shall submit for the Principal Certifying Authority's approval the design of all proposed temporary roadways and detours. *Temporary Roads*

C201.10 DESIGN STANDARDS

1. The standard of alignment and grading adopted shall be in accordance with specific provisions of this Specification and shall otherwise be in accordance with the AUSTROADS publication 'Guide to the Geometric Design of Rural Roads'. *Alignment & Grading*
2. Intersections shall be designed in accordance with the AUSTROADS publication 'Guide to Traffic Engineering Practice - Intersections at Grade'. *Intersections*
3. Design drawings, geometric standards, design speed, wearing surface type and pavement design of the proposed temporary roadways and detours shall be submitted by the Contractor with the Traffic Control Plan. *Standards & Pavement*

C201.11 DESIGN DRAWINGS

1. Design drawings submitted for approval shall show:
 - (a) Alignment and grading at a horizontal scale of 1:2000 for rural roads and 1:500 for urban roads. Where the temporary road rejoins the existing road, levels showing the full cross section shall be extended along the existing road for a minimum length of 200 m. *Contents*
 - (b) A sight distance diagram if opposing traffic is to use a single carriageway
 - (c) Intersections, and any other locations where traffic may be required to make turning, merging or diverging movements, at a scale of 1:500.
 - (d) Pavement marking details.
 - (e) Sufficient cross-sections to indicate the feasibility of making connections between various parts of the work.
 - (f) Sufficient dimensions, especially lane widths, to make clear the geometry and clearances of the proposed Works.
 - (g) A north point or some other location method to orientate the plan.

C201.12 DRAINAGE

1. Drainage structures and drains shall be constructed in accordance with the following Specifications: *Standard*

C220	-	Stormwater Drainage - General
C221	-	Pipe Drainage
C223	-	Drainage Structures
C224	-	Open Drains, including Kerb and Gutter
2. Drainage proposed in accordance with Clause C201.03 shall be able to cope with upstream rainfall run-off resulting from all rainfall intensities up to that expected for a once in five year frequency, without overflow over the road. *Design Frequency*

3. Pavements shall be designed and constructed to not pond water on the wearing surface or shoulders. Temporary formations to be constructed shall not dam water. *Pavement Drainage*

C201.13 CONSTRUCTION OF EARTHWORKS AND PAVEMENT

1. Temporary roadways shall be constructed in accordance with the following Specifications: *Temporary Roadways*
- | | | |
|------|---|-----------------------|
| C212 | - | Clearing And Grubbing |
| C213 | - | Earthworks |
| C242 | - | Flexible Pavements |

C201.14 SURFACING

1. The wearing surface width shall extend across the full width of the traffic lanes plus the width for each shoulder, or as shown on the Drawings. *Wearing Surface*
2. The wearing surface shall be carried onto any existing connecting roadway so as to finish square to the existing roadway centreline. *Tie into existing work*
3. Surfacing shall be constructed in accordance with: *Standards*
- | | | |
|------|---|-------------------------------------|
| C244 | - | Sprayed Bituminous Surfacing and/or |
| C245 | - | Asphaltic Concrete |

C201.15 GUARDFENCE

1. Corrugated steel guardfence shall be erected on all temporary embankments where the vertical height between the edge of the shoulder and the intersection of the embankment slope and natural surface exceeds 2m and as otherwise shown on the drawings. *Warrant*
2. Guardfence shall be erected in accordance with: *Erection*
- | | | |
|------|---|------------|
| C264 | - | Guardfence |
|------|---|------------|

C201.16 OPENING TO TRAFFIC

1. Temporary roadways and detours (including portable or temporary traffic signals sites) shall not be open to traffic until they have been inspected, approved and authorised in writing by the Principal Certifying Authority. *Approval to use*
2. All signposting, pavement marking, guardfence and portable or temporary traffic signals shall be completed before the opening of temporary roadways to traffic. *Signposting*
3. Unless otherwise approved by the Principal Certifying Authority, the opening of temporary roadways shall be arranged so that sections of existing roadway being replaced are not disturbed for a minimum of forty-eight hours in the event of temporary roadway failure and there is a warrant to redirect traffic back onto the existing roadway. The determination to redirect traffic shall be by the Principal Certifying Authority. *Existing Roadway Retained*
4. The costs associated with the redirection of traffic back onto the existing roadway shall be borne by the Contractor. *Contractor's Cost*
5. Unless otherwise approved by the Principal Certifying Authority, traffic shall be switched to a temporary roadway or detour only where the Contractor's usual workforce will be on site for a minimum of two days thereafter. *Traffic Switch*

C201.17 MAINTENANCE

1. The Contractor shall be responsible for the maintenance of temporary roadways and detours *Contractor's Responsibility*

and shall ensure the road surface is kept safe for traffic. Any potholes or other failures shall be repaired without delay.

C201.18 REMOVAL

1. Upon completion of the Work the temporary roadways and/or detour arrangements shall be removed and the area restored to a condition equivalent to that which existed prior to the commencement of the work or restored to a design that was directed at the time of the Road Opening (RO) approval. *Restoration*

ARRANGEMENTS FOR TRAFFIC

C201.19 CONSTRUCTION UNDER TRAFFIC

1. Where a temporary roadway or a detour is not provided or available then, subject to the approval of the Principal Certifying Authority, construction under traffic may be permitted provided a minimum of 3.5 m lane width is available for through traffic on a two lane roadway and where 3.5 m lanes are available in both directions for through traffic when working on multilane roads. *Lane Width*
2. The carriageway/s shall be restored to a safe and trafficable state for through traffic prior to cessation of work each day in accordance with the approved Traffic Control Plan. *Carriageway Restoration*
3. Full details of temporary signposting, traffic control devices and traffic control methods, in accordance with the appropriate arrangement diagrams in SAA HB81, are to be submitted for the Principal Certifying Authority's approval at least ten working days before undertaking any work which would involve construction under traffic. *Signs and Markings*

C201.20 OPENING COMPLETED WORK

1. The contractor shall give the Principal Certifying Authority notice that the completed work is intended to be open to traffic. An inspection is to be arranged and all work is to be to the satisfaction of the PCA prior to the road being opened to traffic. *Written Notice*
2. The Contractor shall be responsible for the removal of all temporary traffic control devices no longer required for the safety of traffic, when the Works or part thereof are opened to traffic. *Contractor's Responsibility*

TRAFFIC CONTROL DEVICES

C201.21 ARRANGEMENT OF TRAFFIC CONTROL DEVICES

1. The arrangement and placement of traffic control devices shall be carried out in accordance with the approved Traffic Control Plan, AS 1742.3 and SAA HB81. The arrangement diagrams illustrate the more common examples of the arrangement of traffic control devices and set out the minimum requirements. *Arrangement Diagrams*
2. All temporary traffic control devices when no longer required shall be covered and/or removed without delay in order to maintain unambiguous safe guidance to traffic. *Unnecessary Signs*

C201.22 MAINTENANCE OF TRAFFIC CONTROL DEVICES

1. All traffic control devices shall be maintained by the Contractor in accordance with AS 1742.3 so that they are in good order and in the correct positions day and night. They shall be neat and clean, and signs shall be clear and legible at all times. *Contractor's Responsibility*
2. The Contractor may need to be contacted outside normal working hours to arrange for *Out of Hours*

adjustments or maintenance of traffic control devices. The Contractor shall notify the Principal Certifying Authority and the local Police, in writing, the names, addresses, and means of communicating with personnel nominated for this purpose. **Contact**

C201.24 REGULATORY TRAFFIC CONTROL SIGNS AND DEVICES

1. A Regulatory Traffic Control Sign or Device shall be in accordance with AS 1742.3, and shall require approval by the Local Traffic Committee before its erection. This approval should be obtained through the Principal Certifying Authority, refer to Clause C201.07. **Prior Approval**

C201.25 SIGNS

1. Signs shall be designed and manufactured in accordance with AS 1743. Details of each letter shall be as shown in AS 1744. **Specifications**
2. The reflective material used on signs shall be Class 2 material complying with AS 1906.1 except where otherwise specified. **Reflective Material**

C201.26 SUPPLEMENTARY SIGNS

1. Signs supplementary to AS 1742.3 are shown in Annexure C201A. These signs may be used in lieu of or in addition to those shown in AS 1742.3.

(a) Heavy Machinery Crossing

This temporary sign, shown as Sign SW5-22, shall be used in lieu of W5-22, trucks entering.

(b) Cycle Hazard Grooved Road

This temporary sign, shown as Sign ST1-10, shall be used in addition to T1-10 of AS 1742.3 where the road is grooved and is a hazard to cyclists.

(c) Tar Spraying Possible Short Delay

This temporary sign, shown as Sign ST3-1, shall be used in addition to T3-1 for bituminous surfacing works.

(d) Changed Traffic Conditions Ahead

This temporary sign, shown as Sign ST1-6, shall be used in addition to T1-1, T1-6, T2-6 and T2-21 on long term works, sidetracks and detours.

C201.27 FLASHING ARROW SIGNS

1. Flashing arrow signs shall comply with AS 1742.3.

C201.28 BARRIER BOARDS

1. Barrier boards shall comply with AS 1742.3. **Standard**
2. Trestles supporting the barrier boards may be manufactured of timber, metal or other suitable material and shall be yellow. The trestles shall provide firm supports for the barrier board and be kept in place by sandbags or other devices. The bases of the trestles shall not protrude beyond the ends of the boards. **Trestle Support**

C201.29 HIGH VISIBILITY MESH FENCING

1. High visibility mesh fencing shall be constructed where shown on the Drawings, Traffic Control Plan or as directed by the Principal Certifying Authority.
2. High visibility mesh fencing shall be constructed in accordance with AS 1742.3, containment fences.
3. The mesh fencing shall be paraweb or equivalent as approved by the Principal Certifying Authority.

C201.30 TEMPORARY POST-MOUNTED DELINEATORS

1. In addition to the requirements of AS 1742.3, temporary post mounted delineators shall be provided in conjunction with high visibility mesh fencing which is erected parallel to and in close proximity to traffic.

C201.31 CONES AND BOLLARDS

- | | |
|---|-------------------------------------|
| 1. Traffic cones and bollards shall comply with AS 1742.3 and be placed in accordance with the arrangement diagrams in SAA HB81. | Standard and Placement |
| 2. Unless cones are firmly fixed in position they shall be used only while work is in progress, or in locations where there is an employee in attendance who shall reinstate any of the cones which have been dislodged by traffic. Otherwise they shall be removed and bollards or barriers substituted. | Conditions of Use |
| 3. Cones and bollards used under night conditions shall be reflectorised in accordance with AS 1742.3. | Reflectorised for Night Work |

C201.32 TRAFFIC WARNING LAMPS

- | | |
|--|----------------------------------|
| 1. Traffic warning lamps shall comply with AS 1165 and shall be installed in accordance with AS 1742.3. The Contractor shall ensure that warning lamps are in good working order, correctly aligned and positioned with respect to the direction of traffic flow each night, before the site is left unattended. | Standards and Positioning |
|--|----------------------------------|

C201.33 TEMPORARY PAVEMENT MARKINGS

- | | |
|---|-------------------------------|
| 1. All pavement markings shall be reflectorised and consist of painted lines, roadmarking tape and/or raised pavement markers in accordance with the relevant Australian Standards or as otherwise approved by the Principal Certifying Authority and shall be provided in accordance with AS 1742.3. | Reflectorised Markings |
| 2. Where the adjoining roadway is edgeline, temporary roadways shall be similarly edgeline. | Adjoining Work |

C201.34 TEMPORARY LINEMARKING

- | | |
|--|--------------------------|
| 1. Where temporary linemarking is required on the final wearing surface, only pavement marking tape shall be used. | On Final Surface |
| 2. Where the pavement linemarking has become ineffective in the opinion of the Principal Certifying Authority, remarking shall be undertaken within forty-eight hours of direction by the Principal Certifying Authority. The cost of remarking the pavement lines shall be borne by the Contractor. | Contractor's Cost |

- | | |
|---|-----------------|
| 3. Where a single carriageway is opened adjacent to or used in lieu of an existing dual | Pavement |
|---|-----------------|

carriageway length, pavement arrows indicating the direction of flow of traffic shall be placed at not more than 500 m or at a spacing nominated by the Principal Certifying Authority. The arrows shall be removed if the section is then reincorporated as dual carriageway. **Arrows**

4. Immediately before or after placement of new markings all superseded pavement markings shall be obliterated or removed to the satisfaction of the Principal Certifying Authority. **Old Markings Removed**
5. On a final surface, obliteration by painting shall not be permitted.

C201.35 RAISED PAVEMENT MARKERS

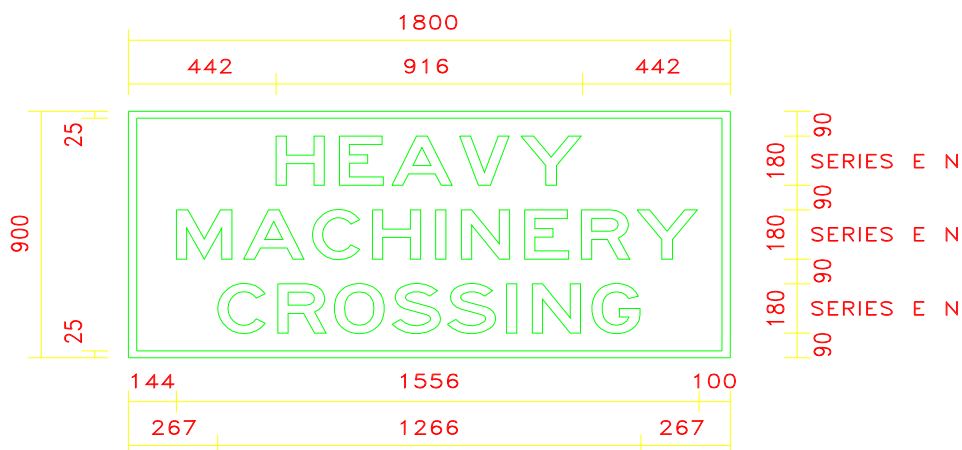
1. Where raised pavement markers have become ineffective in the opinion of the Principal Certifying Authority, they shall be replaced within twenty four hours of direction by the Principal Certifying Authority. **Ineffective Markers**
2. The cost of replacing ineffective pavement markers shall be borne by the Contractor. **Contractor's Cost**
3. All superseded raised pavement markers shall be immediately removed from the pavement by the Contractor. **Removal of Superseded Markers**

ANNEXURE C201A SUPPLEMENTARY TEMPORARY WARNING SIGNS TO AS 1742.3

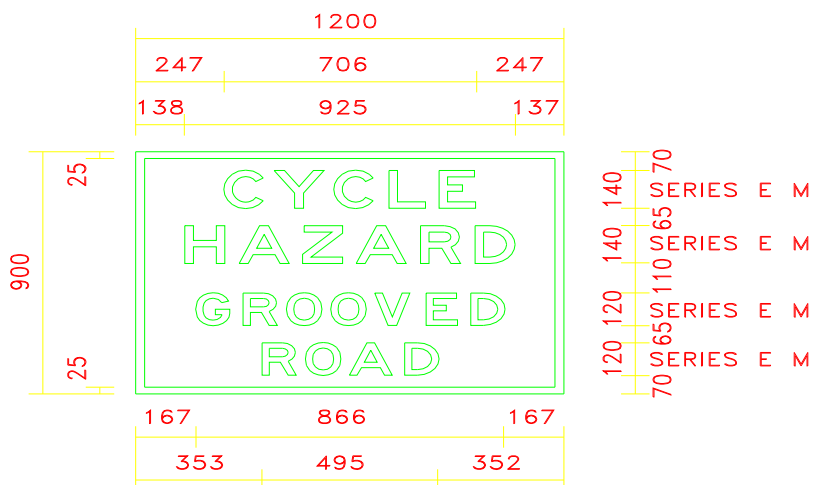
Black letters and border on yellow reflectorised ground

Dimensions are in mm

(i) SW5-22



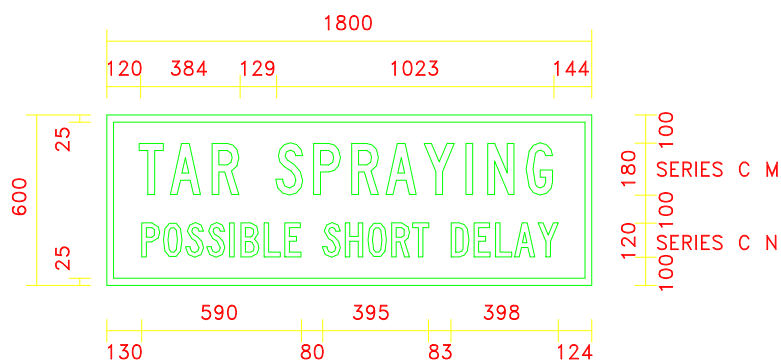
(ii) ST1-10



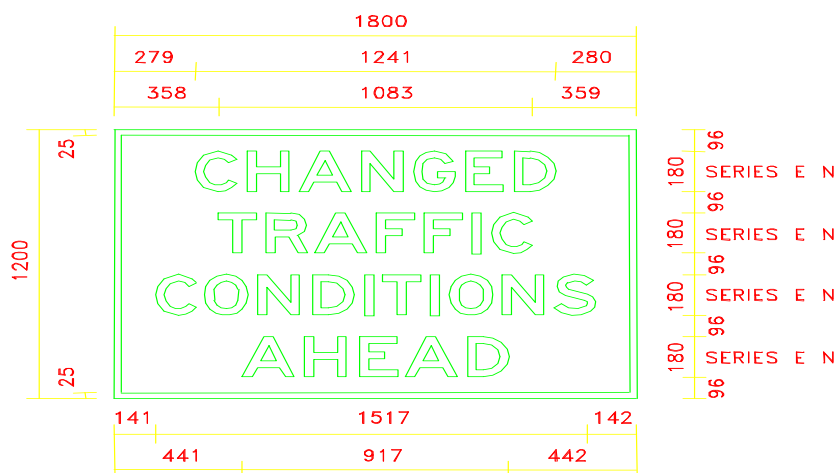
ANNEXURE C201A SUPPLEMENTARY TEMPORARY WARNING SIGNS TO AS 1742.3

Black letters and border on yellow reflectorised ground
Dimensions are in mm

(iii) ST3-1



(iv) ST1-6



DEVELOPMENT CONSTRUCTION SPECIFICATION

C212

CLEARING AND GRUBBING

AMENDMENT RECORD FOR THIS SPECIFICATION PART

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part. The clause numbering and context of each clause are preserved. New clauses are added towards the rear of the specification part as special requirements clauses. Project specific additional script is shown in the specification as italic font.

The amendment code indicated below is 'A' for additional script 'M' for modification to script and 'O' for omission of script. An additional code 'P' is included when the amendment is project specific.

Amendment Sequence No.	Key Topic addressed in amendment	Clause No.	Amendment Code	Author Initials	Amendment Date

CLEARING AND GRUBBING – INDEX

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C212.02	LIMITS OF CLEARING	80
C212.03	CLEARING OPERATIONS	80
C212.04	GRUBBING	81
C212.06	DISPOSAL OF MATERIALS	81

SPECIFICATION C212 CLEARING AND GRUBBING

C212.01 SCOPE

1. The work to be executed under this Specification consists of the clearing and grubbing of all vegetation, structures (such as fences and livestock yards), all rubbish and other materials which are unsuitable for use in the Works. The work also includes the mulching or disposal of all materials that have been cleared and grubbed. *Extent of Work*
2. Prior to, or in conjunction with, clearing and grubbing operations, the Contractor shall install the soil and water management measures in accordance with the Soil and Water Management Plan. *Erosion Control*

C212.02 LIMITS OF CLEARING

1. The area to be cleared shall be limited to the area required for: *Limits of Clearing*
 - a. erosion and sedimentation measures,
 - b. site regrading works,
 - c. road formation construction and
 - d. associated drainage works.
2. A clearance of 2m beyond tops of cuts and toes of embankments will be permitted.
3. The limits of clearing shall be clearly marked by the Contractor.

C212.03 CLEARING OPERATIONS

1. Other than the trees marked for preservation, the area within the limits of clearing shall be cleared of all vegetation, all unnecessary structures (such as fences and livestock yards), all rubbish and other materials which are unsuitable for use in the Works *Extent*
2. The Contractor shall give the Principal Certifying Authority not less than five days' notice of the intention to clear any area of the work. Prior to commencing clearing and grubbing work, the Contractor shall arrange for an inspection of the site by the Principal Certifying Authority. The contractor shall mark any trees that are to be preserved in accordance with the approved plans. Trees are to be identified at the site pre commencement meeting. The Contractor shall not damage nor destroy trees that are to be preserved. *Notice*
Trees to be preserved
3. The Contractor shall execute clearing and grubbing operations to ensure that there is no damage to trees marked for preservation nor any trees outside the limits of clearing. *Trees outside Limits of Work*
4. Every precaution shall be taken to prevent timber or debris from falling on private property and the Contractor shall remove and dispose of any timber so fallen. *Debris in Private Property*
5. Damage of any kind, including damage to trees, fencing, occurring during clearing operations shall be made good by the Contractor. *Damage to Property*
6. Tree removal costs in public areas are to be borne by developer. The removal of trees, including stumps, is to be carried out by suitably qualified tree contractor. This contractor must be appropriately insured to indemnify Council against any loss or damage incurred during the above works. They must also have appropriate WH&S policies and procedures (including traffic control) to ensure that works are carried out in a safe manner and in accordance in Council's own WH&S policies.

The developer must apply for (and be issued) permission under section 138 of the roads act to work within the road reserve. Tree removal must be carried out to the satisfaction of WCC Manager of Works

7. Any branch pruning which has been given approval must be carried out by a qualified arborist in accordance with Australian Standard AS4373-2007 Pruning of Amenity Trees

C212.04 GRUBBING

1. All tree stumps within the work area shall be removed by grubbing. **Extent**
2. Grubbing operations shall be carried out to a depth of not less than 0.5 m below the natural surface or 1.5m below the finished surface level, whichever is the lower. **Depth**
3. Holes remaining after tree stumps have been grubbed shall be backfilled promptly with suitable material. The backfill material shall be compacted to not less than the relative density of the material existing in the adjacent ground. Holes greater than 400mm measured to finished surface level shall be backfilled under Level 1 Supervision in accordance with Specification C213 : Earthworks. **Backfill Holes**

C212.06 DISPOSAL OF MATERIALS

1. All materials cleared and grubbed shall be removed from the site and legally disposed of. **Removal from Site**
2. Unless approved by the Principal Certifying Authority disposal of timber and other combustible materials by burning shall not be permitted. **Burning not Permitted**
3. The Contractor shall produce a wood-chip mulch derived from crowns of trees and branches of shrubs cleared under this Specification. **Wood-chip Mulch**
4. The wood-chip mulch shall be produced from branches having a maximum diameter of 100 millimetres and the chipped material produced shall not have two orthogonal dimensions exceeding 75mm and 50mm. Woodchip kept on site for reuse shall be stored in small stockpiles and turned regularly to prevent the build-up of heat **Dimensions**

DEVELOPMENT CONSTRUCTION SPECIFICATION

C213

EARTHWORKS

AMENDMENT RECORD FOR THIS SPECIFICATION PART

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part. The clause numbering and context of each clause are preserved. New clauses are added towards the rear of the specification part as special requirements clauses. Project specific additional script is shown in the specification as italic font.

The amendment code indicated below is 'A' for additional script 'M' for modification to script and 'O' for omission of script. An additional code 'P' is included when the amendment is project specific.

Amendment Sequence No.	Key Topic addressed in amendment	Clause No.	Amendment Code	Author Initials	Amendment Date

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SPECIFICATION C213 : EARTHWORKS**GENERAL****C213.01 SCOPE**

- | | |
|---|--------------|
| <ol style="list-style-type: none"> 1. The work to be executed under this Specification consists of:- <ol style="list-style-type: none"> (a) removal of topsoil, (b) all activities and quality requirements associated with site regrading, the excavation of cuttings, the haulage of material and the construction of embankments to the extent defined in the Drawings and Specification, (c) removal and replacement of any unsuitable material, (d) any spoil or borrow activities associated with earthworks, and (e) any additional processing of selected material for the selected material zone. | Scope |
|---|--------------|

C213.04 PROTECTION OF EARTHWORKS

- | | |
|--|------------------------------------|
| <ol style="list-style-type: none"> 1. It is the Contractor's responsibility for the care of all Works. | Contractor's Responsibility |
| <ol style="list-style-type: none"> 2. The Contractor shall install soil and water management control measures in accordance with the SOIL AND WATER MANAGEMENT Plan, prior to commencing vegetation clearing and/or earthworks, and shall maintain these control measures for the duration of the work on site. | Soil and Water Management |
| <ol style="list-style-type: none"> 3. Adequate drainage of all working areas shall be maintained throughout the period of construction. | Drainage of Working Areas |
| <ol style="list-style-type: none"> 4. The Contractor shall program and protect the works to minimise ingress of excess water into earthworks material. Particular attention shall be paid to ripped material remaining in cuttings and material placed on embankments. | Wet Weather Precautions |

REMOVAL OF TOPSOIL**C213.07 SCOPE**

- | | |
|---|-----------------------|
| <ol style="list-style-type: none"> 1. Topsoil is surface soil which is reasonably free from subsoil, refuse, clay lumps and stones. | Definition |
| <ol style="list-style-type: none"> 2. Removal of topsoil from any section of the Works shall only commence after soil and water management controls have been implemented. Topsoil throughout the length of the work shall be removed and stockpiled separately clear of the work with care taken to avoid contamination by other materials. | Prerequisites |
| <ol style="list-style-type: none"> 3. The work shall include the following:- <ol style="list-style-type: none"> (a) Cuttings
Removal of the topsoil to the depth indicated on the approved engineering plans or as directed by the Geotechnical Engineer. (b) Embankments
Removal of topsoil from the base of embankments to the depth indicated on the approved engineering plans, or as directed by the Geotechnical Engineer. (c) Other Locations
Removal of topsoil as directed by the Geotechnical Engineer. | Extent of Work |

C213.09 TOPSOIL STOCKPILES

1. Unless otherwise agreed to in writing by Council, the maximum height of stockpiles shall not exceed 2.5 m and the maximum batter slope shall not exceed 2:1. *Height and Batter*
2. Topsoil stockpiles shall not contain any timber or other rubbish and shall be trimmed to a regular shape. *Stockpiles Trimmed*
3. To minimise erosion, stockpile batters shall be stabilised by means acceptable to the Principal Certifying Authority. *Erosion Control*
4. Where seeding of stockpiles to encourage vegetation cover is specified, such work shall be carried out in accordance with the Specification for LANDSCAPING. *Seeding Stockpile*

CUTTINGS**C213.10 SCOPE**

1. Construction of cuttings shall include all operations associated with the excavation of material within the limits of the batters including benching, treatment of cutting floors and transition from cut to fill. *Extent of Work*

C213.11 EXCAVATION

1. Materials encountered in cuttings shall be loosened and broken down as required so that they are acceptable for incorporation in the Works.
2. Cuttings shall have batter slopes as shown on the approved plans. *Batter Slopes*
3. The tops of all cuttings shall be neatly "rounded".
4. Batters shall be trimmed to present a regular and even surface and shall be free from abrupt surface variations. Batters may require progressive flattening at the ends of cuttings due to the presence of less stable material. *Batters to be Even*
5. Cut faces shall be cleaned of loose or unstable material progressively as the excavation proceeds. *Unstable Material*
6. Where material of variable quality or moisture content is encountered, the Contractor shall adjust his excavation methods to ensure blending of the materials, to obtain material meeting the quality and compaction requirements of this Specification. *Blending Material*

C213.12 BATTER TOLERANCES

1. The tolerances for the excavation of batters, measured at right angles to the design grade line, shall be ± 150 mm. *Batter Tolerances*
2. Reserved.
3. If restoration works are required for batters steeper than 1:1, the batter shall be restored to the average batter slope using randomly mortared stone. The stone shall be similar to the sound rock in the cutting and the mortar shall be coloured to match the colour of the rock. *Restoration of Batter Slope*

C213.13 BENCHING IN CUTTINGS

1. Cut batters shall be benched as shown on the Approved Drawings to provide drainage and erosion control. Notwithstanding the tolerances permitted under Clause C213.12, bench widths shall not be less than those shown on the Approved Drawings. **Bench Construction**
2. Benches shall be maintained and cleaned of loose stones and boulders regularly throughout the construction and maintenance period. **Bench Maintenance**

C213.14 TREATMENT OF FLOORS OF CUTTINGS

1. The floors of cuttings shall be excavated to the design floor level which shall be at the underside of the selected material zone or at the underside of the pavement subbase. The floors shall then be trimmed to a level of not more than 10 mm above nor 30 mm below the designed floor level. **Excavation Level**
2. Where the floor of the cutting is in rock, the Contractor shall rip or loosen all material in the floor to a minimum depth of 200 mm below the design floor level for the width of the selected material zone or subbase layer. The maximum dimension of any particles in the ripped or loosened zone shall not exceed 150mm. **Floor Material Ripped**
3. Prior to ripping or loosening the cutting floor the Contractor shall determine the CBR of the material in the floor by AS 1289.F1.1. Sufficient tests shall be taken to represent all the various materials which may exist in the cutting floor. **CBR Testing**
4. Ripped or loosened material shall be made available for inspection by the Geotechnical Engineer and the Principal Certifying Authority before recompaction commences. It shall be recompacted in accordance with Clause C213.36. **Inspection by Super-intendent**
5. After recompaction, the floors of cuttings shall be re-trimmed so that the constructed levels do not vary by more than 10 mm above nor 30 mm below the design floor levels. **Level Tolerances**

C213.15 TRANSITION FROM CUT TO FILL

1. The transition from cut to fill shall be in accordance with the instructions issued by the Geotechnical Engineer controlling the earthworks.

UNSUITABLE MATERIAL**C213.21 GENERAL**

1. Unsuitable material is that occurring below the designed floor level of cuttings and below the nominated depth for stripping topsoil beneath embankments, which the Geotechnical Engineer and/or the Principal Certifying Authority deems to be unsuitable for embankment or pavement support in its present condition. Unsuitable material also includes material which the Geotechnical Engineer and/or the Principal Certifying Authority deems to be unsuitable for embankment construction. **Definition**
2. Such material shall be excavated to the extent directed by the Geotechnical Engineer and/or the Principal Certifying Authority and removed from the works. **Extent of Excavation**
3. After removal of the unsuitable material, the floor of the excavation shall be re-presented to the Geotechnical Engineer and/or the Principal Certifying Authority for inspection, prior to backfilling with replacement material, to determine whether a sufficient depth of unsuitable material has been removed. Prior to placing replacement material the excavated surface shall be compacted in accordance with Clause C213.36. **Floor Inspection**

4. The unsuitable material which has been removed shall be replaced with suitable material placed in accordance with Clause C213.26 and compacted in accordance with Clause C213.36. *Replacement Material*

EMBANKMENT CONSTRUCTION

C213.22 SCOPE

1. Embankment construction includes all operations associated with the preparation of the foundation areas on which fill material is to be placed, the placing and compacting of approved material within areas from which unsuitable material has been removed in accordance with Clause C213.21, the placing and compacting of fill material and of materials of specified quality in nominated zones throughout the Works and all other activities required to produce embankments as specified to the alignment, grading and dimensions shown on the Drawings. It also includes any pre-treatment such as breaking down or blending material or drying out material containing excess moisture. *Extent of Work*

C213.24 FOUNDATIONS FOR EMBANKMENTS

1. Following removal of topsoil in accordance with Clause C213.07, the embankment foundation area shall be made available for inspection by the Geotechnical Engineer. *Inspection*
2. Where the Geotechnical Engineer considers that any underlying material is unsuitable, they may direct that it be removed and replaced in accordance with Clause C213.21. *Unsuitable Material*
- a) Foundations for Shallow Embankments** *Shallow Embankments*
1. Shallow embankments are those embankments of a depth less than 1.0 metre from the top of pavement to natural surface.
2. Material in the foundations for shallow embankments which does not meet the requirements specified in Annexure C213A, shall be deemed unsuitable in accordance with Clause C213.21 and shall be replaced by material of the specified quality. *Unsuitable Material*
3. Foundations for shallow embankments shall be prepared for embankment construction after removing topsoil and unsuitable material, by loosening the material exposed to a depth of 200mm, adjusting the moisture content of the loosened material and compacting as specified in Clause C213.36. The Contractor shall use equipment and techniques to minimise surface heaving or other foundation damage. *Preparation of Foundations*
- b) Other Embankments**
1. For all other embankments the foundation shall be prepared by grading and levelling the general area, adjusting the moisture content where necessary and compacting the top 200mm as specified in Clause C213.36. *Preparation*
2. Where a bridging layer has been specified as a foundation treatment it shall be supplied and placed as part of General Earthworks. The bridging layer shall consist of free-draining granular material with or without geofabric interlayer as specified on the Drawings or as approved by the Geotechnical Engineer. The granular material shall be end-dumped and spread in a single layer and in sufficient depth to allow the passage of earthmoving equipment with minimal surface heaving. The compaction requirements of Clause C213.36 shall not apply to the bridging layer. *Bridging Layer*
3. A bridging layer may also be employed, subject to the approval of the Geotechnical Engineer, where ground water or seepage is encountered in the foundation area or where the Contractor demonstrates that it is impracticable to achieve the degree of compaction specified for the foundation in Clause C213.36. A bridging layer shall not be acceptable if its proximity to the pavement is likely to affect the pavement design. *Seepage from Foundations*

C213.25 HILLSIDE EMBANKMENTS

1. Where embankments are to be constructed on or against any natural slopes or the batters of existing embankments, the existing slope or batter, if it is steeper than 4 horizontal to 1 vertical in any direction shall be cut in the form of horizontal terraces over the whole area to be covered by new filling. The existing slope or batter shall be stepped in successive terraces of 1 metre high or less, each at least 1 metre in width, the terraces to be cut progressively as the embankment is placed. Wherever possible terraces shall coincide with natural discontinuities. Subsoil drainage may be required in some instances. Material thus excavated shall be compacted as part of the new embankment material. **Horizontal Terraces**

C213.26 PLACING FILL FOR EMBANKMENT CONSTRUCTION

1. All work shall be under Level 1 Geotechnical Control in accordance with AS 3798.
2. In the absence of a specific geotechnical engineer's specification, embankments shall be constructed in accordance with the following paragraphs:
 - a. The fill shall be approved by the Principal Certifying Authority. **Uniformity of Material**
 - b. The methods of excavation, transport, depositing and spreading of the fill material shall be selected so as to ensure that the placed material is uniformly mixed.
 - c. The embankment shall be constructed so as to derive its stability from the adequate compaction of the fine material embedding the large rock pieces rather than mechanical interlock of the rock pieces. The fine material shall be compacted to meet the requirements of Clause C213.36. **Embankment Stability**
 - d. Fill material for embankment construction shall be free of tree stumps, roots and other organic matter and shall be placed in layers parallel to the grade line and compacted in accordance with Clause C213.36. The layers shall be of uniform compacted thickness not exceeding 200 mm. **Layer Thickness**
 - e. The maximum dimension, measured in any direction, of rock pieces in the fill material for embankment construction shall not exceed 150 mm. Any larger rock pieces shall be reduced in size for incorporation in the embankment layers. **Maximum Size Rock Pieces**
 - f. Rock material shall be broken down and evenly distributed through the fill material, and sufficient fine material shall be placed around the larger material as it is deposited to fill the voids and produce a dense, compact embankment. Where the Geotechnical Engineer considers insufficient fine material is present to fill the voids, additional fine material shall be obtained from other places in the work or by a change in the method of winning fill material. **Grading of Fill Material**
 - g. Areas with insufficient fine material to fill the voids shall be reworked with additional fine material being blended in to achieve a dense, compact layer. **Reworking**
 - h. In placing embankment layers, the Contractor shall use equipment and techniques to avoid surface heaving or other damage to the foundations and underlying embankment layers. **Equipment Selection for Placement**
 - i. After compaction, embankment material in the zone(s) below the selected material zone (or subbase layer, where no selected material zone) shall have a CBR value not less than that quoted in Annexure C213A for the depth(s) specified in Annexure C213A. **CBR Value**
 - j. For the purpose of this Clause, the CBR value of the material shall be determined by Test Method AS 1289.F1.1. **Test Methods**

C213.27 EMBANKMENT BATTERS

1. When completed, the average planes of the batters of embankments shall conform to those shown on the Drawings or as approved by the Principal Certifying Authority. No point on the completed batter shall vary from the specified slope line by more than $\pm 300\text{mm}$ when measured at right angles to the grade line. However, in no case shall the edge of the formation at the underside of the pavement be nearer to the roadway than shown on the Drawings. **Slope Tolerances**

2. Undulations in the general plane of the batter shall not be permitted.

*Slope
Undulations*

C213.28 ROCK FACING OF EMBANKMENTS

1. Where shown on the Drawings, embankment batters (including embankments at bridge abutments) shall be provided with a facing of clean, hard, durable rock. *Extent*
2. The rock facing shall be built up in layers ahead of each layer of filling. Rock may be placed by hand or plant but shall be placed in such a manner that its least dimension is vertical and that mechanical interlock between the larger stones occurs. Any rock deposited in the rock facing which has an excess of fine material surrounding it shall be removed together with the excess fine material and replaced. *Mechanical Interlock*
3. The Contractor shall adjust his working methods and programme the work so as to obtain hard and durable rock of the specified dimensions as it is required. The space between larger batter rocks shall be filled with progressively smaller rocks to form a 'graded filter' which prevents the leaching out of fines from the fill material but which does not overfill the voids between larger rocks, or cause the larger rocks to lose contact with one another. Fine material shall not cover the outside of the rocks on the face of the batter. *Graded Filter*
4. The Contractor shall exercise extreme caution whilst placing the rock facing. Where embankment material is placed above other roads in use the outer rock layer shall be placed in such a manner as to prevent spillage down the batter. The Contractor shall ensure that, under no circumstances, could any rock be dislodged and roll onto any adjacent roadway or track in use. *Caution in Placement*

C213.29 TRIMMING TOPS OF EMBANKMENTS

1. The tops of embankments at these levels shall be compacted to meet the requirements of Clause C213.36 and trimmed so that they do not vary more than 10 mm above nor 30 mm below the levels as calculated above. *Tolerances*

C213.30 SELECTED MATERIAL ZONE (Includes Subgrade)

1. A selected material zone may be indicated on the Approved Drawings as a zone below the subbase layer and in accordance with the following quality requirements: *Dimension and Quality*
 - (a) it shall be free from stone larger than 100 mm maximum dimension;
 - (b) the fraction passing 19.0mm AS sieve shall have a CBR value of not less than 3.
2. The selected material zone shall be placed and compacted in layers with the compacted thickness of each layer not exceeding 150mm. Compaction shall be 100% standard compactive effort. *Layer Thickness*
3. After placement, the selected material shall be homogeneous and free from patches containing segregated stone or excess fines. *Homogeneous Layers*
4. The top of the selected material zone shall be compacted and trimmed parallel with the designed grade line at a level equal to the finished surface level minus the thickness of pavement layers adopted. The top of the selected material zone shall not vary by more than 10 mm above nor 30 mm below the design level. *Tolerances*

C213.31 FILL ADJACENT TO STRUCTURES

1. For the purpose of this Clause, structures shall include bridges, precast and cast-in-place box culverts and retaining walls. Fill adjacent to other culverts and drainage structures shall be provided in accordance with the particular Specifications for STORMWATER DRAINAGE as appropriate. *Structure Types*

2. No filling shall be placed against structures, retaining walls, headwalls or wingwalls within 21 days after placing of the concrete, unless the walls are effectively supported by struts or the Contractor can demonstrate that 85 per cent of the design strength of the concrete has been achieved. **Time of Placement**

C213.32 TREATMENT AT WEEPHOLES

1. Drainage adjacent to weepholes shall be provided by either a layer of hard broken stone or river gravel consisting of clean, hard, durable particles graded from 50mm to 10mm such that: **Grading**
- (a) The maximum particle dimension shall not exceed 50mm,
 - (b) No more than 5 per cent by mass shall pass the 9.5mm A.S. sieve.
2. The broken stone or river gravel shall be continuous in the line of the weepholes, extend at least 300mm horizontally into the fill and extend to a point 300mm below finished surface level. **Extent**
3. Alternatively the Contractor may provide a synthetic membrane of equivalent drainage characteristics. It shall be stored and installed in accordance with Manufacturer's instructions. The use of a synthetic membrane shall be subject to approval by Council. **Synthetic Membrane**

C213.33 SELECTED BACKFILL

1. Selected backfill shall be placed adjacent to structures in accordance with Table C213.2. The selected backfill shall consist of a granular material having a maximum dimension not exceeding 50mm and a Plasticity Index, determined by AS 1289.3.3.1, neither less than 2 nor more than 12. **Quality**

Structure Type	Selected Backfill	
	Width	Height
Bridge abutments	2m	H
Cast-in-place Box Culverts	H/3	H + 300mm
Corrugated Steel Pipes and Arches	0.5m	H + 500mm
Retaining walls	H/3	H

(Where H = height of structure)

Table C213.2 - Selected Backfill, Width and Height

2. The selected backfill shall be placed in layers, with a maximum compacted thickness of 150mm. Layers shall be placed simultaneously on both sides of box culverts to avoid differential loading. Compaction shall start at the wall and proceed away from it. **Placement in Layers**
3. The backfill material shall be compacted to 100% standard compactive effort within 150mm of the subgrade level and 95% standard compactive effort below this zone. **Compaction**
4. The existing embankment slope behind the structure shall be cut in the form of successive horizontal terraces, each terrace being at least 1 metre in width, and the selected backfill shall be placed in accordance with Clause C213.26. **Horizontal Terraces**
5. No selected backfilling shall be placed against structures, retaining walls, headwalls or wingwalls within 21 days after placing of the concrete, unless the walls are effectively supported by struts to the satisfaction of the Principal Certifying Authority, or when the Contractor can demonstrate that 85 per cent of the design strength of the concrete has been achieved. **Time of Placement**
6. Where a bridge deck is being concreted adjacent to an abutment, no filling shall be placed against the abutment within twenty-one days after placing concrete in the bridge deck. **Adjacent to Concrete Deck**
7. In the case of spill-through abutments, rocks shall not be dumped against the columns or **Spill through**

retaining walls but shall be built up evenly by individual placement around or against such structures. **Abutments**

8. In the case of framed structures, embankments at both ends of the structure shall be brought up simultaneously, the difference between the levels of the embankments at the respective abutments, shall not exceed 500mm. **Framed Structures**

COMPACTION AND QUALITY CONTROL

C213.36 COMPACTION AND MOISTURE REQUIREMENTS

1. All layers shall be uniformly compacted to not less than the relative compaction specified before the next layer is commenced. Each layer of material shall be trimmed prior to and during compaction to avoid bridging over low areas. An evenly trimmed surface shall be presented at the top of each layer. **Trimming and Compaction**
2. The following areas shall be compacted to not less than 95% standard compaction in accordance with AS 1289.5.7.1: **95% (standard) Compaction Requirements**
 - a. Each layer of material replacing unsuitable material as detailed in Clause C213.21.
 - b. Each layer of material placed in embankments, up to the subgrade level.
 - c. The whole area on the floors of cuttings.
 - d. Fill placed adjacent to structures up to 1.0 metre from the top of pavement.
 - e. Material in unsealed verges and within medians up to the level at which topsoil is placed.
3. The following areas shall be compacted to not less than 100% standard compaction in accordance with AS 1289.5.7.1: **100% (standard) Compaction Requirements**
 - a. Foundations for shallow embankments.
 - b. Foundations other than shallow embankments.
 - c. Each layer of the embankment within 150 mm from the subgrade level.
 - d. Each layer of the selected material zone as specified in Clause C213.30.
 - e. The fill material placed adjacent to structures as specified in Clauses C213.31 and C213.33 in each layer within 1.0 metre from the top of the pavement.
4. Prior to the commencement of placing embankment material, the Contractor shall engage a qualified Geotechnical Engineer to determine the optimum moisture content (OMC) for the materials to be used.
5. At the time of compaction the moisture content of the material shall be adjusted so as to permit the specified compaction to be attained at a moisture content which is within the range of the optimum moisture content (OMC) as determined by AS 1289.5.1.1 or AS 1289.5.7.1. Material which becomes wetted up after placement shall not be compacted until it has dried out so that the moisture content is within this range. If there is insufficient moisture in the material for it to be compacted as specified, water shall be added. The added water shall be applied uniformly and thoroughly mixed with the material until a homogeneous mixture is obtained. **Moisture Content**
6. Compaction shall be undertaken to obtain the specified relative compaction for the full depth of each layer in embankments and for the full width of the formation over the entire length of the work. Compaction shall be completed promptly to minimise the possibility of rain damage. **Prompt Compaction**
7. Any material placed by the Contractor that has attained the specified relative compaction but subsequently becomes wetted up so that the moisture content is greater than the apparent optimum, determined by AS 1289.5.7.1, shall be dried out and uniformly recompacted to the required relative compaction in accordance with this Clause before the next layer of material is placed. Alternatively, the Contractor may remove the layer of wetted material to a stockpile site for drying and later re-use. **Moisture Content above Optimum**
8. Prior to placing pavement material, the Proof Roll test shall be passed. **Proof Rolling**

C213.37 TEST LOCATIONS

1. The specified compaction and moisture tests shall be performed in accordance with Annexure CQC - B1. **Testing**
2. If testing confirms that the material does not conform to the Specification, the Contractor shall carry out remedial work as necessary to achieve conformance to the requirements of Clause C213.36. **Non Compliance with Specification**

C213.39 WIDENING OF FORMATION

1. Road shoulders and formation shall be widened to accommodate footpaths, guardfence, streetlight plinths, emergency telephone bays and vehicle standing areas as shown on the Approved Drawings. **Provision for Services**

C213.40 STANDARD OF FILL FOR LOTS

1. Lot filling material shall conform to the following:
 - a. is to be clean material free from large rock, organic matter, builders refuse and other debris , and
 - b. Maximum particle size shall be 100 mm.

Placing of filling shall not commence until the proposed fill material and the prepared area has been inspected and approved by a qualified geotechnical engineer.
2. All work shall be under Level 1 Geotechnical Control in accordance with AS 3798. Fill is to be placed in layers not exceeding 150mm compacted thickness. All fill is to be compacted to 95% standard maximum dry density. Maximum particle size shall be 2/3 of the layer thickness. **Fill Quality**
3. All areas where filling has been placed are to be top dressed with a layer of clean arable topsoil, fertilised and sown with suitable grasses. The topsoil layer shall be between 75 mm (min) and 300 mm (max). **Top Dressing**
4. Allotment earthworks to be completed in accordance with and comply with AS 3798-2007
5. All road verges, between the back of kerb and property boundary, are to have 150mm of topsoil, spray grassed and turf strip located at the back of kerb

LIMITS AND TOLERANCES**C213.45 SUMMARY OF TOLERANCES**

1. The tolerances applicable to the various clauses in this Specification are summarized in the Table below:

Item	Activity	Limits/Tolerances	Spec Clause
1.	Batter Slopes		
	a) Excavation	± 150mm	C213.12
	b) Embankment	± 150mm	C213.27
2.	Floors		
	a) Floor of Cutting	Parallel to the designed grade line and ± 50mm of the designed floor level	C213.14
3.	Tops of Embankments		
	Trimming tops of Embankments	Parallel to the designed grade line, +10mm or -30mm of the levels specified	C213.29
4.	Selected Material (includes subgrade)		
		Parallel to the designed grade line, +10mm or -30mm of the levels specified	C213.30

NOTE: Plus (+) is towards the roadway/surface and minus (-) is away from the roadway/surface. Tolerances are measured at right angles to design surfaces.

DEVELOPMENT CONSTRUCTION SPECIFICATION

C220

STORMWATER DRAINAGE GENERAL

AMENDMENT RECORD FOR THIS SPECIFICATION PART

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part. The clause numbering and context of each clause are preserved. New clauses are added towards the rear of the specification part as special requirements clauses. Project specific additional script is shown in the specification as italic font.

The amendment code indicated below is 'A' for additional script 'M' for modification to script and 'O' for omission of script. An additional code 'P' is included when the amendment is project specific.

Amendment Sequence No.	Key Topic addressed in amendment	Clause No.	Amendment Code	Author Initials	Amendment Date

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SPECIFICATION C220 : STORMWATER DRAINAGE – GENERAL**GENERAL****C220.01 INTRODUCTION**

1. This is the general Specification common and applicable to all types of drainage lines, open drains, kerb and gutter, and drainage structures and shall be read in conjunction with drainage Specifications: **Purpose**

C221	-	Pipe Drainage
C222	-	Precast Box Culverts
C223	-	Drainage Structures
C224	-	Open Drains, including Kerb and Gutter
D05	-	Council's Drainage Design Code

C220.02 SCOPE

1. The work to be executed under this Specification consists of:
- (a) preparation for stormwater drainage construction,
 - (b) temporary drainage during construction,
 - (c) siting of pipes, pipe arches and box culverts.
 - (d) all activities and quality requirements associated with excavation and backfilling,
 - (e) all concrete work associated with stormwater drainage.

C220.03 EXTENT OF WORK

1. Details of the work are shown on the Drawings.

CONSTRUCTION**C220.05 TEMPORARY DRAINAGE DURING CONSTRUCTION**

1. All drainage works carried out by the Contractor shall comply with the SOIL & WATER MANAGEMENT PLAN. **Control**
2. The Contractor shall make adequate provision for runoff at drainage works under construction to avoid damage or nuisance due to scour, sedimentation, soil erosion, flooding, diversion of flow, damming, undermining, seepage, slumping or other adverse effects to the Works or surrounding areas and structures as a result of the Contractor's activities. **Contractor's Responsibility**
3. The Contractor shall not implement any proposals to dam up or divert existing watercourses (either temporarily or permanently) without the prior approval of the Principal Certifying Authority. **Limitations**
4. The Contractor's material and equipment shall be located clear of watercourses or secured so that they will not cause danger or damage in the event of large runoff. **Location of Equipment**

C220.07 EXCAVATION

1. Before undertaking stormwater drainage excavation, topsoil shall be removed in accordance with the Specification for EARTHWORKS. **Topsoil**
2. The Contractor shall provide any shoring, sheet piling or other stabilisation of the sides necessary to comply with statutory requirements. **Safety**

3. Where public utilities exist in the vicinity of stormwater drainage works the Contractor shall obtain the approval of the relevant authority to the method of excavation before commencing excavation. **Approval by Public Utility Authorities**
4. Trench or foundation excavation for stormwater drainage works shall be undertaken to the planned level for the bottom of the specified bedding or foundation level. All loose material shall be removed by the Contractor. **Excavation Level**
5. Any material at the bottom of the trench or at foundation level which the Geotechnical Engineer and/or Principal Certifying Authority deems to be unsuitable shall be removed and replaced with backfill material. The bottom of the excavated trench or foundation, after any unsuitable material has been removed and replaced, shall be parallel with the specified level and slope of the culvert. **Unsuitable Material**

C220.08 BACKFILLING & INSPECTION

1. Backfilling shall be carried out in accordance with the requirements of the relevant culverts or drainage structures Specifications and to the compaction requirements specified below.
2. The Contractor shall arrange for the Principal Certifying Authority to inspect the pipe laying operation at the following stages:
 - a. upon placing and compaction of the bedding material,
 - b. upon laying the pipe and backfilling to haunch zone.

C220.09 COMPACTION

1. Foundations, bedding and backfilling shall be compacted to the following requirements when tested in accordance with AS 1289.5.4.1 for standard compactive effort. **Standard**

	Relative Compaction
Foundations or trench base to a depth of 150mm below foundation levels	95%
Material replacing unsuitable material	95%
Bedding material	95%
Selected backfill and ordinary backfill material	
a. below 1.0m of finished surface	95%
b. within 1.0m of finished surface	100%
Backfill material within the selected material zone	100%

2. All material shall be compacted in layers not exceeding 150mm compacted thickness. Each layer shall be compacted to the relative compaction specified before the next layer is commenced. **Layers**
3. At the time of compaction, the moisture content of the material shall be adjusted so as to permit the specified compaction to be attained at a moisture content which, unless otherwise approved by the Geotechnical Engineer, is neither less than 60 per cent nor more than 95 per cent of the apparent optimum moisture content, as determined by AS 1289.5.7.1 (standard compaction). **Moisture Content**
4. When compacting adjacent to culverts or drainage structures, the Contractor shall adopt compaction methods which will not cause damage or misalignment to any culvert or drainage structure. **Precautions**

C220.10 CONCRETE WORK

1. For all concrete work, the Contractor shall comply with the Specification for MINOR CONCRETE WORKS in relation to the supply and placement of normal class concrete and steel reinforcement, formwork, tolerances, construction joints, curing and protection. **Specification**

C220.11 SPRAYED CONCRETE

1. If sprayed concrete has been specified, shown on the Drawings or directed by the Superintendent, it shall comply with requirements in the Specification for MINOR CONCRETE WORKS. **Standard**

LIMITS AND TOLERANCES**C220.14 SUMMARY OF LIMITS AND TOLERANCES**

1. The limits and tolerances applicable to the various clauses in this Specification are summarised in Table C220.1 below:

Item	Activity	Limits/Tolerances	Spec Clause
1.	Relative Compaction (Standard / Density Index)		
	(a) Foundations or trench base to a depth of 150mm below foundation levels	95% Standard	C220.09
	(b) Material replacing unsuitable material	95% Standard	C220.09
	(c) Bedding zone material	Density Index >70	C220.09
	(d) Haunch and Side zone Material	Density Index > 70	C220.09
	(e) Overlay Zone in roadways elsewhere		C220.09
2.	Backfill		
	(a) Layers	≤ 150mm	C220.09
	(b) Moisture Content	>60%, <95%	C220.09

Table C220.1 - Summary of Limits and Tolerances

DEVELOPMENT CONSTRUCTION SPECIFICATION

C221

PIPE DRAINAGE

AMENDMENT RECORD FOR THIS SPECIFICATION PART

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part. The clause numbering and context of each clause are preserved. New clauses are added towards the rear of the specification part as special requirements clauses. Project specific additional script is shown in the specification as italic font.

The amendment code indicated below is 'A' for additional script 'M' for modification to script and 'O' for omission of script. An additional code 'P' is included when the amendment is project specific.

Amendment Sequence No.	Key Topic addressed in amendment	Clause No.	Amendment Code	Author Initials	Amendment Date

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SPECIFICATION C221 : PIPE DRAINAGE**GENERAL****C221.01 SCOPE**

1. This Specification covers the supply and installation of pipes and pipe arches for stormwater drainage.
2. This Specification shall be read in conjunction with the specification for STORMWATER DRAINAGE - GENERAL. *Associated Specifications*
3. The work to be executed under this Specification consists of supply of pipes and pipe arches, bedding, installation and backfilling. *Extent of Work*

COMMON REQUIREMENTS**C221.03 GENERAL**

1. All pipes and pipe arches shall comply with the appropriate Australian Standards. *Load Testing*
2. The Contractor shall take all necessary steps to drain the excavation to allow the foundation, the bedding and any backfilling to be compacted to the specified relative compaction. *Excavation Drainage*
3. Pipes shall be installed within 20 mm of the grade line and within 50 mm of the horizontal alignment specified on the Drawings. The Contractor shall re-lay any pipe which is not within these tolerances. *Tolerances*
4. At the discharge end of pipes terminating at pits and headwalls a 3m length of 100mm diameter subsurface drain shall be laid in the trench 100mm above the invert level of the pipe and discharging through the wall of the pit. The subsurface drainage pipe shall be sealed at the upstream end and shall be enclosed in a seamless tubular filter fabric in accordance with the Specification for SUBSURFACE DRAINAGE. *Subsurface Drain*
5. Where the Contractor proposes to travel construction plant or vehicles over pipes, the Contractor shall design and provide adequate protective measures for the pipes. *Construction Plant Movement*

REINFORCED CONCRETE AND FIBRE REINFORCED CONCRETE PIPES**C221.04 PIPES**

1. Reinforced concrete pipes shall comply with AS 4058 and shall be of the class and size as shown on the Drawings. *Reinforced Concrete Pipes*
2. Fibre reinforced concrete pipes shall comply with AS 4139 and shall be of the class and size as shown on the Drawings. *Fibre Reinforced Pipes*
3. Pipe joints shall be rubber ring joints as recommended by the manufacturer. *Joints*

C221.05 CONDITIONS OF INSTALLATION

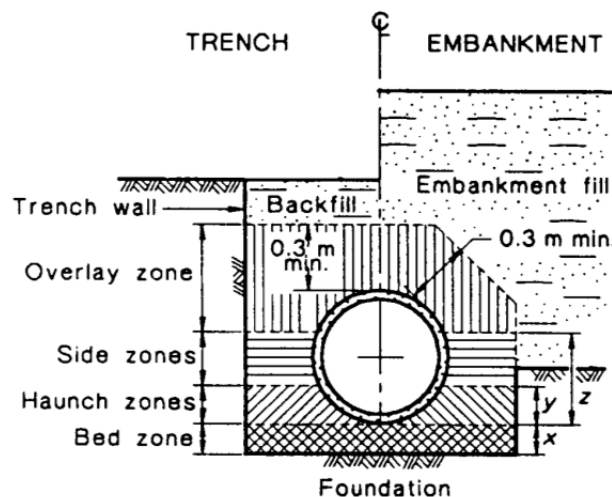
1. Unless otherwise indicated on the Drawings or approved by the Principal Certifying Authority, the formation shall be completed to subgrade level and the pipes then installed in the normal trench condition. *Formation to Subgrade Level*
2. Installation shall be in accordance with this Specification and AS3725 and AS3725

Supplement 1. Type HS3 support shall be used in road reserves. Type HS2 support shall be used elsewhere unless a higher standard is noted on the Drawings.

3. For normal trench conditions, the pipe shall be laid in an excavated trench with bedding as specified below. The trench shall not be excavated wider than 1.4 times the external diameter of the pipe plus 300mm. **Normal Trench Conditions**
4. For a single pipe, embankment conditions apply when $W > D_e + 1$ metre. Where W = Width of trench (m) and D_e is the pipe external diameter (m). **Wide Trench Conditions**
5. For multi-cell pipes, embankment conditions apply when $W > n D_e + nS + 1$ metre where n is the number of pipe cells, D_e is the pipe external diameter (m) and S is the square spacing between the pipelines (m).

C221.06 BEDDING

1. Unless otherwise shown on the Drawings, the bedding requirements shall be as set out in this clause. **Requirements**
2. Figure C221.1 indicates the proportionate dimensions of bedding and backfilling for pipes laid in trench conditions and embankment conditions. **Bedding Dimensions**



where, $Z = 0.7D$
 $Y = 0.3D$
 $X = 100\text{mm}$ for $D < 1500\text{mm}$
 $X = 150\text{mm}$ for $D > 1500\text{mm}$
 D = Internal Diameter of Pipe

Figure C221.1
Pipe Installation Conditions

3. Bedding material for the bed and haunch zones shall consist of a granular material having a grading, determined by AS 1141.11, complying with Table C221.2, and a Plasticity Index, determined by AS 1289.3.3.1 of less than 6. **Material Requirements**

Sieve size mm	Mass passing %
19.0	100
2.36	100 - 50
0.60	90 - 20
0.30	60 - 10
0.15	25 - 0
0.075	0

Table C221.2
Bedding Material Grading Limits

4. The Contractor shall advise the Principal Certifying Authority of the source of bedding material. **Source**
5. Bedding material in the bed and haunch zones shall be placed and compacted in layers to a minimum density index of 70 per cent as determined by AS 1289.E6.1. **Compaction Requirements**
6. Reserved

C221.07 INSTALLATION

(a) General

1. Pipes shall be laid with the socket end placed upstream. Pipes which have marks indicating the crown or invert of the pipes shall be laid strictly in accordance with the markings. Unless specified, no individual length of pipe shall be shorter than 1.2m. **Positioning of Pipes**
2. In the case of pipes 1.2 m or more in diameter, laid in situations where embankments are to be more than 3m high, measured above the invert of the pipe, pipes shall be stiffened temporarily by the Contractor by interior timber struts, erected before filling is placed. Struts shall be of hardwood measuring at least 100mm by 100mm or 125mm diameter. One strut shall be placed in a vertical position at each pipe joint, thence at a spacing not greater than 1.2 m. Struts shall bear against a sill laid along the invert of the pipe and a cap bearing against the crown of the pipe. Both the sill and the cap shall be continuous throughout the length of the pipe and they shall be of sawn hardwood, of cross section not less than 100mm by 100mm. Struts shall be made to bear tightly by the use of wedges between the top of the struts and the cap. Struts, sills and caps shall be removed on completion of the embankment, unless removal is ordered earlier. **Stiffening of Culverts**
3. Lifting holes in pipes shall be sealed before the commencement of backfilling with an appropriate plug specifically designed for the purpose. Where a lifting hole has been made in a length of pipe by the contractor, it shall be sealed with a 3:1 sand: cement mortar. **Seal Lifting Holes**

(b) Joints in Steel Reinforced Concrete Pipes

1. Before making the joint, the spigot and socket and the rubber ring shall be clean and dry except for any lubricants recommended by the manufacturer. **Clean and Dry Material**
2. The rubber ring shall be stretched on to the spigot end of the pipe, square with the axis and as near as possible to the end, care being taken that it is not twisted. The spigot end of the pipe shall then be pushed up to contact the socket of the pipe with which it is to join, and be concentric with it. The spigot end shall then be entered into the socket of the already laid pipe and eased home. **Procedure**
3. The joint shall be tested to ensure that the rubber ring has rolled evenly into place. **Joint Test**

(c) Joints in Fibre-Reinforced Concrete Pipes

1. Joints shall be of a flexible type. Rubber rings shall be used to seal joints in both rebated and spigot and socket jointed pipes in the manner specified in Clause C221.07(b). Alternatively, a jointing compound comprising plasticised butyl rubber and inert fillers may be used to seal such pipes in accordance with the manufacturer's instructions. **Procedure**

C221.08 BACKFILL

1. Roads, Carriageways and Accessways. Backfill to the side, overlay and backfill zones shall consist of material defined in Table C221.2. Backfill to the side, overlay and backfill zones shall be compacted to density index of not less than 70. **Procedure**
2. Council or Public Drainage Easements and Interallotment Drainage Easements. Backfill to the side and overlay shall consist of material defined in Table C221.2 and shall be compacted to a density index of not less than 70. The backfill zone shall comprise material that is clean, free from large rock, organic matter, builders refuse and other debris and has a maximum particle size of 50 mm. The backfill zone shall be compacted to a relative compaction of 95% Standard Compaction.
3. Backfilling on both sides of the pipe and both sides of the wingwalls shall be carried out simultaneously. Backfilling and compaction shall commence at the pipe or wall so as to confine remaining uncompacted material at commencement. **Sequence**

UPVC PIPES**C221.19 PIPE MATERIALS**

1. Unplasticised PVC (uPVC) Pipes and Fittings shall be manufactured in accordance with AS 1254. **Specification**

C221.20 INSTALLATION

1. The materials utilised, the excavation requirements, bedding, backfill and jointing requirements for uPVC pipes are those set out in Section 7 of AS 2032. Installation of all uPVC pipes shall comply with the requirements of this Australian Standard.

LIMITS AND TOLERANCES

C221.26 SUMMARY OF LIMITS AND TOLERANCES

Item	Activity	Tolerances	Spec Clause
1.	Pipe Position		
	(a) Grade Line	± 10mm	C221.03
	(b) Horizontal Alignment	± 50mm	C221.03
2.	Bedding		
	(a) Compacted Layers	< 150mm	C221.06
3.	Installation		
	(a) Normal Trench	<1.4 x External Diameter + 300mm	C221.05
	(i) Trench Width		
	(b) Pipe Length	Not less than 1200mm	C221.07a
	(c) Strut Stiffening		
	(i) Timber Size	> 100mm x 100mm	C221.07a
	(ii) Spacing	< 1200mm	C221.07a

Table C221.2 - Limits and Tolerances

DEVELOPMENT CONSTRUCTION SPECIFICATION

C222

PRECAST BOX CULVERTS

AMENDMENT RECORD FOR THIS SPECIFICATION PART

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part. The clause numbering and context of each clause are preserved. New clauses are added towards the rear of the specification part as special requirements clauses. Project specific additional script is shown in the specification as italic font.

The amendment code indicated below is 'A' for additional script 'M' for modification to script and 'O' for omission of script. An additional code 'P' is included when the amendment is project specific.

Amendment Sequence No.	Key Topic addressed in amendment	Clause No.	Amendment Code	Author Initials	Amendment Date

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SPECIFICATION C222 : PRECAST BOX CULVERTS**GENERAL****C222.01 SCOPE**

1. This Specification covers the installation of precast concrete box culverts and should be read in conjunction with the Specification for STORMWATER DRAINAGE - GENERAL.
2. The work to be executed under this Specification consists of:
 - (a) preparation of foundations;
 - (b) provision of bedding;
 - (c) construction of base slabs;
 - (d) installation of precast culvert units;
 - (e) headwalls and wingwalls;
 - (f) backfilling against structures;
 - (g) provision and removal of coffer dams;
 - (h) excavation of inlet and outlet channels.

Extent of Work**MATERIALS****C222.03 CULVERT UNITS, LINK AND BASE SLABS**

1. The supply and testing of precast reinforced concrete box culvert units, link and base slabs shall be in accordance with AS 1597.1 for small culverts not exceeding 1200mm width and 900mm depth and AS 1597.2 for large culverts from 1500mm span and up to and including 4200mm span and 4200mm height with the following alterations or additional requirements:
 - (a) Proof load testing shall be arranged by the Contractor in batches as specified in either AS 1597.1 or AS1597.2 as appropriate.
 - (b) Lifting holes, galvanised lifting points or steel lifting eyes shall be provided in the culvert units, link and base slabs.
 - (c) The end units shall have factory installed starter bars for headwall and wingwall construction.
2. The Supplier shall implement and maintain a Quality System in accordance with ISO 9002 to ensure materials, manufacture and proof load testing conform to the appropriate Standards.
3. A conformance certificate, to AS 1597.1 or AS 1597.2, for the box culvert units shall be submitted to the Principal Certifying Authority at least 3 working days prior to despatch.
4. Each unit shall be marked at time of manufacture with:
 - (a) Type and size
 - (b) Casting date
 - (c) Manufacturer's name
 - (d) Inspection pass and date

Supply**C222.04 CONCRETE**

1. The concrete and reinforcement for cast-in-situ base slabs shall comply with the Specification for MINOR CONCRETE WORKS.

Quality

C222.05 SELECTED BACKFILL

1. The quality of selected backfill shall comply with the requirements in AS 1597.2.

Quality**C222.06 ORDINARY BACKFILL**

1. Ordinary backfill is material obtained from culvert excavations, cuttings and/or borrow areas which is in accordance with the requirements for the upper 1.0m of embankment construction as detailed in the Specification for EARTHWORKS.

Quality**CONSTRUCTION****C222.07 COFFER DAMS**

1. The Contractor shall obtain approval from Council and the Department of Infrastructure, Planning and Natural Resources for the construction of coffer dams.

2. Coffers shall be sufficiently watertight to prevent damage of the concrete by percolation or seepage through the sides, and shall be taken sufficiently below the level of the foundations to prevent loosening of the foundation materials by water rising through the bottom of the excavation. Coffers shall be adequately braced and shall be so constructed that removal will not weaken or damage the structure.

Construction

3. A coffer dam may be constructed to the actual size of the reinforced concrete invert slab and used as side forms for the concrete. The details of the coffer dam and formwork, and the clearances proposed shall be subject to the approval of the Principal Certifying Authority, but the Contractor shall be responsible for the successful construction of the work.

**Contractor's
Responsibility**

4. Coffers which have tilted or have moved laterally during sinking, shall be righted or enlarged to provide the clearances specified. This work will be at the Contractor's expense.

**Specified
Clearances**

5. No timber or bracing shall be left in the concrete or in the backfill of the finished structure. Coffers, including temporary piles, shall be removed at least to the level of the invert after completion of the structure.

Removal**C222.08 EXCAVATION**

1. Excavation shall be carried out in accordance with the provisions in the Specification for STORMWATER DRAINAGE - GENERAL.

Specification

2. The trench width shall be the width of the base slab plus 150mm minimum each side.

Trench Width**C222.09 FOUNDATIONS**

1. Rock foundations shall be neatly excavated to the underside of the mass concrete or selected fill bedding shown on the Drawings. All minor fissures shall be thoroughly cleaned out and refilled with concrete, mortar or grout. All loose material shall be removed.

**Rock
Foundations**

2. Where rock is encountered over part of the foundation only, or lies within 300mm below the underside of the mass concrete or selected fill, all material shall be removed to a depth of 300mm below the mass concrete or selected fill for the full width of the foundation over the length where the rock is encountered. This additional excavation shall be backfilled with ordinary backfill material.

**Additional
Excavation**

3. Over-excavation or uneven surfaces shall be corrected with mass concrete so as to provide a uniform surface at least 50mm above the highest points of rock.

**Uniform
Surface**

4. Earth foundations shall be finished to line and level to the underside of bedding shown on the Drawings. Care shall be taken to avoid disturbing material below this level. **Line and Level**
5. All soft, yielding or unsuitable material shall be removed and replaced with ordinary backfill material as directed by the Principal Certifying Authority and backfilled in accordance with the Specification for STORMWATER DRAINAGE - GENERAL. **Unsuitable Material**

C222.10 BEDDING

(a) Cast-In-Situ Base Slabs

1. No bedding material shall be placed until the foundations have been inspected and approved by the Principal Certifying Authority. **Inspection**
2. Bedding shall be either mass concrete or lightly bound DGB20 in accordance with the Specification for FLEXIBLE PAVEMENTS, whichever is shown on the Drawings. **Type**
3. Mass concrete bedding shall not be less than 50mm thick over any point in the foundation. It shall be laid to the line and level of the underside of the base slab to a tolerance of ± 10 mm in level and ± 5 mm in line. The bedding shall be finished to a smooth surface. **Mass Concrete**

(b) Precast Base Slabs

1. Precast base slabs, U-shaped culvert units and one piece culvert units shall be supported on a bed zone of selected backfill of minimum compacted depth 150mm in accordance with AS 1597.2. **Selected Fill**

C222.11 CAST-IN-SITU BASE SLABS

1. Cast-in-situ base slabs shall be constructed to the dimensions shown on the Drawings and in accordance with the requirements of the Specification for MINOR CONCRETE WORKS. The invert levels shall be within -10 mm to $+10$ mm of the design level, grade 5mm in 2.5m (1 in 500) and plan position ± 50 mm. **Construction**
2. Recesses to accommodate the walls of the precast crown units shall be formed in the base slab to the dimensions shown on the Drawings. **Recesses for Walls**
3. Concrete for cast in situ base slabs shall be grade N32. **Concrete N32**
4. Concrete for base slabs shall not be placed until the Principal Certifying Authority has inspected and approved the formwork and reinforcement. **Inspection**

C222.12 INSTALLATION OF PRECAST UNITS

1. Precast units shall not be installed until the base slab has attained a compressive strength of not less than 20 MPa. **Minimum Strength**
2. Precast crown units shall be placed on a bed of mortar in the recesses in the base slab. Any gaps between the side walls and the sides of the recesses shall be packed with cement mortar. Lifting holes and butt joints between units shall be packed or sealed with cement mortar or grout. **Mortar Bed in Recess**
3. Before placement of top slabs on U-shaped units or link slabs on adjacent crown units, the bearing areas of the supports shall be thoroughly cleaned and covered with a bed of mortar of minimum thickness 5mm after placement of precast unit. **Mortar Bed on Supports**
4. Steel lifting hooks shall be cut flush with the surface of the concrete, cleaned to bright metal and coated with two coats of coal tar epoxy. Alternatively, they shall be cut off 12mm below the surface of the unit and the recess sealed with epoxy mortar. **Lifting Hooks**

- | | | |
|----|--|---------------------------------|
| 5. | In the case of multi-cell culverts, a nominal 15mm gap shall be provided between adjacent cells. This gap shall be filled with cement mortar or grout. | <i>Gap Between Cells</i> |
| 6. | All mortar joints shall be protected from the sun and cured in an approved manner for not less than 48 hours. | <i>Curing of Joints</i> |
| 7. | All external surfaces of joints between precast crown units, both laterally and longitudinally, shall be covered full length, and minimum 250mm width, with strips of non-woven geotextile of minimum mass 270 g/m ² in accordance with AUSTROADS Guide to Geotextiles. | <i>Joint Covering</i> |

C222.13 BACKFILL

- | | | |
|----|---|-----------------------------------|
| 1. | All bracing and formwork shall be removed prior to backfilling. | <i>Removal of Formwork</i> |
| 2. | Selected backfill shall be placed in the side zones of the box culverts and wingwalls, and to a depth of 300mm in the overlay zone of the culverts, in layers with a maximum compacted thickness of 150mm in accordance with the backfilling and compaction requirements of AS 1597.2. The remainder of the excavation shall be backfilled with ordinary embankment fill in accordance with the Specification for EARTHWORKS. | <i>Selected Fill</i> |
| 3. | No backfill shall be placed against wingwalls until 21 days after casting. | <i>Wingwalls</i> |
| 4. | Backfill layers shall be placed simultaneously on both sides of the culvert with a maximum 600mm level difference to avoid differential loading. Backfilling and compaction shall commence at the wall and proceed away from it. | <i>Sequence</i> |
| 5. | Where the slopes bounding the excavation are steeper than 4:1, they shall be cut in the form of successive horizontal terraces of at least 1m width before the backfill is placed. | <i>Horizontal Terraces</i> |

C222.14 EXCAVATION OF INLET AND OUTLET CHANNELS

- | | | |
|----|--|----------------------|
| 1. | Excavation of inlet and outlet channels shall be carried out as shown on the Drawings and shall extend to join the existing stream bed in a regular manner as detailed in the Specification for OPEN DRAINS INCLUDING KERB AND GUTTER. | <i>Extent</i> |
|----|--|----------------------|

C222.15 CONSTRUCTION LOADING ON CULVERTS

- | | | |
|----|--|------------------------------------|
| 1. | Construction vehicles and plant shall not pass over the culvert until 28 days after the casting of the base slab or until the cylinder compressive strength of the base slab concrete has reached 32MPa. | <i>Traffic Over Culvert</i> |
| 2. | Construction vehicle loads on culverts for various design fill heights shall be in accordance with AS 1597.2. | <i>Loading Restrictions</i> |

LIMITS AND TOLERANCES

C222.16 SUMMARY OF TOLERANCES

1. The tolerances applicable to the various clauses in this Specification are summarised in the Table below:

Item	Activity	Tolerance	Spec Clauses
1.	Mass Concrete Correction		
	a) Over highest points of rock	50mm	C222.09
2.	Mass Concrete Bedding		
	a) Level	± 10mm	C222.10
	b) Line	± 5mm	C222.10
3.	Culvert Location		
	a) Invert Level	±10mm	C222.11
	b) Grade	5mm in 2.5m (1 in 500)	C222.11
	c) Plan Position	±50mm	C222.11

Table C222.1 - Summary of Limits and Tolerances

DEVELOPMENT CONSTRUCTION SPECIFICATION

C223

DRAINAGE STRUCTURES

Amendment Record for this Specification Part

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part. The clause numbering and context of each clause are preserved. New clauses are added towards the rear of the specification part as special requirements clauses. Project specific additional script is shown in the specification as italic font.

The amendment code indicated below is 'A' for additional script 'M' for modification to script and 'O' for omission of script. An additional code 'P' is included when the amendment is project specific.

Amendment Sequence No.	Key Topic addressed in amendment	Clause No.	Amendment Code	Author Initials	Amendment Date

DRAINAGE STRUCTURES – INDEX

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SPECIFICATION C223 : DRAINAGE STRUCTURES**GENERAL****C223.01 SCOPE**

This Specification covers the construction of drainage structures and shall be read in conjunction with the Specification for STORMWATER DRAINAGE - GENERAL and other drainage Specifications as applicable: *Associated Specifications*

- C221 - Pipe Drainage
- C222 - Precast Box Culverts
- C224 - Open Drains, including Kerb and Gutter

The work to be executed under this Specification consists of the construction of headwalls, wingwalls, pits, gully pits, inspection pits, junction boxes/pits, drop structures, inlet and outlet structures, energy dissipaters, batter drains and other supplementary structures as shown on the Drawings. *Extent of Work*

CONSTRUCTION**C223.03 GENERAL**

Drainage structures shall be constructed in concrete and in accordance with the Specification for MINOR CONCRETE WORKS. *Concrete Work*

All structures shall be constructed as soon as practicable.

Time for Completion

C223.04 ALIGNMENT

Unless otherwise shown on the Drawings, headwalls and pits shall be constructed parallel to the road centreline and wingwalls at 135° to the headwall.

Energy dissipaters shall be constructed in accordance with the Drawings and on the centreline of the axis of the culvert. *Energy Dissipaters*

C223.05 HEADWALLS AND WINGWALLS

The wingwalls shall be constructed to retain the batters effectively. Where the dimensioned drawings do not satisfy this requirement the Principal Certifying Authority shall be notified before the headwalls and wingwalls are constructed. The Principal Certifying Authority shall direct the Contractor as to the action to be taken. *Batter Retention*

C223.06 PITS

All new pits, including gully grates and frames complying with AS 3996, shall be constructed to the details shown on the Drawings. Modification of existing pits is only to be carried out if such is shown on the Drawings. *Modification*

Where pits and drop structures are deeper than 1.2m the Contractor shall install suitable non corroding step irons at a vertical spacing of 300mm in one wall of the pit, for the full depth of the pit. *Step Irons*

C223.07 PRECAST UNITS

Where precast units are provided in the design they shall be handled and installed in accordance *Manufacturer's*

with the manufacturer's instructions.

Instructions

If the Contractor proposes to use precast units, detailed drawings and complete details of installation procedures shall be submitted for the approval of the Principal Certifying Authority.

Contractor's Responsibility

Unless otherwise approved by the Principal Certifying Authority, precast units shall not be delivered to the site before satisfactory documentary evidence has been submitted to the Principal Certifying Authority that quality tests have been carried out.

Delivery

C223.08 JOINTING

Where drainage structures abut concrete paving, kerb and gutter or other concrete structures, a 10mm wide joint shall be provided between the structure and paving, or kerb and gutter or other concrete structures. The joint shall consist of pre-formed jointing material of bituminous fibreboard.

Pre-formed Jointing Material

C223.09 MASS CONCRETE BEDDING

Mass concrete bedding for reinforced concrete bases shall not be placed on earth or rock foundations until the foundations have been inspected and approved by the Principal Certifying Authority. Following such approval, the surface of the foundation shall be dampened and a layer of concrete not less than 50mm thick, shall be placed over the excavated surface and shall be finished to a smooth even surface.

Mass Concrete Base Foundation Inspection

Unreinforced concrete bases may be cast on earth or rock foundations without the mass concrete bedding.

Unreinforced Concrete Base

C223.10 BACKFILL

Backfilling shall not commence until the compressive strength of concrete has reached at least 15MPa unless otherwise approved by the Principal Certifying Authority.

Commencement

Selected backfill shall be placed against the full height of the vertical faces of structures for a horizontal distance equal to one-third the height of the structure.

Selected Backfill

Selected backfill shall consist of a granular material in accordance with the requirements in the Specification for EARTHWORKS.

Composition

Special care shall be exercised to prevent wedge action against vertical surfaces during the backfilling. Where the sides of the excavation are steeper than 4 horizontally to 1 vertically they shall be cut in the form of successive horizontal terraces at least 600mm in width, as the backfill is placed.

Horizontal Terraces

Backfill on both sides of the structure shall be carried up to level alternately in layers so as to avoid wedge action or excessive horizontal forces. Backfilling and compaction shall commence at the wall. Compaction shall be in accordance with the Specification for STORMWATER DRAINAGE - GENERAL.

Procedure

DEVELOPMENT CONSTRUCTION SPECIFICATION

C224

OPEN DRAINS INCLUDING KERB & GUTTER (CHANNEL)

Amendment Record for this Specification Part

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

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Amendment Sequence No.	Key Topic addressed in amendment	Clause No.	Amendment Code	Author Initials	Amendment Date
1	<i>Stormwater outlet requirement in Point 8</i>	224.12	M	MB	21/01/08

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SPECIFICATION C224 : OPEN DRAINS, INCLUDING KERB AND GUTTER

GENERAL

C224.01 SCOPE

The work to be executed under this Specification consists of the construction, lining and protection of all types of open drains including the construction of rock filled wire mattresses and gabions.

This Specification should be read in conjunction with the Specification for STORMWATER DRAINAGE - GENERAL, and other drainage Specifications as applicable:

C221	-	Pipe Drainage
C222	-	Precast Box Culverts
C223	-	Drainage Structures

C224.02 DEFINITION

Open drains are all drains other than pipe lines and box culverts and include catch drains, contour drains, diversion drains, table drains, batter drains, swales, channels, gutters and kerbs and gutters.

Definition

UNLINED OPEN DRAINS

C224.04 GENERAL

Unless shown otherwise on the Drawings, drains shall be of parabolic or trapezoidal cross section and shall not be less than 300mm deep and have a minimum waterway area of 0.2 square metres.

Shape

Open drains shall be graded to ensure free flow of water and, shall not have a grade of less than 0.5 %.

Grade

Where trees exceeding 1m in girth at 500mm above the ground, trees marked for preservation or rock outcrops occur in the line of a drain, the drain may be neatly diverted if approved by the Principal Certifying Authority.

Trees and Rock Outcrops

Open drains shall be extended as necessary to lead the water clear of the work to natural drainage depressions, culverts, or pits connected to underground drainage systems. The drains shall follow existing watercourses and depressions in the natural surface, unless other locations are shown on the Drawings

Open Drains

All work shall be undertaken in accordance with the requirements of the Specification for CONTROL OF EROSION AND SEDIMENTATION.

Control of Erosion

C224.05 TYPES

Catch drains shall be provided above the tops of cuttings or along the toes of embankments where shown on the Drawings before construction of the adjacent roadway. The edges of catchdrains shall be positioned not be less than 2m from the tops of cuttings or the toes of embankments nor more than is necessary to maintain the fall of the drains.

Catch Drains

Minor diversion and contour drains shall be constructed where shown on the Drawings or directed by the Principal Certifying Authority. Minor diversion drains shall have the same capacity as the nearest pipe culvert on the line of the drain unless otherwise approved by the Principal Certifying Authority.

Diversion & Contour Drains

Table drains, swales and depressed medians shall be constructed to the line and level shown or

Table Drains

calculated from the Drawings. Their construction is deemed to be part of earthworks.

Inlet, outlet and diversion channels shall be excavated as shown on the Drawings and, unless indicated otherwise, shall extend to join the existing stream bed in a regular manner, avoiding disturbance in stream flow. The channel shall be excavated to the full width of the structure but the existing stream bed shall be preserved as far as possible outside the limits of the excavation.

Channels

C224.06 CONSTRUCTION

Where the drawings permit the material excavated from drains to be placed on the lower sides of the drains and formed as banks, the material shall be compacted in accordance with AS 1289.5.4.1 to not less than 95% standard compactive effort.

Excavated Material

The Contractor shall ensure that none of the activities associated with the work disturbs any watercourse. Any excavation below the level of the natural channel shall be backfilled with suitable material compacted to a density equal to and compatible with that existing naturally.

Contractor's Responsibility

Any excess material shall be legally and responsibly disposed of by the Contractor.

Excess Material

Unlined drains and areas adjacent to open drains shall be revegetated immediately after the drains are complete.

Revegetation

LINED OPEN DRAINS

C224.07 GENERAL

Lined open drains include concrete gutters/channels and kerb and gutter.

Where shown on the Drawings, open drains shall be lined. Lining shall conform to the profile of the drain and shall be provided as soon as possible after forming the drain.

Profile

Before placing any lining material, the foundation material shall be shaped and compacted to form a firm base for the lining. Other than for kerb and gutter constructed on pavement courses, the relative compaction, as determined by AS 1289.5.7.1 or AS 1289.5.4.1 shall not be less than 95 per cent for standard compactive effort.

Compaction of Foundations

C224.08 CONCRETE LINING

Concrete lining for open drains shall be cast-in-situ or sprayed concrete supplied and placed in accordance with the Specification for MINOR CONCRETE WORKS. In wet areas weepholes shall be provided in the concrete at intervals as determined by the Principal Certifying Authority.

Method

Contraction joints in concrete lining, consisting of narrow transverse and vertical grooves, 20mm deep, shall be formed neatly in the surface of the freshly placed concrete at intervals of 3m unless otherwise specified by the Principal Certifying Authority. Unless other approved by the Principal Certifying Authority, expansion joints shall be placed at intervals not more than 15m and shall consist of preformed jointing material of bituminous fibreboard and shall be of sufficient depth to fill the joint.

Jointing

C224.09 STONE PITCHING

Stone Pitching shall consist of sound durable rock not less than 100mm thick, properly bedded on approved loam or sand and mortared to present a uniform surface. The exposed surface of each stone or block shall be approximately flat and not less than 0.05 square metres in area. Spaces between adjacent stones or blocks shall not exceed 20mm in width.

Rock Quality and Placing

C224.10 BATTER DRAINS

Batter drains shall be constructed using either half round steel pipes or precast nestable concrete units as shown and detailed on the Drawings.

Type

The units shall be installed in carefully excavated and template controlled trench to produce an even rim line of +0 to -50 mm from the batter line at the underside of topsoil.

Installation

Any over excavation and undulations in the batter line shall be backfilled and both sides of the drain compacted over the full length to form a firm shoulder against the rim of the batter drain.

Compaction

When topsoil is placed it shall be tapered over a width of 1m to zero thickness at the rim of the drain. Both sides of the drain shall then be turfed for minimum width of 600mm and pinned down as provided in the Specification for LANDSCAPING.

Topsoil and Turfing**C224.12 KERB AND GUTTER (CHANNEL)**

Kerb and/or gutters (channel) may be constructed in fixed forms, by extrusion or by slip forming, in accordance with AS 2876.

Method

The foundation, concrete quality, curing and testing details shall be in accordance AS 2876.

Construction Details

The top and face of the finished kerb and gutter shall be true to line and the top surface shall be of uniform width, free from humps, sags or other irregularities.

Finish

The level at any point on the surface of the gutters shall be within ± 10 mm of design levels. When a straight edge 3m long is laid on top of or along the face of the kerb or on the surface of gutters, the surface shall not vary more than 5mm from the edge of the straight edge, except at kerb laybacks, grade changes or curves or at gully pits requiring gutter depression.

Tolerances

Unless shown otherwise on the Drawings, contraction joints, shall be formed every 3m of gutter length for a minimum of 50 per cent of cross sectional area. The joint shall be tooled 20mm in depth to form a neat groove of 5mm minimum width.

Contraction Joints

Unless shown otherwise on the Drawings, expansion joints, 10mm in width for the full depth of the kerb and gutter, shall be constructed at intervals not exceeding 15m and where the gutter abuts against gutter pits, retaining walls and overbridges. Expansion joints shall consist of a preformed jointing material.

Expansion Joints

Where kerbs and/or gutters are cast adjacent with a concrete pavement the same type of contraction, construction and expansion joints specified in the concrete base shall be continued across the kerb and/or gutter.

Adjacent Concrete Pavement

A minimum of one Council approved stormwater outlet shall be provided through the kerb for each allotment which drains to a road system.

Stormwater Outlets

Where shown on the Drawings or where directed by the Principal Certifying Authority, vehicular and pedestrian access ramps shall be provided which comply with the requirements for access for persons with disabilities.

Vehicular or Pedestrian Access**ROCK FILLED WIRE MATTRESSES AND GABIONS****C224.13 GENERAL**

Installation shall be in accordance with the manufacturer's instructions. A geotextile approved by the Principal Certifying Authority shall be placed between the wire cage and the material being protected.

Location and Geotextile

C224.14 MATERIALS

For wire mattresses and gabions, the galvanising requirements for wire of circular cross section cited in this Clause as 'heavily galvanised', shall comply with the coating mass requirements for wire in AS 1650, type A wire.

(a) Gabions

The gabions shall be of the sizes shown on the Drawings and fabricated of woven heavily galvanised wire mesh and PVC coated where specified on the Drawings. Each gabion shall be divided by diaphragms into cells whose length shall not be greater than the width of the gabions plus 100mm. Gabions shall have a nominal mesh size of 80mm x 100mm and body wire shall be a minimum diameter of 2.7mm heavily galvanised with an additional thickness of 0.5mm PVC coating where specified on the Drawings. The minimum core diameters of heavily galvanised selvedge wire and lacing wire shall be 3.4mm and 2.2mm respectively.

Dimensions

(b) Wire Mattresses

Unless specified otherwise, the wire mattresses shall be supplied in units having dimensions of 6m x 2m x 230mm, and shall be cut to suit areas as shown on the Drawings. The mattresses shall be divided by diaphragms into cells of length not exceeding 600mm. Unless otherwise specified, they shall be fabricated of woven heavily galvanised wire and PVC coated where specified on the Drawings.

**Mattress
Dimension**

Mattresses shall have a mesh size of 60mm x 80mm and body wire shall be a minimum diameter of 2.0mm heavily galvanised with an additional minimum thickness of 0.5mm PVC coating where specified on the Drawings. The minimum core diameters of heavily galvanised selvedge wire and lacing wire shall be 2.7mm and 2.2mm respectively.

**Wire
Dimensions**

(c) Geotextile

A chemically and biologically stable geotextile with a minimum strength rating (G) of 1350 and minimum mass of 180 grams per square metre, in accordance with AUSTROADS Guide to Geotextiles, shall be used.

Type

Samples, manufacturer's specification and instructions on installation shall be submitted to the Principal Certifying Authority seven days before the intended use of geotextile.

Sample

(d) Rock Fill Material

The rock fill shall consist of clean hard rock with a minimum wet strength of 100 kilo newtons and a maximum wet/dry strength variation of 45 per cent as determined by AS 1141.22.

Rock Quality

Rock fill for gabions shall have particle sizes between 100mm and 250mm and preferably not greater than 200mm. Rock fill material may be placed by hand or suitable mechanical device to ensure fill is tightly packed with a minimum of voids. Fill material shall be levelled off 25mm to 50mm above the top of the mesh to allow for settlement.

For Gabions

Rock fill for wire mattresses shall have particle sizes between 75mm and 150mm and preferably not greater than 125mm. When the mattress is on a slope, rock fill material shall be placed into the units starting from the low end. Units shall be filled slightly overfull to allow for settlement and to provide an even tight and smooth surface of the required contour.

**For Wire
Mattresses**

C224.15 ASSEMBLY AND ERECTION

Before laying out the gabions or wire mattresses, a filter fabric approved by the Principal Certifying Authority shall be placed on the founding material. The edges of wire mattresses shall be firmly tied to galvanised star pickets driven a minimum of 900mm into the surrounding ground at 1m maximum intervals and the star pickets cut off level with the top of the mattress. The upstream edge of wire mattresses shall be folded down into a trench of minimum depth 300mm and filled with rock fill. This edge shall be tied to star pickets.

Procedure

LIMITS AND TOLERANCES

C224.16 SUMMARY OF LIMITS AND TOLERANCES

The limits and tolerances applicable to the various clauses in this Specification are summarised in Table C230.7 below.

Item	Activity	Tolerances	Spec Clause
1.	Open Drains - General		
	(a) Grading	Grade >0.5%	C224.04
	(b) Depth	>300mm	C224.04
	(c) Waterway Area	>0.2 sq m	C224.04
	(d) Catch Drain Location	>2m from top of cuttings or toes of embankments	C224.05
2.	Open Drains - Lining		
	(a) Compaction of Foundation	>95% (standard compaction)	C224.07
3.	Stone Pitching		
	(a) Rock Dimensions	>100mm thickness	C224.09
	(b) Exposed Surface Area	>0.05 sq m	C224.09
	(c) Spaces between Stones	<20mm width	C224.09
4.	Batter Drains		
	(a) Rim line	+0, -50 from batter line	C224.10
5.	Kerb and Gutter		
	(a) Level of gutter surface	Level ± 10 mm of design level	C224.12
	(b) Surface uniformity	Deviation of kerb and gutter surface from 3m straight edge ± 5 mm	C224.12
6.	Rock Fill for Gabions and Wire Mattresses		
	(a) Wet Strength	>100kN	C224.14d
	(b) Wet/Dry Strength variation	<45%	C224.14d
	(c) Particle size for Gabions	>100mm <250mm	C224.14d
	(d) Fill Level	>25mm <50mm above top of mesh	C224.14d
	(e) Particle size for Wire Mattresses	>75mm <150mm	C224.14d

Item	Activity	Tolerances	Spec Clause
7.	Erection of Wire Mattresses		
	(a) Star pickets for ties	Depth in ground >900mm Spacing <1m	C224.15
	(b) Trench Depth for upstream edge	Depth >300mm	C224.15

Table C224.1 - Summary of Limits and Tolerances

DEVELOPMENT CONSTRUCTION SPECIFICATION

C230

SUBSURFACE DRAINAGE GENERAL

AMENDMENT RECORD FOR THIS SPECIFICATION PART

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SPECIFICATION C230 : SUBSURFACE DRAINAGE - GENERAL**GENERAL****C230.01 INTRODUCTION**

This is the general specification common and applicable to all types of subsurface drainage and shall be read in conjunction with subsurface drainage specifications:

Purpose

- C231 - Subsoil and Foundation Drains
- C232 - Pavement Drains
- C233 - Drainage Mats

as applicable to particular contracts.

C230.02 SCOPE

The work to be executed under this Specification consists of:

- (a) preparation for subsurface drainage construction;
- (b) siting of subsurface drainage facilities;
- (c) the supply of all materials associated with the provision of the subsurface drainage system;
- (d) all activities and quality requirements associated with the supply, placement and compaction of filter material;
- (e) the provision of a detailed record of all subsurface drain installations;
- (f) the marking on the ground of the location of all subsurface drains.

C230.03 EXTENT OF WORK

Details of the work are shown on the Drawings or as directed by the Principal Certifying Authority and Geotechnical Engineer.

C230.06 SITING OF WORK

The Principal Certifying Authority may amend the locations or designed levels or the lengths to suit actual site conditions.

Amendments to Planned Work

Should the Contractor propose changes to the location, length, designed levels, conditions of installation or cover to suit the Contractor's construction procedures, the Contractor shall present the proposed set-out in addition to the designed set-out for consideration by the Principal Certifying Authority. No changes shall be made unless the prior written approval of the Principal Certifying Authority is obtained.

Proposed Changes by Contractor**C230.07 EXCAVATION**

The Contractor shall provide shoring, sheet piling or other stabilisation of the sides necessary to comply with statutory requirements.

Safety

Where service utilities exist in the vicinity of drainage works the Contractor shall obtain the approval of the relevant authority to the method of excavation before commencing excavation.

Approval by Public Utility Authorities

Trenches shall be excavated to the line, grade, width and depth shown on the Drawings or as directed by the Principal Certifying Authority. The bottom of the trench shall be constructed so that no localised ponding can occur. All loose material shall be removed by the Contractor.

Excavation Level

Any material at the bottom of the trench or at foundation level which the Principal Certifying Authority

Unsuitable

deems to be unsuitable shall be removed and disposed in accordance with the Specification for EARTHWORKS by the Contractor and replaced with backfill material in accordance with the requirements of this Specification. The bottom of the excavated trench or foundation, after any unsuitable material has been removed and replaced, shall be parallel with the specified level or grade of the pipe.

Material

C230.08 BACKFILLING

Backfilling shall be carried out in accordance with the requirements of the relevant subsurface drainage structures Specifications.

Detail

C230.09 OUTLET STRUCTURES FOR SUBSURFACE DRAINAGE

Subsurface drainage pipes shall be connected to discharge into gully pits or to outlet structures as shown on the Drawings or as directed by the Principal Certifying Authority.

Discharge

Outlets shall be spaced at a maximum interval of 80m.

Spacing

Outlets shall be made rodent proof using galvanised wire netting.

Rodent Proof

The outlet shall be located so that erosion of the adjacent areas does not occur or shall be protected by the placement of selected stone or similar approved treatment.

Erosion Control

Outlet pipes from curtain drains shall be unslotted. At no point shall an outlet pipe be higher than the pipe at the end of the curtain drain.

Outlet Pipe

All concrete used in the construction of outlet structures shall conform to the requirements of the Specification for MINOR CONCRETE WORKS.

Concrete Specification

MATERIALS

C230.10 CORRUGATED PLASTIC PIPE

Corrugated plastic pipe shall be Class 1000 complying with AS2439.1 of 100mm diameter unless otherwise indicated on the Drawings. All pipe shall be slotted unless otherwise indicated on the Drawings.

Specification

Joints, couplings, elbows, tees and caps shall also comply with AS2439.1 and only the manufacturer's recommended fittings shall be used.

Fittings

The Contractor shall obtain from the Manufacturer a Test Certificate demonstrating compliance with AS2439.1.

Compliance

C230.12 FILTER MATERIAL

(a) General

The filter material shall consist of clean, hard, tough, durable particles and comply with the following requirements:

Grading

TEST METHOD	PROPERTY	REQUIREMENT
AS 1141.11	Material passing AS sieve	Per cent by mass
	6.7mm	100
	4.75mm	85 to 100
	2.36mm	0 to 40
	1.18mm	0 to 5
	425um	0 to 2
Table C230.1 - Filter Material		

C230.13 GEOTEXTILE

(a) General

The geotextile, other than seamless tubular filter fabric, shall consist of a needle punched felt which shall be manufactured from synthetic materials other than polyamide. It shall be bio-stable and resistant to attack by alkalis, acids, dry heat, steam, moisture, brine, mineral oil, petrol, diesel and detergents.

Properties

The geotextile shall be resistant to ultra-violet light. No geotextile shall be left exposed to sunlight during storage and construction for a period longer than a total of twenty-one days. If exposure in excess of twenty-one days does occur, the geotextile shall be tested and if its characteristics have deteriorated to or below 90 per cent of the characteristics claimed by the manufacturer or the characteristics determined on unexposed geotextile, whichever is the better, it shall be removed and replaced with a geotextile complying with this Specification.

*Ultra Violet
Light
Resistant*

The geotextile shall be capable of retaining particles of particle size greater than 100 microns.

*Particle
Retention*

The minimum mass of geotextiles for different types of subsurface drainage shall be as follows:

Mass

TYPE OF SUBSURFACE DRAINAGE	MINIMUM MASS OF GEOTEXTILE (Grams per square metre)
Trench Drains and Drainage Mats	250
Curtain Drains	500
Table C230.6 - Geotextile Mass	

In addition to the above requirements, geotextiles for curtain drains shall consist of either polyester, polypropylene or polyethylene. When subjected to a pressure of 200 kPa applied at right angles to the plane of the fabric and to a constant head of water no greater than 50 mm applied to the top edge of the fabric, geotextiles for curtain drains shall have a rate of water transmission not less than 20 litres per hour per metre width of fabric through a 300 mm length of the fabric.

*Water
Transmission
Rate*

(b) Seamless Tubular Filter Fabric

Specification

Seamless knitted tubular filter fabric shall be used to enclose all slotted pipes and shall be manufactured from either polypropylene or polyester. The fabric shall be free of imperfections in weave or yarn and have abrasion resistant and weave stability qualities such that it shall not form holes, ladder, deweave, tear or unravel more than 5mm from a cut end.

RECORDING OF DRAINAGE

C230.14 RECORDING OF SUBSURFACE DRAINAGE INFORMATION

The Contractor shall keep a detailed record of all subsurface drainage pipes and the completed subsurface drainage systems shall be shown on the work-as-executed plans.

**Work As
Executed
Plans**

The Work As Executed plans shall include:

Detail

- a. Type of Drain,
- b. Pipe Size,
- c. Depth below FSL, and
- d. Locations of Outlets.

LIMITS AND TOLERANCES

C230.17 SUMMARY OF LIMITS AND TOLERANCES

The limits and tolerances applicable to the various clauses in this Specification are summarised in Table C230.7 below.

Item	Activity	Tolerances	Spec Clause
1.	Outlets Spacing	Max 80m	C230.09
2.	Filter Material	Table C230.1	C230.12
3.	Geotextile (a) Exposure to sunlight	<21 days If >21 days deterioration not to exceed 10% of claimed characteristics	C230.13
) Curtain Drains Water Transmission	>20 litres/hr/m	C230.13

Table C230.7 - Table of Limits and Tolerances

DEVELOPMENT CONSTRUCTION SPECIFICATION

C231

SUBSOIL AND FOUNDATION DRAINS

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SUBSOIL AND FOUNDATION DRAINS – INDEX

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SPECIFICATION C231 : SUBSOIL AND FOUNDATION DRAINS

GENERAL

C231.01 SCOPE

The work to be executed under this Specification covers the excavation, bedding, installation and backfilling of subsoil and foundation drains.

Scope

Subsoil and foundation drains shall be constructed where and as shown on the Drawings or as directed by the Geotechnical Engineer and the Principal Certifying Authority.

Location

This Specification should be read in conjunction with the Specification for SUBSURFACE DRAINAGE - GENERAL.

Associated Specification

C231.02 TERMINOLOGY

Subsoil drains are intended for the drainage of ground water and/or the pavement in cuttings.

Subsoil Drains

Foundation drains are required for the drainage of seepage, springs and wet areas within and adjacent to the foundations.

Foundation Drains

C231.04 ORDER OF CONSTRUCTION

(a) Subsoil Drains

Subsoil drains shall be constructed as soon as possible after necessary earthworks are completed in the area of the drain.

Timing of Work

Where a Selected Material Zone is specified and excessive ground water is encountered, subsoil drains may be installed in two stages as follows:

Two Stage Construction

Stage 1: Standard subsoil drains installed below the base of the cutting prior to placement of select material in the Selected Material Zone.

Stage 2: Extension of subsoil drain to top of the Selected Material Zone after placement of selected material.

(b) Foundation Drains

1. Foundation drains shall be constructed after completion of clearing and stripping operations, and preceding the commencement of embankment construction.

Timing of Construction

CONSTRUCTION

C231.05 SUBSOIL DRAINS

(a) Excavation

Trenches for subsoil and foundation drains shall be excavated to the line, grade, width and depth as shown on the Drawings or as directed by the Principal Certifying Authority.

Dimensions and Grade

The bottom of the trench shall be excavated to the same grade as the design pavement surface. Where the grade of the design pavement surface in the direction of the trench is less than 0.5 per cent, the trench depth shall be increased to provide a minimum grade of fall in the trench of 0.5 per cent. The bottom of the trench shall be excavated so that no localised ponding of water occurs.

Minimum Grade

If at any location the trench is excavated below the specified floor level, the trench shall be backfilled

Over-excavation

with non-porous subgrade material so that when the subgrade material is compacted to a relative compaction, determined by AS 1289.5.4.1, of at least 95 per cent (standard compaction), the bottom of the trench shall be at the specified floor level.

Where a subsoil drain is constructed in two stages, the excavation for Stage 2 shall be carried out after placement and compaction of the selected material zone or the stabilised subgrade layer. The Stage 2 trench shall be excavated to the same line and width as the Stage 1 trench and to a depth to provide a clean, full contact with the filter material placed in Stage 1. All excavated material shall be disposed to waste or incorporated into fills.

Two Stage Construction

(b) Laying of Pipe

Bedding

The 100mm diameter corrugated slotted plastic piping, complying with the Specification for SUBSURFACE DRAINAGE - GENERAL, shall be laid on a bed of filter material 50mm in thickness and shall be laid to the required line and grade.

The type of filter material shall comply with Table C230.1.

Filter Material

Joints in the pipeline shall be kept to the minimum number and, where required, shall be made using a suitable external joint coupling. The inlet end of the pipe shall be fitted with a cap.

Joints and Capping

(c) Backfilling

The trench shall be backfilled with filter material to the subgrade level. The filter material shall be placed and compacted in layers with a maximum compacted thickness of 300mm. Tamping around and over the pipe shall be done in such a manner as to avoid damage or disturbance to the pipe.

Filter Material

The filter material shall be compacted for its full depth to a relative compaction of not less than 100 per cent (standard compaction) as determined by AS 1289.5.4.1.

Compaction of Filter Material

(d) Outlets

Outlets are to be provided at maximum intervals of 80m. Where possible, subsoil drains shall discharge into gully pits and other stormwater drainage structures. Where not possible, an outlet shall be constructed of unslotted plastic pipe of the same diameter as the main run to discharge below the edge of the road shoulder. An outlet structure in accordance with the Drawings shall be constructed at the discharge end.

Pipes and Structures

C231.06 FOUNDATION DRAINS

(a) Excavation

Excavation shall be undertaken in accordance with the requirements of the Specification for SUBSURFACE DRAINAGE - GENERAL and Clause C231.05 of this Specification.

Associated Specification

(b) Laying of Pipe

The 100mm diameter corrugated slotted plastic piping, complying with the Specification for SUBSURFACE DRAINAGE - GENERAL, shall be laid on a bed of filter material 50mm in thickness and shall be laid to the required line and grade.

Bedding

The type of filter material shall be as shown in Table C230.1

Filter Material

Joints in the pipeline shall be kept to the minimum number and, where required, shall be made using a suitable external joint coupling. The inlet end of the pipe shall be fitted with a PVC cap.

Jointing of Pipe

(c) Backfilling

The trench shall be backfilled with filter material in accordance with the provisions of Clause C231.05(c).

Filter Material

The upper section of the trench, above the level specified for filter material backfill, shall be backfilled with suitable earth backfill material, compacted for its full depth to a relative compaction of

Earth Backfill and Compaction

not less than 95 per cent (standard compaction) as determined by AS 1289.5.4.1.

Where shown on the Drawings or as directed by the Geotechnical Engineer and the Principal Certifying Authority, a geotextile, conforming with the requirements of the Specification for SUBSURFACE DRAINAGE - GENERAL, shall be provided at the interface between the filter material and adjoining materials. Laps of 500mm shall be provided at joints in the fabric.

Geotextile

(d) Outlets

An outlet structure in accordance with the detail shown on the Drawings and the Specification for SUBSURFACE DRAINAGE - GENERAL shall be constructed at the discharge end. The outlet shall be located so that erosion of the adjacent area does not occur or shall be protected by the placement of selected stone in the splash zone of the outlet.

Construction Detail

LIMITS AND TOLERANCES

C231.08 SUMMARY OF LIMITS AND TOLERANCES

The limits and tolerances applicable to the various clauses in this Specification are summarised in Table C231.1 below.

Item	Activity	Tolerances	Spec Clause
1.	Excavation Trench Grade	≥0.5%	C231.05(a)
2.	Subsoil Drain Backfill		
	(a) Layer thickness	300mm max	C231.05(c)
	(b) Compaction Relative) Filter and Backfill material	100% standard	C231.05(c)
3.	Outlet Spacing	80m max	C231.05(d)
4.	Foundation Drain Backfill		
	(a) Layer thickness	300mm max	C231.05(c)
	(b) Compaction Relative) Filter material	100% Standard	C231.05(c)
	Backfill material	>95% Standard	

Table C231.1 - Table of Limits and Tolerances

DEVELOPMENT CONSTRUCTION SPECIFICATION

C233

DRAINAGE MATS

AMENDMENT RECORD FOR THIS SPECIFICATION PART

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part. The clause numbering and context of each clause are preserved. New clauses are added towards the rear of the specification part as special requirements clauses. Project specific additional script is shown in the specification as italic font.

The amendment code indicated below is 'A' for additional script 'M' for modification to script and 'O' for omission of script. An additional code 'P' is included when the amendment is project specific.

Amendment Sequence No.	Key Topic addressed in amendment	Clause No.	Amendment Code	Author Initials	Amendment Date

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SPECIFICATION C233 : DRAINAGE MATS**GENERAL****C233.01 SCOPE**

The work to be executed under this Specification covers the installation of Drainage Mats (Blankets).

Scope

Drainage mats shall be constructed where and as shown on the Drawings or as directed by the Geotechnical Engineer and Principal Certifying Authority.

Location

This Specification should be read in conjunction with the Specification for `SUBSURFACE DRAINAGE - GENERAL.

Associated Specification

C233.02 TERMINOLOGY

Type A drainage mats are intended to ensure continuity of a sheet flow of water under fills, to collect surface seepage from a wet seepage area or for protection of vegetation or habitat downstream of the road reserve where a fill would otherwise cut the flow of water.

Type A Mats

Type B drainage mats are constructed to intercept water which would otherwise enter pavements by capillary action or by other means on fills and to intercept and control seepage water and springs in the floors of cuttings.

Type B Mats

C233.04 ORDER OF CONSTRUCTION

Type A drainage mats shall be constructed after the site has been cleared and grubbed and before commencement of embankment construction.

Type A Mats

Type B drainage mats shall be constructed after completion of the subgrade construction and before construction of the pavement.

Type B Mats

CONSTRUCTION**C233.05 TYPE A MATS**

Type A drainage mats shall be constructed under embankments as and where shown on the Drawings or as directed by the Geotechnical Engineer and Principal Certifying Authority.

Location

After the embankment foundation has been trimmed and any necessary trench drains installed, a geotextile complying with the requirement of the Specification for SUBSURFACE DRAINAGE - GENERAL, shall be laid on the embankment foundation. The area of geotextile laid shall be sufficient to cover the area of the Type A drainage mat and an additional amount for enclosing the sides of the drainage mat after the filter material has been placed. Laps of minimum width of 500mm shall be provided at each join in the geotextile.

Placing of Geotextile

Filter material, as shown on the Drawings or as determined by the Geotechnical Engineer and Principal Certifying Authority, shall be placed on the geotextile and compacted to the satisfaction of the Geotechnical Engineer and Principal Certifying Authority. The minimum thickness of the compacted filter material shall be 300mm plus an allowance for the expected consolidation of the embankment foundation under the embankment load or 500mm if the amount of the expected total consolidation of the embankment foundation is not known. The filter material shall be placed in two or more layers so that no layer, when compacted, has a thickness greater than 250mm.

Placing of Filter Material

After completion of placement and compaction of the filter material, geotextile shall be placed on top of and around the sides of the filter material so that the filter material is completely enclosed by geotextile. The geotextile shall be secured in such a manner as to prevent movement of the geotextile by wind or by construction plant placing subsequent layers of filter material or earth filling

Securing of Geotextile

over the drainage mat.

An additional layer of geotextile shall be placed on the drainage mat under the base of any rock facing which may be placed as part of the embankment construction. The additional layer of geotextile shall extend beyond the outside and inside faces of the bottom layer of rock.

***Geotextile
under Rock
Facing***

Care shall be taken not to damage the geotextile during the construction of the drainage mat or during placement of subsequent layers of filter material, earth filling or rock facing. Any geotextile so damaged shall be repaired or replaced by the Contractor to the satisfaction of the Geotechnical Engineer and Principal Certifying Authority.

***Damaged
Geotextile***

Type A drainage mats shall extend 2m beyond the toes of embankments and such extensions shall be covered by a 300mm thick layer of filter material, as determined by the Geotechnical Engineer and Principal Certifying Authority. This protective layer shall be placed immediately after completion of construction of each drainage mat.

***Protective
Layer***

Outlets from Type A drainage mats may be surface outlets at the toes of embankments or piped outlets connected to other drainage systems. Where piped outlets are constructed they shall conform to the requirements of the Specification for SUBSURFACE DRAINAGE - GENERAL.

Outlets

C233.06 TYPE B MATS

Type B drainage mats shall be constructed in cuttings as and where shown on the Drawings or as directed by the Geotechnical Engineer and Principal Certifying Authority. Type B drainage mats shall be constructed for the full width of cuttings and for the pavement width in other locations.

***Location and
Width***

After the subgrade material has been compacted and trimmed, a geotextile complying with the requirements of the Specification for SUBSURFACE DRAINAGE - GENERAL, shall be laid on the subgrade. Laps of minimum width of 500mm shall be provided at each join in the geotextile.

***Placing of
Geotextile***

Slotted thick walled unplasticised PVC pressure pipe complying with AS 1477, shall be laid on the geotextile at a distance of 200mm from and parallel to the longitudinal edges of the drainage blanket as shown in the Drawings.

***UPVC
Pressure Pipe***

Filter material shall be placed on the geotextile and compacted to achieve a relative compaction, determined by AS 1289.5.4.1, of at least 100 per cent (standard compaction). Alternatively, the Geotechnical Engineer and Principal Certifying Authority may approve the use of a coarser filter material having a maximum particle size of 75mm and a maximum D90/D10 ratio of three.

***Placing of
Filter Material***

The thickness of the compacted filter material shall be as shown on the Drawings or as directed by the Geotechnical Engineer and Principal Certifying Authority. If the required thickness of compacted filter material is greater than 250mm, the filter material shall be placed in two or more layers so that no layer, when compacted, has a thickness greater than 250mm.

***Thickness of
Filter Material***

After completion of placement and compaction of the filter material, geotextile shall be placed on top of and around the sides of the filter material so that the filter material is completely enclosed by geotextile. The geotextile shall be secured in such a manner as to prevent movement of the geotextile by wind or by construction plant placing pavement layers over the drainage mat.

***Securing of
Geotextile***

Care shall be taken not to damage the geotextile during the construction of the drainage mat or during placement of subsequent pavement layers. Any geotextile so damaged shall be repaired or replaced by the Contractor to the satisfaction of the Geotechnical Engineer and Principal Certifying Authority.

***Damaged
Geotextile***

The surface of the completed drainage mat shall be at the design level for the top of the drainage mat with a tolerance of plus zero and minus 40mm.

***Surface Level
Tolerance***

Outlet structures where specified, or where directed by the Geotechnical Engineer and Principal Certifying Authority, shall be in accordance with the requirements of the Specification for SUBSURFACE DRAINAGE - GENERAL.

LIMITS AND TOLERANCES

C233.08 SUMMARY OF LIMITS AND TOLERANCES

1. The limits and tolerances applicable to the various clauses in this Specification are summarised in Table C233.1 below.

Item	Activity	Tolerances	Spec Clause
1.	Filter Material		
	(a) Layer thickness	250mm max	C233.05 C233.06
2.	Type B Mats		
) Design level at top of mat	+0, -40mm	C233.06

Table C233.1 - Table of Limits and Tolerances

DEVELOPMENT CONSTRUCTION SPECIFICATION

C242

FLEXIBLE PAVEMENTS

AMENDMENT RECORD FOR THIS SPECIFICATION PART

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part. The clause numbering and context of each clause are preserved. New clauses are added towards the rear of the specification part as special requirements clauses. Project specific additional script is shown in the specification as italic font.

The amendment code indicated below is 'A' for additional script 'M' for modification to script and 'O' for omission of script. An additional code 'P' is included when the amendment is project specific.

Amendment Sequence No.	Key Topic addressed in amendment	Clause	Amendment Code	Author Initials	Amendment Date
1	<i>Modification of Primer Seal to Wearing Course</i>	242.25	M	MB	21/01/08
1	<i>Modification of Primer Seal to Wearing Course</i>	242.26	M	MB	21/01/08
1	<i>Definition of Proof Roll</i>	242.18	M	MB	21/01/08

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SPECIFICATION 242 : FLEXIBLE PAVEMENTS

GENERAL

C242.01 SCOPE

The work to be executed under this Specification consists of the supply, spreading, compaction and trimming of base and subbase courses of flexible pavements to the specified levels and thicknesses as shown on the Drawings.

C242.02 TERMINOLOGY

Materials designated as 'base' require the provision of a wearing surface comprising either a sprayed bituminous seal or asphalt up to 50mm thick.

Definitions

Materials designated as 'subbase' require a covering course of 'base'. The subbase may consist of one or more layers.

A flexible pavement consists of a base and a subbase constructed of unbound materials. For the purpose of this Specification it also includes lightly bound pavements.

Modified material incorporates small amounts of stabilising binder to improve the properties of the material without significantly affecting structural stiffness.

C242.04 PAVEMENT STRUCTURES

Flexible or semi-rigid pavement material types and layer thicknesses shall be as shown on the Drawings.

**Material Types
and Layer
Thickness**

C242.05 INSPECTION, SAMPLING AND TESTING

Inspection, sampling and testing of the pavement shall be undertaken by the Contractor in accordance with the requirements of this Specification before, during and after the construction of the pavement. Testing shall be carried out by a NATA registered laboratory with appropriate accreditation and suitably qualified personnel.

**Contractor's
Responsibility**

The Contractor shall provide the Principal Certifying Authority with written notice when testing is being carried out and copies of all test reports for approval to proceed.

Written Notice

Field density tests shall be carried out in accordance with AS 1289.5.3.1, or, with the Principal Certifying Authority's concurrence, with a Nuclear Density Meter in accordance with Clause 242.12.

Density Tests

MATERIALS

C242.06 GENERAL

The Contractor shall submit details of all constituents of the proposed base and subbase materials, including sources of supply and the proposed type and proportion of any binder. These details shall be submitted to the Principal Certifying Authority, supported with test results from a NATA registered laboratory confirming that the constituents comply with the requirements of this Specification.

**Details of
Proposed Base
and Subbase to
be Submitted**

No material shall be delivered until the Principal Certifying Authority has approved the source of supply.

**Source of
Supply**

If, after the Contractor's proposals have been approved, the Contractor wishes to make changes in any of the material constituents the Contractor shall inform the Principal Certifying Authority in writing of the proposed changes. No delivery of material produced under the altered proposal shall

**Variations by
Contractor**

take place without the approval of the Principal Certifying Authority.

At least two days before placement of the material on site, the Contractor shall submit a Certificate from a laboratory with appropriate NATA registration demonstrating and stating that the unbound material or the mix and its constituents comply with the requirements of this Specification. **NATA Certificate**

Ongoing testing of materials during delivery and construction shall be undertaken on samples taken from the site. **Sampling on-site**

C242.07 TRAFFIC CATEGORY

Pavement materials are specified in terms of the Traffic Categories given in Table C242.1 for the calculated design traffic of the pavement. **Pavement Material Traffic Category**

The Traffic Category (or Design Traffic) for the pavement materials shall be as shown on the Drawings. **Drawings**

Pavement Material Traffic Category	Description
1	Roads with design traffic equal to or exceeding 10^7 equivalent standard axle (ESA) repetitions.
2a	Roads with design traffic exceeding 4×10^6 ESAs but less than 10^7 ESAs.
2b	Roads with design traffic exceeding 10^6 ESAs but less than or equal to 4×10^6 ESAs.
2c	Roads with design traffic exceeding 10^5 ESAs but less than or equal to 10^6 ESAs.
2d	Roads with design traffic less than or equal to 10^5 ESAs.

Table C242.1 - Pavement Material Traffic Categories

C242.08 UNBOUND BASE AND SUBBASE

Unbound materials, including blends of two or more different materials, shall consist of granular material which does not develop significant structural stiffness when compacted. Material produced by blending shall be uniform in grading and physical characteristics. **Granular Material**

Unbound crushed rock materials are designated as follows: **Crushed Rock**

DGB20 20mm nominal sized densely graded base
DGS20 20mm nominal sized densely graded subbase
DGS40 40mm nominal sized densely graded subbase

The acceptable material types for each Traffic Category are given in Table C242.2. **Material Types**

Traffic Category	Acceptable Base Material	Acceptable Subbase Material
1	DGB20	DGS20, DGS40
2a	DGB20	DGS20, DGS40
2b	DGB20	DGS20, DGS40
2c	DGB20	DGS20, DGS40
2d	DGB20	DGS20, DGS40

Table C242.2 - Acceptable Pavement Material Types

Base materials shall comply with the requirements of Table C242.3.

Base

Test Method	Description	Base Material Requirements			
		DGB20			
AS 1289.3.6.1	Coarse Particle Size Distribution % passing 75.0mm sieve % passing 53.0mm sieve % passing 37.5mm sieve % passing 26.5mm sieve % passing 19.0mm sieve % passing 13.2mm sieve % passing 9.5mm sieve % passing 6.7mm sieve % passing 4.75mm sieve % passing 2.36mm sieve % passing 0.425mm sieve % passing 0.075mm sieve	- - - 100 95-100 - - 50-70 - 35-55 - -			
AS 1289.3.6.3	Fine Particle Size Distribution Ratios expressed as percentages (for that portion of the material passing 2.36mm sieve) Pass 425mm sieve %	 35-55			
	Pass 75mm sieve % Pass 425mm sieve	35-55			
	Pass 13.5mm sieve % Pass 75mm sieve	35-60			
AS 1289.3.1.1	Liquid Limit (if non plastic) *	max 20			
AS 1289.3.3.1	Plastic Limit (if plastic)	max 20			
AS 1289.3.3.1	Plasticity Index ■	max 6			
T114	Maximum Dry Compressive Strength on fraction passing 19mm sieve (only applies if Plasticity Index is less than 1)	min 1.7 MPa			

Test Method	Description	Base Material Requirements			
		DGB20			
AS 1141.14	Particle Shape by Proportional Calliper % mis-shapen (2 : 1)	max 35			
AS 1141.22	Aggregate Wet Strength ◇				
	For category 1 or 2a For category 2b or 2c For category 2d	min 80 min 70 min 60			
AS 1141.22	Wet/Dry Strength Variation ◇ <u>Dry - Wet</u> % Dry				
	For category 1 or 2a For category 2b or 2c For category 2d	max 35 max 40 max 45			
AS 1289.F1.1	4 day Soaked CBR (98% Modified Compaction)	-			

Table C242.3 - Unbound Base Material Properties**NOTES ON TABLE C242.3:**

Material consisting of rounded river stone shall have a minimum of two fractured faces on at least 75 per cent of the particles larger than 6.70mm.

The maximum value of the Liquid Limit may be increased to 23 for non-plastic material, provided that the value determined is not influenced by the presence of adverse constituents.

For category 2d base materials the maximum Plasticity Index shall be 8.

◇ All fractions of the sample specified by AS 1141.22 must be within specification. The fraction with the highest wet/dry strength variation is the value for determining conformance with the specification. The fractions 19.0mm to 13.2mm and 6.7mm to 4.75mm must be tested.

Subbase materials shall comply with the requirements of Table C242.4

Subbase

Test Method	Description	Subbase Material Requirements				
		DGS20	DGS40			
AS 1289.3.6.1	Coarse Particle Size Distribution	-	-			
	% passing 75.0mm sieve	-	100			
	% passing 53.0mm sieve	-	-			
	% passing 37.5mm sieve	100	-			
	% passing 26.5mm sieve	95-100	50-85			
	% passing 19.0mm sieve	-	-			
	% passing 13.2mm sieve	-	-			
	% passing 9.5mm sieve	50-70	30-55			
	% passing 6.7mm sieve	-	-			
	% passing 4.75mm sieve	35-55	25-50			
	% passing 2.36mm sieve	-	-			
	% passing 0.425mm sieve	-	-			
	% passing 0.075mm sieve					

Test Method	Description	Subbase Material Requirements				
		DGS20	DGS40			
AS 1289.3.6.3	Fine Particle Size Distribution Ratios expressed as percentages (for that portion of the material passing 2.36mm sieve) Pass 425mm sieve %	35-55	35-60			
	B. Pass 75mm sieve % Pass 425mm sieve	35-55	35-60			
	C. Pass 13.5mm sieve % Pass 75mm sieve	35-60	35-65			
AS 1289.3.1.1	Liquid Limit (if non plastic)	max 23	max 23			
AS 1289.3.3.1	Plastic Limit (if plastic)	max 20	max 20			
AS 1289.3.3.1	Plasticity Index	max 12	max 12			
T114	Maximum Dry Compressive Strength on fraction passing 19mm sieve (only applies if Plasticity Index is less than 1)	min 1.0 MPa	min 1.0 MPa			
AS 1141.14	Particle Shape by Proportional Calliper % mis-shapen (2 : 1)	max 35	max 35			
AS 1141.22	Aggregate Wet Strength ①	min 50kN	min 50kN			
AS 1141.22	Wet/Dry Strength Variation ◇ <u>Dry - Wet</u> % Dry	max 60	max 60			
AS 1289.F1.1	4 day Soaked CBR (98% Modified Compaction)	-	-			

Table C242.4 - Unbound Subbase Material Properties

NOTES ON TABLE C242.4:

Material consisting of rounded river stone shall have a minimum of two fractured faces on at least 75 per cent of the particles larger than 6.70mm.

All fractions of the sample specified by AS 1141.22 must be within specification. The fraction with the highest wet/dry strength variation is the value for determining conformance with the specification. The fractions 19.0mm to 13.2mm and 6.7mm to 4.75mm must be tested.

Where the proposed unbound base material complies with all of the requirements of Table C242.3 except gradings (AS 1289.3.6.1 and AS 1289.3.6.3), the Contractor may propose the use of the material, subject to approval of the Council, if the material complies with the RTA Modified Texas Triaxial Classification Number (T171) requirements specified in Table C242.5, (T171 tested at not less than 85 per cent of Optimum Moisture Content and 98 per cent of Maximum Dry Density as determined by AS 1289.5.2.1).

**Modified Texas
Triaxial
Classification**

Traffic Category	Modified Texas Triaxial Classification Number (Test Method T171)
1	max 2.0
2a	max 2.2
2b	max 2.5
2c	max 3.0
2d	max 3.0

Table C242.5 - RTA Modified Texas Triaxial Classification Number Requirements

DELIVERY, STOCKPILING AND PROCESSING OF PAVEMENT MATERIAL

C242.11 DELIVERY TO SITE

Materials shall be supplied sufficiently damp to avoid segregation and loss of fines during transit.

Damp Condition

C242.12 STOCKPILING OF UNBOUND MATERIALS

Stockpile sites shall be located as shown on the Drawings or as approved by the Principal Certifying Authority.

Stockpile Sites

Stockpile sites, which shall be cleared of all vegetation and extraneous matter, shall be shaped to form a crown so as to be free draining and compacted over the whole area to provide a relative compaction, determined by AS 1289.5.4.1 for standard compactive effort, of not less than 95 per cent.

**Compacted and
Free Draining**

Stockpiles and stockpile sites shall be maintained so as to prevent the stockpiled materials from becoming intermixed or contaminated with foreign material.

**Stockpile
Requirements**

The total height of any stockpile shall not exceed 2.5 m.

Height

Stockpiles shall be of uniform shape with side slopes neither steeper than 1.5 to 1 nor flatter than 3 to 1.

Shape

The worked face of any stockpile shall be the full face of the stockpile. The stockpiled material shall be maintained at a moisture content sufficiently damp to avoid loss of fines.

Maintained Damp

At the completion of the works, stockpile sites shall be cleared of all surplus material and left in a clean and tidy condition.

**Completion of
Work**

SPREADING OF PAVEMENT MATERIAL

C242.14 SPREADING PAVEMENT MATERIALS

Unbound materials shall not be spread upon an underlying pavement layer which has a moisture content exceeding 90 per cent, the laboratory optimum moisture content as determined by AS 1289.5.2.1 or which has become rutted or mixed with foreign matter. The underlying layer shall be corrected to comply with this Specification before spreading of the next layer of pavement.

Underlying Layer Quality

Each layer of material shall be deposited and spread in a concurrent operation and, after compaction, the finished surface levels on the base and subbase courses shall be within the permitted tolerances stated in Clause C242.22(c) without subsequent addition of material. The thickness of each compacted layer shall be neither less than 100mm nor more than 200mm for all pavement layer types.

Tolerances

When spread for compaction processes the moisture content of the base or subbase materials shall be in the range of 60-90 per cent of laboratory optimum moisture content in accordance with AS 1289.5.2.1.

TRIMMING AND COMPACTION

C242.15 GENERAL REQUIREMENTS

Each layer of the base and subbase courses shall be uniformly compacted over its entire area and depth to satisfy the requirements of relative compaction set out in Clauses C242.19 and C242.20.

Uniform Compaction

On sections of pavement with one-way crossfall, compaction shall begin at the low side of the pavement and progress to the high side. On crowned sections, compaction shall begin at the sides of the pavement and progress towards the crown. Each pass of the rollers shall be parallel with the centreline of the roadway and uniformly overlap each preceding pass.

Compaction Procedure

At locations where it would be impracticable to use self-propelled compaction plant, the pavement material shall be compacted by alternative hand-operated plant approved by the Principal Certifying Authority.

Hand Operated Plant

If any unstable areas develop during rolling, the unstable material shall be rejected. The rejected material shall be removed for the full depth of the layer, disposed of and replaced with fresh material in accordance with Clause C242.24.

Unstable Areas

The placement of subsequent layers shall not be allowed until the requisite testing has been completed and the test results for each layer have been accepted by the Principal Certifying Authority.

Placing Subsequent Layers

Any unbound material in a layer that has attained the specified relative compaction but subsequently becomes wetted up shall be dried out and, if necessary, uniformly recompacted and trimmed to meet the specified density requirements and level tolerances.

Excessive Moisture Content

ACCEPTANCE OF COMPACTED LAYERS

C242.17 ACCEPTANCE

Acceptance of work, as far as compaction is concerned, shall be based on:

Requirements

- (a) density testing of each layer,
- (b) proof rolling of each layer, and

- (c) deflection testing on the completed final pavement layer.

A lot shall be nominated by the Contractor, but shall conform to the following:

- (a) cover only a single layer of work which has been constructed under uniform conditions in a continuous operation and not crossing any transverse construction joints;
- (b) for unbound materials it may equal a day's output using the same material.

C242.18 COMPACTION ASSESSMENT

For residential, commercial and industrial roads, the Contractor shall arrange for testing to assess compaction on the basis of either one test per 50 lin. m or 250 m² (whichever is the greater) with a minimum of two tests in any one length. The results shall be presented to the Principal Certifying Authority for approval.

Sampling

For rural roads, the Contractor shall arrange for testing to assess compaction on the basis of either one test per 100 lin. m or 500 m² (whichever is the greater) with a minimum of two tests in any one length. The results shall be presented to the Principal Certifying Authority for approval.

Acceptance of final pavement layer shall be determined according to the elastic rebound deflection. The elastic rebound deflection shall be taken as the maximum deflection in accordance with Test Method T160 utilising the Benkelman Beam or equivalent. The average maximum deflection for any lot shall not exceed the limits stated in AUSTROADS. The co-efficient of variation (CV) in recorded deflections shall not exceed 30 per cent. Measurements shall be taken at maximum spacings of 10 metres (alternating wheel paths) in each lane, with not less than 4 measurements per any one length of road.

Benkelman Beam Testing

Proof rolling shall be performed on all subgrades, subbases and base courses with the method, instruments and results acceptable to the Principal Certifying Authority.

Proof Roll Test

C242.19 RELATIVE COMPACTION

The relative compaction of pavement material at each location tested for in-situ dry density shall be calculated in accordance with AS 1289.5.4.1 as follows:

Calculation

$$\text{Relative Compaction (per cent)} = \frac{\text{In-situ dry density}}{\text{Comparative dry density}} \times 100$$

The Council may approve some or all of the in-situ dry density testing to be carried out with a single probe Nuclear Density Meter in the direct transmission mode in accordance with AS 1289.5.8.1.

In-Situ Dry Density Testing

For unbound layers, the sample shall be tested in accordance with AS 1289.5.2.1 to determine the maximum dry density (modified compactive effort) for the material.

Maximum Dry Density

The maximum dry density so determined shall be used as the comparative dry density in relative compaction calculations for all like material from that lot or day's production placed in a single layer of work whichever is the lesser.

Comparative Dry Density

C242.20 REQUIREMENTS FOR ACCEPTANCE

A lot shall be accepted for compaction if:

a. for sub-base:

- i. The minimum value of all calculated relative compaction for modified compactive effort is not less than 95 per cent within the lot or the area of pavement being assessed.
- ii. Pass proof roll test
- iii. Thickness within tolerance as determined from test pits at locations nominated by the Principal Certifying Authority.

b. for base:

- i. the minimum value of all calculated relative compaction for modified compactive effort is

not less than 98 per cent within the lot or the area of pavement being assessed.

- ii. Pass proof roll test
- iii. Thickness within tolerance as determined from test pits at locations nominated by the Principal Certifying Authority.
- iv. Comply with deflection criteria of Benkelman Beam Testing.

Areas of pavement not achieving these specified values shall be rejected. Unbound layers may be reworked as provided by Clause C242.21. **Rejection**

C242.21 REWORKING OF REJECTED UNBOUND LAYERS

Lots or areas of pavement that have been rejected in regard to compaction shall be reworked before resubmission for compaction assessment. **Reworking**

Material that has become degraded, segregated or otherwise reduced in quality by reworking shall be rejected. The rejected material shall be removed, disposed of and replaced with fresh material complying with this Specification in accordance with Clause C242.24. When a lot or area of pavement is resubmitted for compaction assessment, testing shall be carried out in accordance with Clauses C242.18 and C242.19. **Rejected Material**

C242.22 TOLERANCES

a) General

The tolerances stated are the acceptable limits of departure from the dimensions shown on the Drawings. **Tolerances**

b) Width

At any cross section without kerb and/or guttering, and for pavement layers extending under the kerb and/or guttering, the horizontal dimension measured from the design centre line to the edge of the constructed pavement surface shall be neither less than 50mm less than the dimension nor more than 300 mm greater than the dimension shown on the Drawings. **Horizontal Dimensions**

The average width of the layer determined from measurements at three sites selected at random by the Principal Certifying Authority over any 200 metre road length, or part thereof, shall be not less than the specified width. **Average Width**

c) Levels and Surface Trim

The levels of the finished surface of the top of the unbound subbase course shall not vary from the design levels by more than ± 20 mm. **Subbase Surface Level**

Level tolerances at the top of the unbound base course shall not exceed ± 10 mm. In addition, where kerb and gutter exists or is being constructed, the level of the top of the base course adjacent to the kerb and gutter shall not vary by more than ± 5 mm from the lip level of the gutter minus the design thickness of the wearing surface. **Base Surface Level**

The design level of the top of the subbase course shall be determined from the design level of the finished road surface less the thickness of the base course and the wearing course. **Subbase Design Level**

The pavement surface after trimming and immediately prior to sealing shall be of a quality such that the deviation under a 3 metre straight edge placed in any direction does not exceed 12 mm. **Straight Edge Deviation**

C242.23 ACTION ON REJECTION

(a) Unbound Materials

Rejection Criteria

A lot that has not complied with the requirements for width or level tolerance as set out in Clauses C242.22(b) and C242.22(c) respectively shall be rejected except as otherwise provided in this Clause. Rejected lots shall be removed, disposed of and replaced with fresh material in accordance with Clause C242.24.

Corrective Action

Notwithstanding the above, where the rejected lot can be corrected by further trimming, the Principal Certifying Authority may allow the surface to be corrected without complete removal and replacement with fresh material. Such trimming shall be undertaken in a manner that produces a uniform, hard surface and shall be achieved by cutting only without filling. After any such cutting, the level tolerances in Clause C242.22(c) shall apply.

C242.24 REMOVAL AND REPLACEMENT OF REJECTED COURSES

Rejected Material

Sections of the work that have been rejected shall be removed from the work and replaced with fresh material. Rejected material shall be removed from site.

Length to be Removed

In rejected sections the material shall be removed over the full length of the rejected lot. Any damage to underlying or abutting layers or structures shall be made good by the Contractor using methods approved by the Principal Certifying Authority.

Superintendents Discretion

The Principal Certifying Authority may approve removal for less than the full width as constructed if the cause of the rejection of the work can be isolated transversely to the Principal Certifying Authority's satisfaction. In this case, the new longitudinal cold joint shall be formed and located along the centreline of the road pavement.

Inspection Before Replacement

After removal of rejected base or subbase course material, the section shall be presented for inspection by the Principal Certifying Authority before replacement work is commenced.

Replacement Material

Materials used as replacement materials, and the subsequent spreading, compaction, trimming, curing and testing of the replacement materials, shall comply with the requirements of this Specification.

C242.25 MAINTENANCE BEFORE COMPLETION OF WEARING SURFACE

Completion Time Limit

Following the Principal Certifying Authority's acceptance of any section of the work, the Contractor shall maintain the prepared surface of the base in the condition specified for acceptance until the wearing course is completed. The wearing course shall be provided in accordance with the Specification for ASPHALTIC CONCRETE within seven days of the date of the acceptance of such sections, unless otherwise approved by the Principal Certifying Authority.

Contractor's Responsibility

Should the Principal Certifying Authority withdraw permission to proceed due to a deterioration of the base course during the seven day period, the Contractor shall re-prepare the base course and re-present the base course for inspection by the Principal Certifying Authority.

OPENING PAVEMENT TO TRAFFIC

C242.26 GENERAL REQUIREMENTS

Restrictions on Movement

For unbound pavements, construction plant and vehicles not involved in the current construction or testing of the work shall not be permitted to use the pavement until the wearing course has been applied, unless otherwise approved by the Principal Certifying Authority.

LIMITS AND TOLERANCES

C242.27 SUMMARY OF LIMITS AND TOLERANCES

The tolerances applicable to the various clauses in this Specification are summarised in the Table below:

Item	Activity	Tolerances	Spec Clause
1.	Stockpile Sites	(i) Relative Compaction >95% (ii) Stockpile height <3m (iii) Stockpile batter <1.5:1 and >3:1	C242.12 C242.12
2.	Spreading Pavement Materials		
	(i) Compacted Layer Thickness	100mm min 200mm max	C242.14
3.	Compaction Acceptance		
	Minimum value of all calculated relative compaction results	95 % (modified) - subbase 98% (modified) - base	C242.20
4.	Width of Pavement		
	Design centre-line to edge of constructed pavement	- 50mm to +300mm of dimensions on Drawings	C242.22(b)
	(ii) Average Width	The average width determined from 3 random sites over any 200m road length, or part thereof, shall be not less than the specified width.	C242.22(b)
5.	Surface Level		
	Subbase levels	± 20mm from design level	C242.22(c)
	(ii) Base levels	± 10mm from design level	C242.22(c)
	(iii) Base levels adjacent to Kerb and Gutter	± 5mm from the lip levels of adjacent gutter minus design thickness of wearing surface.	C242.22(c)
	(iv) Shape	Deviation from a 3m long straightedge on base surface immediately prior to sealing shall be less than 12mm	C242.22(c)

Table C242.3 - Summary of Limits and Tolerances

DEVELOPMENT CONSTRUCTION SPECIFICATION

C244

SPRAYED BITUMINOUS SURFACING

AMENDMENT RECORD FOR THIS SPECIFICATION PART

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part. The clause numbering and context of each clause are preserved. New clauses are added towards the rear of the specification part as special requirements clauses. Project specific additional script is shown in the specification as italic font.

The amendment code indicated below is 'A' for additional script 'M' for modification to script and 'O' for omission of script. An additional code 'P' is included when the amendment is project specific.

Amendment Sequence No.	Key Topic addressed in amendment	Clause No.	Amendment Code	Author Initials	Amendment Date

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SPECIFICATION C244 SPRAYED BITUMINOUS SURFACING

GENERAL

C244.01 SCOPE

1. The work to be executed under this Specification consists of the supply of all materials and the application of any or all of the following types of sprayed bituminous surfacing:
 - (i) Prime
The application of a primer of field or refinery cutback bitumen without aggregate to provide penetration of the surface (preferably from 5 to 10 mm) and waterproofing.
 - (ii) Primerseal
The application of a primerbinder of field or refinery cutback bitumen to provide surface penetration (preferably from 2mm to 5mm), into which aggregate is incorporated to provide a temporary wearing surface prior to the application of the final wearing surface.
 - (iii) Seal or Reseal
The application of a bitumen binder into which aggregate is incorporated to provide a durable wearing surface.
2. The locations and required types of sprayed bituminous surfacings, including types of binders and aggregate sizes, shall be as shown on the Drawings and/or as detailed in Annexure C244.A.
3. For multiple application treatments, the binder and aggregate may be required to be laid in one or more separate applications.

MATERIALS

C244.03 BINDERS

(a) Bitumen

1. Bitumen shall be Class 170 conforming to AS2008.

(b) Refinery Cutback Bitumen

1. Refinery cutback bitumen shall conform to AS 2157.

C244.04 ADDITIVES

(a) Cutter Oil

1. Cutter oil shall conform to the requirements of AS3568, displaying an Abel flash point of not less than 38°C and a viscosity at 40°C not greater than 2.0 millipascal seconds, with the following qualifications to the properties for its classification as set down in AS3568 Table 1:
 - (i) Either "Aniline point" or "Aromatic content" is acceptable.
 - (ii) There shall be no "Density" requirement.
 - (iii) The presence of water, assessed visually as an immiscible phase in any sample of the material, shall be grounds for its rejection. AS2341.9 shall not be demanded as a referee test if more than 0.1% of liquid water is found in any delivery or batch.
 - (iv) If the viscosity is calculated by the equation given in Table 1, Note 3 of AS3568, "f" shall

**Cutter
Specification**

be taken to be 0.0009 per °C.

2. Delivery and storage procedures for cutter oil delivered in drums or in bulk shall ensure that all containers are clean and free from any deleterious material prior to filling with cutter oil, and all drums are stored so as to ensure that entry of water through seals or welds in the drums is prevented.

Delivery & Storage

(b) Adhesion Agent

Adhesion Agent

1. Bitumen adhesion agents shall conform to RTA Specification 3259.

C244.05 AGGREGATE

1. Aggregate shall conform to AS 2758.2.
2. The Contractor shall obtain test results for each lot/stockpile of aggregate, and certification of compliance with AS 2758.2 from a suitably accredited NATA laboratory, before aggregate from the lot is incorporated in the Works.

Specification

Test Requirements

C244.06 PRECOATING AGENT

1. Aggregate precoat agent(s) shall conform to RTA Specification 3258.

Specification

C244.07 SAMPLING AND TESTING OF MATERIALS

1. Sampling and testing of materials shall be arranged by the Contractor and carried out by a NATA registered laboratory in accordance with the relevant materials specifications cited in this Specification.

NATA Registration

DESIGN OF BITUMINOUS SURFACING

C244.08 GENERAL

1. Reserved.
2. The Contractor shall carry out the design of bituminous surfacing in accordance with the procedure contained in AUSTROADS Design of Sprayed Seals (1987) and shall submit these design details to the Principal Certifying Authority. Design application rates shall be known as "nominated application rates" and materials as "nominated materials".
3. The following additional details are required:
 - (i) Test results for all nominated materials.
 - (ii) Aggregates - source, geological type, nominated grading, ALD.
 - (iii) Precoat agent and bitumen adhesion agent - types and proportions.
 - (iv) Bitumen - refinery source, certification of compliance with AS2008.
 - (v) Cutback bitumen - refinery source of bitumen, source of cutter, certification of compliance with AS2157.

AUSTROADS Design Procedure

Additional Information Sought

APPLICATION OF SPRAYED BITUMINOUS SURFACING

C244.09 GENERAL

1. The Contractor shall carry out sprayed bituminous surfacing so as to:
 - (i) provide a uniform application of binder with adequate adhesion to the underlying surface;

Work Quality

- (ii) provide a complete cover of interlocking aggregate particles, and
 - (iii) achieve effective bond between binder and aggregate.
2. The Contractor shall give the Principal Certifying Authority two days' notice of intention to commence sprayed bituminous surfacing, confirming spray rates, nominal aggregate size and ALD, and shall obtain the Principal Certifying Authority's approval to proceed.

C244.10 PRECOATING OF AGGREGATE

- 1. The aggregate precoat agent shall be applied to the aggregate in a manner and at a rate and time which will provide a complete, light, uniform, effective cover of all aggregate particles at the time of spreading. **Application**
- 2. Precoating of aggregate shall not be carried out when rain is imminent. If aggregate has been precoat and rain appears imminent, the aggregate shall be adequately covered to prevent the precoat material being washed from the aggregate particles. **Weather Conditions**
- 3. The Contractor shall take precautions, such as covering stockpiles, to prevent settlement of dust, penetration of moisture or drying out of the precoat agent on the stockpiled aggregate. **Cover for Stockpiles**

C244.11 PLANT

- 1. A mechanical sprayer shall be used to apply primer, primerbinder and binder. The sprayer shall have a current Sprayer Certificate (RTA Form 354) issued by the Roads and Traffic Authority of NSW. **Sprayer Certificate**
- 2. The spray nozzles shall be of the make and type endorsed on the Sprayer Certificate. Any nozzles which may be damaged or become unduly worn or defective shall be replaced by satisfactory nozzles of similar type. A sufficient number of nozzles for this purpose shall be available at all times. **Spray Nozzles**
- 3. Mechanical spreading equipment shall be used to spread aggregate and shall be capable of achieving a uniform spreading rate. **Aggregate Spreader**
- 4. Rollers shall be in accordance with Clause C244.20. **Rollers**
- 5. The Contractor shall remove from the work any plant or equipment not fully operational or not in a satisfactory condition for carrying out work in accordance with this Specification. **Faulty Equipment**

C244.12 PREPARATION OF PAVEMENT SURFACE

- 1. Before the application of primer, primerbinder or binder, the pavement surface shall be swept by the use of a mechanically-operated rotary road broom or suction broom to provide a uniformly clean surface. If necessary, additional sweeping shall be done by hand, using stiff brooms. Sweeping shall extend at least 300mm beyond each edge of the area to be sprayed. **Pavement Sweeping**
- 2. Adherent patches of foreign material shall be removed from the surface of the pavement. **Foreign Matter on Pavement**
- 3. For the spraying of primer or primerbinder, the pavement surface shall be slightly damp so as to impede dust interfering with initial adhesion. **Damp Pavement**

C244.13 REVIEW OF NOMINATED APPLICATION RATES

- 1. The Contractor shall select the locations where each lot of aggregate is to be incorporated in the Works. **Aggregate Lots**
- 2. The Contractor shall review the bituminous surfacing design at each location based on the actual ALD test result for the lot of aggregate instead of the ALD value of the nominated **Target Application Rates**

aggregate, and using the AUSTROADS Design of Sprayed Seals (1987). The revised application rates shall be known as “target application rates”.

3. The Contractor shall submit details of the aggregate lot and target application rates of each work location to the Principal Certifying Authority for approval before commencing sprayed sealing at that location. **Contractor's Responsibility**

C244.14 BINDER TEMPERATURE REQUIREMENTS

1. Bitumen and cutback bitumen shall be within the range shown in Table C244.1 when incorporated with cutter oil. **Mixing Temperature**
2. Temperature ranges for spraying of primers, primer binders and binders shall be within the ranges shown in Table C244.1. **Spraying Temperature**
3. The Contractor shall measure and record the temperature of the binder, using a thermometer. The thermometer shall be verified as accurate to within 2.5 percent of the correct temperature. **Measurement of Temperature**
4. If the temperature of the bituminous material is below the applicable lower limit from Table C244.1, the bituminous material may be heated providing safe heating practices are adopted. Burners shall not be used unless the level of the material in the heating tank is at least 250 mm above the tops of the heating tubes. The Contractor shall comply with the Bush Fires Act, 1949 and the Local Government Act 1993. Two or more suitable fully-charged pressurised chemical fire extinguishers shall be placed conveniently to the heaters at all times while heating is in progress. **Safe Heating Practices**
5. During heating, the temperature of the bituminous material shall not exceed the applicable upper limit from Table C244.1. The temperature of the bituminous material just above the heating tubes shall be checked at regular intervals to ensure that there is no local overheating. **Heating Limits**
6. Bituminous materials shall not be held at temperatures within the ranges shown in Tables C244.1 for periods in excess of ten hours. **Max Period of Heating**
7. Any bituminous material which has been overheated shall not be used in the work. The Contractor shall record disposal of such material confirming its exclusion from use under this contract. **Overheated Bitumen**

C244.15 PAVEMENT TEMPERATURE AND WEATHER CONDITIONS

1. The Contractor shall measure and record pavement temperatures at regular intervals during the course of the work. For this purpose, a suitable type of thermometer shall be placed in direct contact with the pavement and allowed to remain in position until the reading becomes steady. The bulb of the thermometer shall be covered from direct sunlight with a small heap of grit or similar material. **Measurement and Recording**
2. If the pavement is partly in sun and partly in shade, the temperatures for both conditions shall be taken and recorded. **Sun and Shade Conditions**
3. Spraying primers, primerbinders and binders shall be undertaken only if the pavement temperature has been at or above the minimum temperature shown in Table C244.1 for at least one hour before commencement of spraying and does not fall below the specified minimum pavement temperature for spraying during the period of spraying. **Minimum Pavement Temperature**
4. Spraying shall not be carried out on a wet pavement, while rain appears imminent or during high winds or dust storms. **Spraying Conditions**

TYPE OF MATERIAL	CLASS OR GRADE	EQUIVALENT % CUTTER	MAX HEATING TEMP (°C)	MIN PAVEMENT TEMP (°C)	SPRAYING TEMP (°C)
Bitumen	170		190	10	160 - 190
Cutback Bitumen	AMC 00	Conventional Cutter	30	10	10 - 20
	AMC 0	56)	55	10	35 - 55
	AMC 1	44)	80	10	60 - 80
	AMC 2	34)	100	10	75 - 100
	AMC 3	27)	115	10	95 - 115
	AMC 4	21)	135	10	110 - 135
	AMC 5	16)	150	10	120 - 150
	AMC 6	11)	160	10	135 - 160
	AMC 7	7)	175	10	150 - 175
		3)			
Cutback Bitumen	FC2	Fast Evaporating Cutter	95	5	70 - 75
	FC3	25)	95	5	80 - 90
	FC4	20)	110	5	95 - 110
	FC5	15)	140	10	120 - 140
	FC6	10)	150	10	130 - 150
	FC7	7)	160	10	140 - 160
		3)			

Table C244.1 - Temperature Limits

C244.16 INCORPORATION OF CUTTER OIL AND ADHESION AGENT

(a) Cutting Back Bitumen

The Contractor shall determine and record the proportion of cutter oil required for each sprayer load, using MR Form 466 and based on the measured pavement temperatures.

Contractor's Responsibility

The cutter oil, without being previously heated, shall be pumped into the sprayer, followed by the hot bitumen. The full sprayer load of cutback bitumen shall be circulated at a rate of at least 700 litres per minute for twenty minutes to ensure that the mixture is homogeneous.

Mixing Cutter Oil

If a part sprayer load of field cutback bitumen is unused on the date of mixing, and needs to be returned to the heater tanks, it shall be placed in an empty tank reserved for that purpose. No bitumen or cutter shall be added to the returned cutback bitumen unless the tank is fitted with an effective mechanical mixing system. When the returned cutback bitumen is subsequently used as part of a sprayer load, allowance shall be made for the cutter oil contained in the returned cutback bitumen.

Unused Cutback Bitumen

(b) Bitumen Adhesion Agent

Where bitumen adhesion agent is to be included, it shall be added to the bitumen in the sprayer and the mixture circulated at a rate of at least 700 litres per minute for fifteen minutes before spraying.

Mixing Adhesion Agent

C244.17 APPLICATION OF BINDER

(a) General

The area to be sprayed with primer/binder or binder shall be limited to the area which can be covered with aggregate at the target application rate within fifteen minutes of spraying bitumen or cutback bitumen.

Limit on Spray Area

Nominated and target application rates and quantities of binder shall be based on the volumes of bitumen measured at a temperature of 15°C and shall not include any bitumen adhesion agent

Nominated and Target Rates

and/or cutter oil.

Where bitumen adhesion agent and/or cutter oil have been added to the binder, the application rate of the total binder at 15°C shall be adjusted to allow for the quantities of bitumen adhesion agent and/or cutter oil in the mixture. **Adjustment of Application Rate**

The Contractor shall determine the hot application rate of total binder, including bitumen adhesion agent and/or cutter oil, using MR Form 466. **Calculation of Hot Application**

Where refinery cutback bitumen is used as the binder, the target application rate of binder shall be increased by the Contractor to allow for the percentage cutter oil in the mixture as indicated in Table C244.1. **Refinery Cutback Bitumen Variation**

(b) Operation of the Sprayer

The type of spray nozzles to be used on the spray bar of the sprayer shall be compatible with the nature of the binder to be sprayed and its application rate. **Nozzle Type**

Where the longitudinal edges of spray runs are not required to overlap, either special type end nozzles or intermediate nozzles set with a jig as end nozzles may be used. Where an overlap is required, the overlap of spray between adjacent longitudinal runs shall be in the range 50-100mm for special type end nozzles. If intermediate nozzles are to be used to overlap adjacent longitudinal sprays the nozzles shall be set in the normal manner for intermediate nozzles and the overlap shall be in the range 250-350mm. **Spray Overlap**

The spraying of primer, primerbinder or binder for each run of the sprayer shall commence on a protective strip of heavy paper weighing not less than 120 grams per square metre laid across and held securely to the pavement surface beforehand. The sprayer shall commence moving at a sufficient distance in advance of the protective strip to ensure that the road speed for correct application is attained at the commencement of spraying. **Protective Paper Strip**

The sprayer shall maintain a constant road speed throughout the length of each sprayer run. **Road Speed**

The spraying for each run shall terminate on a protective strip of paper laid across and held securely to the pavement surface beforehand. The width of paper at the commencement and/or termination of each run shall not be less than that endorsed on the Sprayer Certificate. **Terminating Paper Strip**

Spraying shall cease immediately any defect develops in the spraying equipment and spraying shall not recommence until the fault has been rectified. **Equipment Defects**

Where any blockage or partial blockage of nozzles occurs, spraying shall cease immediately. If the blockage is due to the condition of the binder being sprayed, that load together with any binder from the same bulk tanker or supply unit shall not be used. **Nozzle Blockage**

Where a mechanical sprayer is not able to satisfactorily spray small areas or areas of irregular shape, such areas shall be sprayed by means of the hand spray equipment attached to the sprayer. **Hand Spraying**

After each sprayer run, the quantity of binder sprayed shall be checked against the area covered and any necessary adjustments shall be made to ensure that the target application rate is achieved in subsequent runs. If the actual application rate of binder after three runs differs by more than 5 per cent from the target application rate, the sprayer shall not be used until a new Sprayer Certificate has been obtained. **Application Rate Checks**

Areas not within 5 percent of the target application rate of primer, primerbinder or binder shall constitute a 'Non-conformance' under the Contract. **Non-conformance**

C244.18 WORK RECORDS

Particulars of the work performed shall be recorded by the Contractor on RTA Form 23 - Bituminous Surfacing Daily Record or a record of at least equivalent detail. Details of primer, primerbinder, binder and aggregate applied shall be recorded immediately after every sprayer run. Each form shall **Sprayer Run Records**

be signed by the Contractor's representative as a true record of the work performed. The Contractor shall supply to the Principal Certifying Authority a copy of each completed form.

C244.19 CONTROL OF TRAFFIC

The Contractor shall provide for traffic in accordance with the requirements of the Specification for CONTROL OF TRAFFIC while undertaking the work and shall take all necessary precautions to protect the work from damage until such time as the new seal coat has developed sufficient strength to carry normal traffic without disturbance of the aggregate.

Contractor's Responsibility

Where early use of the new seal is needed to facilitate the movement of traffic, vehicles may be allowed to run on the work after initial rolling has taken place provided that vehicles are controlled to such slow speeds that no displacement of aggregate occurs. Where necessary, the Contractor shall use patrol vehicles to ensure that traffic travels at an acceptable speed.

Speed Control

The Contractor shall take all necessary steps to avoid or minimise delays and inconvenience to road users during the course of the work. Where adequate detours or side tracks are included in the Contract or are otherwise available, traffic shall be temporarily diverted while the work is in progress.

Minimise Traffic Delays

If facilities for the diversion of traffic are not available, the Contractor may spray part width of the pavement in the one operation and make available to traffic the adjacent strip of roadway, except during the actual spraying operation when all traffic movement through the work shall cease. Traffic shall not be permitted to encroach upon the edge of the sprayed bituminous material until such time as it is covered with aggregate.

Part Width Spraying

C244.20 APPLICATION AND INCORPORATION OF AGGREGATE

The application of aggregate shall proceed after spraying is commenced and shall be completed within fifteen minutes of spraying bitumen or cutback bitumen.

Time for Completion

Wet aggregate shall not be used.

Wet Aggregate

The Contractor shall apply the aggregate of the specified nominal size and at the target aggregate application rate. Sufficient loaded and measured trucks of dry aggregate shall be at the site to provide full cover for the area sprayed.

Procedure

The aggregate shall be spread uniformly over the sprayed surface by means of suitable mechanical spreading equipment.

Uniform Application

Any bare or insufficiently covered areas shall be re-run by the mechanical spreader or covered by hand as necessary to give a uniform and complete coverage. Any aggregate spread in excess of the target aggregate application rate shall be removed before rolling is commenced.

Deficient or Excess Aggregate

After the aggregate has been applied to each section of the work, initial rolling shall be carried out with two or more dual axle smooth pneumatic tyred multi-wheel rollers of minimum load of one tonne per tyre and minimum tyre pressure of 550 kPa. Initial rolling shall continue until the aggregate is firmly embedded in the primerbinder or binder.

Initial Rolling

If the aggregate is not evenly distributed over the surface of the pavement, the surface shall be traversed with a light drag broom or by light hand brooming after the initial rolling. If the broom has any tendency to dislodge aggregate particles bedded in the primerbinder or binder, the Contractor shall defer or eliminate the drag brooming.

Brooming of Surface

Backrolling shall then be carried out for a minimum period of one hour per roller per 1000 square metres sprayed.

Backrolling

Where a bituminous surfacing is specified with separate applications of coarse and fine aggregate on a single application of binder, the coarse aggregate shall be applied first, rolled and any necessary brooming carried out as described above, before application of the fine aggregate and its subsequent rolling and brooming. In this case, the time limits for incorporation of aggregate

Two Aggregate Application

(paragraph 1 above) shall apply only to the application of the coarse aggregate. The application of fine aggregate will proceed in any case as soon as possible after satisfactory application and embedment of the coarse aggregate.

When the aggregate has been evenly spread and embedded in the binder, any remaining loose particles of aggregate shall be removed from the pavement not prior to two days and not later than ten days after sealing. *Removal of Loose Particles*

C244.21 PROTECTION OF SERVICES AND ROAD FIXTURES

The Contractor shall take all necessary precautions to prevent primer, primerbinder, binder, aggregate or other material used on the work from entering or adhering to gratings, hydrants or valve boxes, access chamber covers, kerb and gutter, bridge or culvert decks and other road fixtures. *Contractor's Responsibility*

Immediately after aggregate has been spread over the binder, the Contractor shall clean off or remove any sprayed surfacing material and leave the services and road fixtures in a condition equivalent to that existing when the Contractor commenced the sprayed surfacing work. *Services and Road Fixtures*

NON-CONFORMANCE OF MATERIALS AND WORK

C244.22 GENERAL

Non-conforming materials and work shall be rejected.

Replace or Correct Non-conformance

LIMITS AND TOLERANCES

C244.29 SUMMARY OF LIMITS AND TOLERANCES

1. The limits and tolerances applicable to the various clauses in this Specification are summarised in Table C244.2 below:

Item	Activity	Limits/Tolerances	Spec Clause
1.	Design of Bituminous Surfacing	Contractor to provide details of design to Principal Certifying Authority at least seven days before proposed commencement of work	C244.08
2.	Sweeping of Pavement Surface	Sweeping shall extend at least 300mm beyond each edge of the area to be sprayed	C244.12
3.	Bitumen Heating		
	(a) Bitumen Temperature	When incorporated with cutter oil, bitumen shall be in temperature ranges as per Table C244.1.	C244.14
	(b) Refinery Cutback Bitumen Temperature	At the time of spraying shall be in temperature range as per Table C244.1.	C244.14
	(c) Overheating of Bitumen	Bituminous material shall not be heated above the upper temperature limits of Table C244.1. Overheated material shall be rejected.	C244.14
	(d) Retention of Temperature	Bituminous materials shall not be held at temperatures within the ranges of Table C244.1 for periods in excess of 10 hours.	C244.14
4.	Spraying Temperature		
	(a) Pavement Temperature	Bituminous surfacing shall not be undertaken if the pavement temperature has not been at or above temperatures given in Table C244.1 for at least one hour before commencement of spraying.	C244.15
5.	Cutting Back Bitumen	Circulation of hot bitumen and cutter oil mixture in the sprayer shall be at the rate of 700 litres per minute for 20 minutes.	C244.16
6.	Bituminous Adhesion Agent	Circulation of bituminous adhesion agent with hot bitumen shall be at the rate of 700 litres per minute for 15 minutes.	C244.16
7.	Application of Bituminous Material		
	(a) Spray Area	Area to be sprayed shall be limited to area which can be covered by aggregate at target application rate within 15 minutes of spraying.	C244.17
	(b) Application Rates	Application rates and quantities shall apply to a temperature of 15°C.	C244.17
	(c) Primer	At least a 48 hour period shall elapse after spraying of primer before binder for a seal is applied.	C244.17

Item	Activity	Limits/Tolerances	Spec Clause
	(d) Primerbinder	At least a 14 day period shall elapse after spraying of primerbinder before application of binder.	C244.17
	(e) Nonconformance	Areas not within 5 percent of the target application rate of primer, primerbinder or binder shall constitute 'nonconformance' under the Contract.	C244.17
8.	Application of Aggregate		
	(a) Spreading Time	Application of aggregate shall be completed within 15 minutes of spraying bitumen or cutback bitumen on each section.	C244.20
9.	Rolling		
	(a) Roller Numbers and Type	Initial rolling shall be carried out with two or more dual axle smooth pneumatic tyred multi-wheeled rollers. Minimum load of one tonne per tyre and minimum tyre pressure 550KPa.	C244.20
	(b) Backrolling	Backrolling shall be undertaken for minimum of one hour per roller per 1000 square metres sprayed.	C244.20

Table C244.2 - Summary of Limits and Tolerances

ANNEXURE C244A - DETAILS OF WORK

Section		Prime	Primer Seal		Seal or Reseal	
From	To		Binder	Aggregate	Binder	Aggregate

DEVELOPMENT CONSTRUCTION SPECIFICATION

C245

ASPHALTIC CONCRETE

AMENDMENT RECORD FOR THIS SPECIFICATION PART

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part. The clause numbering and context of each clause are preserved. New clauses are added towards the rear of the specification part as special requirements clauses. Project specific additional script is shown in the specification as italic font.

The amendment code indicated below is 'A' for additional script 'M' for modification to script and 'O' for omission of script. An additional code 'P' is included when the amendment is project specific.

Amendment Sequence No.	Key Topic addressed in amendment	Clause No.	Amendment Code	Author Initials	Amendment Date

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C245.01 GENERAL

1. This specification details requirements for asphalt paving of road, footpath and parking areas and includes the following work:
 - a) Notification of residents,
 - b) Supply of all materials for the manufacture of asphaltic concrete,
 - c) Design of asphalt meeting the requirements of this specification,
 - d) Heating and mixing in an approved plant,
 - e) Sampling and testing,
 - f) Sweeping and cleaning and tack coating of surfaces to be treated,
 - g) Key in to existing pavement, kerbs and other fixtures,
 - h) Hauling asphaltic concrete from plant to site of work,
 - i) Spreading, compacting and finishing the asphaltic concrete,
 - j) Removal and disposal of excess materials and waste.

C245.03 QUALITY ASSURANCE

1. Asphaltic concrete contractors shall have Third Party Quality Assurance Accreditation to Australian Standard AS 9001 for the manufacture, supply and laying of Asphaltic Concrete. Documentary evidence shall be provided to the PCA prior to placing any asphaltic concrete.
2. Records of quality assurance shall be maintained by the Contractor and be available for inspection on request.

C245.04 NOTIFICATION

1. Before commencing site operations, the Contractor shall notify all affected residents, businesses and the Principal Certifying Authority of the scheduled works.
2. Such notification shall consist of two parts:
 - a. Written notice delivered at least seven days in advance of proposed work; and
 - b. A further written or verbal confirmation delivered not less than 24 hours prior to commencement of work.
3. Such notices shall detail:
 - intended date of commencement;
 - duration of project;
 - hours of work;
 - name of street(s) affected and limits of work;
 - a contact phone number of Contractor's local representative;
 - description of work;
 - any precautions to be followed by the public.
4. A sample of proposed written notification for residents and businesses shall be submitted to the Principal Certifying Authority for approval prior to use.

C245.05 SUPPLY OF ASPHALT**1. Materials for Asphalt****(a) Aggregates****(i) Coarse Aggregate**

Coarse aggregate comprises all mineral matter retained on a 4.75mm Australian Standard sieve. Coarse aggregate shall consist of crushed rock, metallurgical slag or gravel which is clean, dry, hard, tough, sound and free from dust, clay, dirt or other matter deleterious to asphalt.

The coarse aggregate shall conform to the following requirements -

- **Wet Strength - AS 1141.22**

The wet strength shall not be less than 100kN for any fraction

- **Wet/Dry Strength Variation - AS1141.22**

The wet/dry strength variation shall not exceed 35 percent for any fraction or constituent.

- **Particle Shape - AS1141.14**

The proportion of misshapen particles in the fraction retained on the 9.50mm Australian Standard sieve shall not exceed 35 percent using a calliper ratio of 2:1.

- **Fractured Faces of Coarse Aggregate - Test Method T239**

Aggregate which is retained on a 6.70mm Australian Standard sieve shall consist of at least 80 percent by mass of particles with at least two fractured faces.

(ii) Fine Aggregate

Fine aggregate comprises all mineral matter passing a 4.75mm Australian Standard sieve and retained on a 0.075mm Australian Standard sieve. The fine aggregate shall generally consist of natural sand or material derived from the crushing of sound stone or gravel and be free of coatings or loose particles of clay, silt or other matter deleterious to asphalt.

(b) Mineral Filler

Mineral filler comprises all material passing a 0.075mm sieve.

Mineral filler shall comply with AS2357.

(c) Binder

1. The binder shall be bitumen conforming to the requirements of AS2008.
2. The class of bitumen to be used in the work shall be Class 320 unless otherwise specified.
3. The Contractor shall when directed by the Principal Certifying Authority provide documentary evidence of the binder quality for each delivery used in a particular work.

(d) Polymer Modified Bitumens

1. Polymer modified bitumens shall be used where the asphaltic concrete will be subjected to traffic loads which will cause shoving and/or rutting such as roundabouts and queueing areas.
2. Polymer modified bitumens shall comply with the limits shown in Table C245.1 as appropriate and the requirements set out below.
3. The binder shall be pumped and stored at the manufacturer's recommended temperatures.

Table C245.1
Specified Properties for Polymer Modified Bitumens

Test	A3L	Test Method
Elastic Recovery at 60°C (%)	90 min	MBT 21
Consistency on ER at 60°C (Pa.s)	5000 min	MBT 21
Torsional Recovery at 25°C (%)	50 min	MBT 22
Viscosity at 180 °C (Pa.s)	0.6 max	MBT 11

NOTE: For the purpose of assessing compliance with this Table samples shall be heated to 135°C without high shear mixing and immediately cast into test moulds.

2. Proportioning of mixes

The suppliers shall design nominal size mixes to comply with the general limits in Table C245.2. These mixes shall be known as the Nominated Mix. Mix designs For AC14, AC20 and AC28 complying with Roads and Road Traffic Specification Part R116 will be deemed to comply to this specification.

TABLE C245.2
ASPHALTIC CONCRETE MIX
GENERAL LIMITS

	Mix Designation						
	AC 5	AC 7	GG10	AC10	AC14	AC20	AC28
Marshall Stability (50 blows) kN (Min)	5	5	4	6	6.5	6.5	
Flow (mm)	2-4	2-4	2-5	2-4	2-4	2-4	
Voids in Compacted Mix (%)	3-7	3-7	2-6	3-7	3-7	3-7	3-7
Binder Grade	Class 170 or 320			Class 320 Bitumen			
	Mix Designation						
	AC 5	AC 7	GG10	AC10	AC14	AC20	AC28
	General Limits of Aggregate Grading (job mix to be designed within these limits)						
Sieve Size	% Passing						
37.5mm	-	-	-	-	-		100
26.5mm	-	-	-	-		100	90-100
19.0mm	-	-	-		100	95-100	72-90
13.2mm	-		100	100	85-100	70-90	55-80
9.5mm	-	100	90-100	90-100	70-85	55-80	45-70
6.7mm	100	80-100	65-85	70-90	60-80	45-70	35-60
4.75mm	85-100	70-90	60-80	60-80	50-72	38-60	30-50
2.36mm	55-75	45-60	55-75	40-60	35-55	27-50	20-40
1.18mm	38-57	35-50	45-65	27-45	25-44	18-40	14-30
600µm	26-43	22-35	30-50	17-35	17-32	14-29	10-25
300µm	15-28	14-25	20-30	13-26	10-24	9-22	6-18
150µm	8-18	8-16	10-18	7-16	7-16	6-15	4-14
75µm	5-11	5-8	5-11	4-10	4-8	3-7	3-7
Binder Content as percentage by mass of total mix	5-7	5-7	5.5-7.5	5-7	4.5-6.5	4-6	3.5-5.5
Ratio Filler/Binder content (by mass)	0.8 – 1.5						

3. Nominated Mixes

(a) Submission of Nominated Mixes

The Contractor shall submit details of each asphalt mix proposed together with test Certificates from a laboratory with appropriate N.A.T.A. accreditation. Where mixes complying to the limits in Table C245.2 are already being produced, details of these mixes should be submitted in place of the design mix and be clearly defined as "Nominated Job Mix".

Work shall not commence until a nominated mix has been approved by the Principal Certifying Authority.

The aggregate grading and binder content of a nominated mix shall be known as the "nominated aggregate grading" and "nominated binder content" respectively.

The following details of nominated mixes shall be submitted to the Principal Certifying Authority:

(i) Constituent Materials

- . Aggregates - source, geological type
- . Mineral Filler - type, source.
- . Binder - source, class or grade.
- . Bitumen Adhesion Agent - name, type, source of supply.
- . Relevant test results verifying material properties for the abovementioned materials.

(ii) Mix Design

Test results of the following properties of each nominated mix are to be supplied.

- Aggregate Grading.
- Binder Content, by mass of total mix.
- Marshall Stability (50 blows).
- Voids in the compacted mix, expressed as percent by volume.
- Proportion of each constituent by percentage of mass of total asphalt mix

The required testing shall have been carried out within the twelve month period prior to the date of submission to Council. Notwithstanding this, materials tested shall be representative of those which will constitute the asphalt to be supplied. All phases of any particular test shall be performed at one laboratory.

(b) Variations to Nominated Mixes

If the Contractor proposes to vary the proportions of the constituents in a nominated mix or proposes to change the source of supply of any constituent, the Contractor shall submit a new nominated mix.

4. Production of Asphalt

(a) Plant

Mixing shall be undertaken in a manufacturing plant which complies with AS 2150. The plant shall have sufficient capacity to supply asphalt for continuous operation of the paver.

(b) Temperatures of Materials

Heating of aggregates shall be limited to such a temperature that, when mineral filler and binder are added, the temperature of the mixed asphalt shall be within the appropriate asphalt temperature range shown in Table C245.3.

TABLE C245.3
TEMPERATURE FOR PRODUCTION OF ASPHALT

Type of Binder	Class 170 Bitumen	Class 320 Bitumen
Binder Temperature	140°C - 165°C	145°C-170°C
Asphalt Temperature	140°C - 165°C	145°C-170°C

(c) Storage of Asphalt

Asphalt shall be stored in accordance with AS2150, Section 7.

5. Properties of Plant Mix

During production, any mix produced shall not vary from the nominated mix by more than the amounts listed in Table 3.

TABLE C245.4**VARIATIONS TO NOMINATED MIX**

Sieve Size	Permissible Variation Percent by Mass of Total Aggregate
4.7mm and larger	± 7
2.36mm and 1.18mm	± 5
600mm and 300mm	± 4
150 μ m	± 2.5
75 μ m	± 1.5
Binder Content	$\pm 0.3\%$

Marshall Stability, voids and Filler/Binder ratio shall not vary from the limits given in Table C245.2.

6. Sampling and Testing Asphalt

- (a) **Sampling.** Asphalt shall be sampled at either the point of loading or the point of delivery to the work. Sampling of each nominal size of asphalt supplied shall be undertaken by the Contractor in accordance with AS2891.1.
Council may take audit samples for testing by it's own staff or any NATA accredited organisation nominated by it.
- (b) **Testing.** Asphalt supplied for the work shall be tested in accordance with Table C245.6 by, or on behalf of, the Contractor at his cost. Testing shall be carried out by a laboratory with appropriate N.A.T.A. accreditation.
- (c) **Minimum Frequency of Sampling and Testing.** The minimum frequency of sampling and testing of asphalt for the quantity of asphalt supplied to the work each day shall be as specified in Table C245.5.
- (d) **Test Results.** The Contractor shall provide copies of all test results prior to the release of the final plan of subdivision.

TABLE TABLE C245.5**MINIMUM FREQUENCY OF SAMPLING AND TESTING OF ASPHALT**

Quantity of Asphalt Supplied Each Shift	Minimum Frequency of Sampling and Testing
Less than 100 tonnes	One per 50 tonnes, or part thereof
101 to 300 tonnes	One per 100 tonnes, or part thereof
301 to 600 tonnes	One per 150 tonnes, or part hereof
Over 600 tonnes	One per 200 tonnes, or part thereof

TABLE C245.6**TESTING OF ASPHALT**

Characteristic Analysed	Test Method	Minimum Frequency of Sampling and Testing
Grading of combined aggregate	AS 2891.3.1	As set out in Table C245.5
Binder Content	AS 2891.3.1	As set out in Table C245.5
Voids in compacted asphalt	AS 2891.9.1	As set out in Table C245.5

C245.06 TRANSPORT

1. Delivery of the mix shall be at a uniform rate within the capacity of the spreading and compacting equipment. Transport shall be as expeditious as possible to minimise cooling of the asphaltic concrete.
2. Unless approval is given to other means of measurement, the mass of all truckloads of mix shall be measured on a weighbridge certified by the Department of Consumer Affairs.

C245.07 PREPARATION OF PAVEMENT

1. **Cleaning of Surface.** The existing surface shall be dry, clean and free of any loose stones, dirt and foreign matter. When sweeping is required it shall extend, if feasible, beyond the edge of the proposed asphaltic concrete layer by at least 300mm. Any foreign matter adhering to the pavement and not swept off by the broom shall be removed by other means. Any areas significantly affected by oil contamination shall be cleaned by an approved method.
2. **Key-in to Existing Fixtures and Surfaces.** Key-in to existing kerbs and fixtures shall be such that the total asphalt cover is not less than the pavement being surfaced
3. Where an existing pavement is being overlaid, transverse Key-in joints shall be provided at the start and finish of the overlay such that:-
 - a. the compacted thickness of new asphalt at the joint is not less than 2.5 times the nominal size of aggregate in the mix.
 - b. a smooth transition from the existing to new be at a grade not greater than 3%.

C245.08 TACK COAT

1. **General.** Except on unsealed surfaces or as otherwise directed by the Principal Certifying Authority, the whole of the area to be sheeted with asphaltic concrete shall be lightly and evenly coated with cationic rapid setting bitumen emulsion, conforming to the requirements of AS1160.
2. The application rate of residual bitumen shall be 0.1 to 0.2 litres per square metre and shall be applied by a mechanical sprayer with spray bar, unless the areas to be sprayed are small, irregular or inaccessible to mechanical sprayers, in which case application by hand spraying or brushing may be permitted.
3. All contact surfaces or kerbs and other structures and all cold joints shall be coated with a thin uniform application of tack coat. Adequate time is to be allowed for the tack coat to break or cure before asphaltic concrete is laid. Over application of tack coat, due to existing surface depressions, shall be removed or dispersed by brushing.
4. **Precautions.** Care shall be taken to ensure that bitumen emulsion is not sprayed on, or allowed to coat any concrete kerbs, guardrail or bridge handrails adjacent to the pavement or shoulder. Any material so sprayed shall be removed as directed by the Principal Certifying Authority.
5. In locations with heavy pedestrian traffic, such as shopping areas, extra care shall be taken to keep pedestrians off tack coated areas.

C245.09 SPREADING

1. The spreading procedure shall follow the guidelines as set out in Section 7 of AS 2734 for spreading by self-propelled paving machines. The laying temperatures shall be according to Table C245.7 below.

TABLE C245.7**MIX LAYING TEMPERATURES**

Road Surface Temperature in Shade (°C)	Mix Temperatures °C			
	Layer Thickness Less Than 30mm	Layer Thickness 30mm to 40mm	Layer Thickness 45mm to 100mm	Layer Thickness Over 100mm
5-10	Not Permitted	150*	145*	130-155
10-15	150*	145*	140*	125-150
15-25	145*	140*	135*	120-145
Over 25	140*	135*	130*	115-140

* Minimum laying temperature.

2. The laying of asphaltic concrete will not be permitted when the surface of the road is wet or when cold winds chill the mix to such an extent that, in the opinion of the Principal Certifying Authority, spreading and compaction are adversely affected. The Principal Certifying Authority may reject that part of any truck load which contains lumps of cooled asphaltic concrete which are liable to affect the quality of the finished surface. Payment at the scheduled rate will be made for the actual quantity of asphaltic concrete used.

C245.10 COMPACTION

1. **Plant and Equipment.** Plant and equipment shall be as described in AS 2734, excepting that pneumatic rollers shall be used for secondary or intermediate rolling
2. **Acceptance Criteria for Compaction.** The acceptance for compaction shall be on a statistical basis where each day's work is a lot. When a days work is less than 100 tonnes of asphaltic concrete then two successive day's work may be aggregated as one lot. Any defective areas which show cracking, or bony or fatty material shall be excluded from the lot and shall be rectified by the Contractor before being tested.
3. For each lot the Contractor shall take the cores on a random basis from the whole area and perform density tests on the cores in accordance with AS2891.9.1.
4. When the depth of the course is greater than 60mm, the Principal Certifying Authority may elect to use a nuclear density gauge to measure density insitu.
5. For core tests the layer thickness shall be deemed to be the mean thickness of the cores. For nuclear tests the layer thickness is the nominal layer thickness.
6. The results shall be expressed as % voids related to the mean maximum density of the lot determined in accordance with AS2891.7.
7. The Characteristic value of in Situ Voids (SV) of a lot shall be calculated from the formula:

$$SV = \bar{X} + ks$$

where \bar{X} and s are the mean and standard deviation respectively of the individual void test values of the lot and k is a constant depending on the number of test values in the lot as described in Table C245.8 :-

Table C245.8

k	No. of Tests
1.06	3
0.98	4
0.94	5
0.92	6
0.91	7
0.90	8
0.89	9
0.88	10

8. In general, the number of tests per lot shall be six for cores and ten for nuclear density gauges. A different number of tests may be taken at the discretion of the Principal Certifying Authority.
9. No cores or nuclear density measurements shall be taken within 150mm of a joint or free edge. Unless directed by the Principal Certifying Authority, layers less than 30mm in thickness shall not be cored.
10. The Characteristic value of in Situ Voids (SV) shall not fall outside the range designated for the mix in Table C245.2. Where the compacted layer thickness is less than 50mm the range may be increased by 1% in each direction.

C245.11 JOINTS

1. **General.** The location of longitudinal and transverse joints shall be as approved by the Principal Certifying Authority and at the spacing nominated in the drawings. The surface finish of the asphalt at joints shall by inspection be similar to that of the remainder of the layer.
2. **Longitudinal Joints.** An automatically controlled joint matching device shall be used to control the levels of adjacent runs. Care shall be taken to provide positive bond between adjoining runs. Longitudinal joints shall be:
 - a. continuous and parallel.
 - b. coincident within 150mm of line of change in crossfall.
 - c. offset by at least 150mm from joints in underlying layers.
 - d. located away from traffic wheel paths.
 - e. located beneath proposed traffic linemarkings in the case of a wearing course.
3. Work shall be arranged to avoid longitudinal joint faces being left exposed overnight.
4. When pavers are laying asphalt in echelon, the hot joint so produced shall be constructed by leaving an uncompacted strip approximately 150 mm wide along the edge of the first run, and after the adjoining run has been spread, both sides of the joint shall be rolled simultaneously.
5. A joint shall be considered 'cold' when the temperature of the asphalt has dropped below 80°C.
6. **Transverse Joints.** When the end of the asphalt layer has cooled due to disruption of the work, or when resuming work on the next day, a transverse joint shall be formed.
7. Transverse joints shall be at right angles to the direction of laying. They shall be staggered by at least 1.0 m between successive layers and between adjacent runs.
8. Runs shall end either against a timber bulkhead to ensure a straight vertical, well compacted edge or by feathering out and compacting. In the latter case, before continuing the run the feathered material shall be cut back to a line where the full layer thickness exists. The surface shape of the end of the run shall be checked by a straight edge to locate the line of cut. The end of the previous run shall be lightly tack coated before the laying of the next run proceeds.
9. When the asphalt layer is required to join and match the level of an existing pavement surface, bridge deck or other fixture, sufficient of the existing material shall be cut out to achieve the minimum layer thicknesses as set out in Table C245.9.

C245.12 LEVEL CONTROL AND FINISHED PAVEMENT PROPERTIES

1. For RTA classified roads, the riding quality of the finished surface as measured with a calibrated NAASRA (AUSTROADS) roughness meter vehicle or laser profilometer, shall have a roughness value not exceeding 50 counts per kilometre.
2. Where the roughness value of an existing layer exceeds 70 counts per kilometre the resurfaced pavement shall have a value not exceeding the value (S).
3. The roughness value shall be determined as follows –
$$S = (A \times 0.6) + 5 \text{ counts /km}$$

Where:

A = count prior to overlay, and S and A are reported to the nearest 1 count per km

 - i) Each lane shall be divided into sections 100 metres long. Any length less than 100 metres shall be included with the section immediately preceding it. Start and finish joints of the entire work shall not be included in any section.
 - ii) The Roughness Value, reported for each 100 metre section, shall be the average of three (3) repeat runs over each 100 metre section, reported in NAASRA (AUSTROADS) roughness counts per kilometre.
 - iii) Roundabouts and other traffic calming devices shall not be measured according to this clause
4. The Principal Certifying Authority may require that the requirements of clause 245.11 apply to local roads with a design AADT greater than 2000 (10% heavy) or where the speed limit will be greater than 60 km/h.
5. For residential streets the finished surface shall not deviate from a 3m straight edge by more than 5 mm.

C245.13 TRAFFIC CONTROL

1. Traffic Control for the works shall comply with AS1742.3 and be guided by the Roads and Traffic Authority's "Traffic Control at Worksites Manual". All traffic controllers shall be accredited to RTA Standards and shall carry their current RTA endorsed Traffic Controllers Certificate.
2. Traffic arrangement diagrams (Traffic Plans) and evidence of traffic controllers accreditation shall be submitted for the Principal Certifying Authority approval at least 2 days prior to commencement of work. Records of plans used at each site shall be retained by the Contractor.

C245.14 CLEANING UP

1. The contractor shall remove and dispose of all surplus materials and waste generated by the works at the completion of the project.

C245.15 DEFECTIVE WORK

1. Work for which either the mix and/or paving work fails to meet this specification shall be rejected.
2. If the mix and/or paving work falls within the tolerances outlined in Table C245.9, Table C245.10 and Table C245.11, the Principal Certifying Authority may consider accepting the mix and/or paving work subject to the Contractor performing such remedial works as required by and to the satisfaction of the Principal Certifying Authority.
3. **Voids.** The voids content of asphalt laid, when available, shall be used to determine whether the actions in Table C245.9 shall apply. In all other cases the voids in mix determined during plant control shall apply.

TABLE C245.9

LABORATORY DENSITY (50 BLOW MARSHALL) AIR VOIDS (%)	ACTION TO BE TAKEN FOR VARIATION IN SPECIFIED VOIDS (%)	
	DENSE GRADED	GAP GRADED
Less than 1	Material to be replaced	Material to be replaced
1	Contractor to show cause why the material should not be removed	Contractor to show cause why the material should not be removed
2	Contractor to show cause why the material should not be removed	Accept
3	Accept	Accept
4	Accept	Accept
5	Accept	Accept
6	Accept	Accept
7	Accept	Contractor to show cause why the material should not be removed
8	Contractor to show cause why the material should not be removed	Contractor to show cause why the material should not be removed
9	Contractor to show cause why the material should not be removed	Contractor to show cause why the material should not be removed
10	Contractor to show cause why the material should not be removed	Material to be replaced
11 or greater	Material to be replaced	Material to be replaced

Note: In testing for voids content, the percentage of voids will be taken to the nearest whole number.

4. **Compaction.** The actions scheduled in Table C245.9 shall apply based on density tests taken in accordance with Clause C245.10.
5. **Aggregate Grading and Binder Content.** For asphalt having aggregate grading or binder content outside the limits specified in Clause 245.05, the deduction points shown in Table C245.10 shall apply, and shall be cumulative. If the combined deduction points exceed 20, the Contractor shall remove the asphalt and replace it with asphalt conforming to this specification at no cost to Council.

TABLE C245.10**DEDUCTION POINTS FOR
AGGREGATE GRADING AND BINDER CONTENT**

DESCRIPTION	VARIATIONS*	DEDUCTION POINTS
Aggregate Grading Element	(% by mass of total aggregate)	
Pass 37.5mm AS sieve	Each 2 or part thereof	1
Pass 26.5mm AS sieve	Each 2 or part thereof	1
Pass 19.0mm AS sieve	Each 2 or part thereof	1
Pass 13.2mm AS sieve	Each 2 or part thereof	1
Pass 9.50mm AS sieve	Each 2 or part thereof	1
Pass 6.70 mm AS sieve	Each 2 or part thereof	1
Pass 4.75mm AS sieve	Each 2 or part thereof	1
Pass 2.36mm AS sieve	Each 1 or part thereof	1
Pass 1.18mm AS sieve	Each 1 or part thereof	1
Pass 0.600mm AS sieve	Each 1 or part thereof	1
Pass 0.300mm AS sieve	Each 1 or part thereof	2
Pass 0.150mm AS sieve	Each 0.5 or part thereof	2
Pass 0.075mm AS sieve	Each 0.5 or part thereof	2
Binder Content for	(% by mass of total asphalt mix)	
20mm asphalt or smaller	Each 0.1 or part thereof	3
28mm and 40mm asphalt	Each 0.1 or part thereof	2
Filler/Binder Ratio	Each 0.1 or part thereof	1

Note* Outside the ranges for aggregate grading and binder content set out in Table C245.2

6. **Riding Quality.** For sections having riding quality outside that specified in Clause C245.12, the actions in Table C245.11 shall apply.

TABLE C245.11**ACTION TO BE TAKEN FOR VARIATIONS
IN RIDING QUALITY**

Tolerance	Action
Roughness Count Rate above specified count (counts/km) >10	Top 30mm to be removed and replaced providing remaining thickness of layer >25mm otherwise remove and replace whole depth of layer
Deviation from a 3 m straight edge > 7mm	Top 30mm to be removed and replaced providing remaining thickness of layer >25mm otherwise remove and replace whole depth of layer

C245.16 WORK RECORDS

1. Work records shall include the following for each street treated;
 - Date of treatment;
 - Road name;
 - Location of starting point from nearest intersection;
 - Location of finishing point from nearest intersection;
 - Length of work (m);
 - Nominal pavement width (m);
 - Area (including widenings) (m²);
 - Road temperature (°C);
 - Weather condition;
 - Details of any non-conformances.
2. A copy of the work record shown in Annexure A shall be provided to the Principal Certifying Authority prior to the release of the final plan of subdivision.

Plan No: _____ Mix Type: _____ New Surfacing ☐ Resurfacing ☐ Existing Surface Type: _____

Remarks: _____

Recorder: _____ Sampling by: _____ Suppliers _____ Contractor's _____

Affiliation: _____ Affiliation: _____ Representative: _____ Representative: _____

(Signature) (Signature)

DEVELOPMENT CONSTRUCTION SPECIFICATION

C247

MASS CONCRETE SUBBASE

AMENDMENT RECORD FOR THIS SPECIFICATION PART

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part. The clause numbering and context of each clause are preserved. New clauses are added towards the rear of the specification part as special requirements clauses. Project specific additional script is shown in the specification as italic font.

The amendment code indicated below is 'A' for additional script 'M' for modification to script and 'O' for omission of script. An additional code 'P' is included when the amendment is project specific.

Amendment Sequence No.	Key Topic addressed in amendment	Clause No.	Amendment Code	Author Initials	Amendment Date

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SPECIFICATION C247 MASS CONCRETE SUBBASE

GENERAL

C247.01 SCOPE

1. The work to be executed under this Specification consists of the construction, by mechanical or hand placement of mass concrete subbase including trial sections and subgrade beams to the dimensions and levels shown on the Drawings and in accordance with the provisions of the Contract.

C247.02 THICKNESS AND LEVELS OF SUBBASE

1. The subbase thickness and levels shall be as shown on the Drawings. *Levels*

C247.03 PROVISION FOR BASE SLAB ANCHORS

1. During construction of the subbase, in advance of concrete base construction the Contractor shall make provision to permit construction of base slab anchors at the locations and to the dimensions shown on the Drawings. Excavation of material, trimming of trenches, compacting of the bottom of the trench, disposal of surplus material and construction of the concrete anchors shall be carried out in accordance with the Specification for PLAIN OR REINFORCED CONCRETE BASE as part of the concrete base construction. *Base Slab Anchors*

MATERIALS FOR CONCRETE

C247.05 CEMENT

1. Cement shall be Type GP Portland cement or Type GB blended cement complying with AS 3972. Cement shall be from a source included in the New South Wales Government Cement Quality Assurance Scheme. *NSW QA Scheme*
2. When submitting details of the nominated mix in accordance with Clause C247.15 the Contractor shall nominate the brand and source of the cement. On approval of a nominated mix by the Principal Certifying Authority, the Contractor shall use only the nominated cement in the work. *Nominated Brand and Source*
3. Documentary evidence of the quality and source of the cement shall be furnished by the Contractor to the Principal Certifying Authority upon request at any stage of the work. *Proof of Quality*
4. If the Contractor proposes to use cement which has been stored for a period in excess of three months from the time of manufacture, the Principal Certifying Authority may require a retest to ensure the cement complies with AS 3972, before the cement is used in the work. *Storage Time*
5. Cement shall be transported in watertight containers and shall be protected from moisture until used. Caked or lumpy cement shall not be used. *Transport and Storage*

C247.06 FLYASH

1. Flyash shall be from a source included in the New South Wales Government Cement Quality Assurance Scheme. The use and the quality of flyash shall comply with AS 3582.1. *NSW QA Scheme*
2. When submitting details of the nominated mix in accordance with Clause C247.15, the Contractor shall nominate the powerhouse source of the flyash. On approval of a nominated mix by the Principal Certifying Authority, the Contractor shall use only flyash from the nominated powerhouse. *Source*
3. Documentary evidence of the quality and source of the flyash shall be furnished by the Contractor to the Principal Certifying Authority upon request at any stage of the work. *Documentary Evidence*

C247.07 WATER

1. Water used in the production of concrete shall be potable, free from materials harmful to concrete or reinforcement, and be neither salty nor brackish. **Quality**

C247.08 ADMIXTURES

1. Chemical admixtures and their uses shall comply with AS 1478. Admixtures shall not contain calcium chloride, calcium formate, or triethanolamine or any other accelerator. Admixtures or combinations of admixtures other than specified below, shall not be used. An air-entraining agent may be included in the mix. If an air-entrainer is used, the air content of the fresh concrete shall comply with Clause C247.14. **Quality**
2. Fresh concrete with an air content not complying with Clause C247.14 shall be rejected. **Excess Air Content**
3. During the warm season (October to March inclusive), a lignin or lignin-based ('ligpol') set-retarding admixture (Type Re or Type WR Re) approved by the Principal Certifying Authority, shall be used to control slump within the limits stated in Clause C247.13. The dosage shall be varied to account for air temperature and haul time in accordance with the manufacturer's recommendations. A copy of the NATA endorsed Certificate of Compliance with AS 1478 for Type Re or Type WR Re shall be submitted to the Principal Certifying Authority, together with the proposed 'dosage chart' in accordance with Clause C247.15. **Retarder for Warm Season**
4. During the cool season (April to September inclusive), only a lignin or lignin-based set retarding admixture containing not more than 6 per cent reducing sugars (Type WR Re complying with AS 1478) may be used in the mix or, alternatively, omitted altogether. If the Contractor proposes to vary the admixture between the warm and cool seasons such variation shall constitute a proposed change to an approved mix for the purposes of Clause C247.16. **Retarder for Cool Season**
5. When submitting details of the nominated mix in accordance with Clause C247.15, the Contractor shall nominate the proprietary source, type and name of each admixture to be used. Documentary evidence of the quality shall be furnished by the Contractor to the Principal Certifying Authority upon request at any stage of the work. **Source and Type**

C247.09 AGGREGATES**(a) General**

1. When submitting details of the nominated mix in accordance with Clause C247.15, the Contractor shall nominate the sources of aggregate to be used and shall submit details of the geological type of each aggregate. **Source and Type**
2. Aggregates shall all pass the 37.5 mm AS sieve and shall comply with AS 2758.1 in respect of bulk density, water absorption (maximum 5 per cent), material finer than 75 micrometres, impurities and reactive materials. The proportion of misshapen particles (2:1 ratio) determined by AS 1141.14 shall not exceed 35 per cent. **Quality**
3. When submitting details of the nominated mix, the Contractor shall submit to the Principal Certifying Authority a NATA Certified Laboratory Test Report on the quality and grading of the aggregate proposed to be used. The grading shall be known as the "Proposed Grading". **Proposed Grading**
4. If the Contractor proposes to blend two or more aggregates to provide the Proposed Grading the Test Reports for each constituent material shall be submitted separately and the Principal Certifying Authority advised of the proportions in which the various sizes and constituents are to be combined. The aggregate from each source and the combined aggregate shall comply with the requirements of this clause. **Blending of Aggregates**
5. All aggregate used in the production of concrete shall be clean, hard, durable rock fragments free from the inclusion of mineral salts, oils, organic matter or other materials deleterious to the performance of concrete.

(b) Grading

- The grading of the combined aggregate used in the work, determined by AS 1141.11, shall not deviate from that of the Proposed Grading by more than the amounts shown in Table C247.1.

Australian Standard Sieve	Maximum Deviation Per Cent Passing by Mass of Total Sample
37.5 mm	-5
19.0 mm	+ or -10
4.75 mm	+ or -10
1.18 mm	+ or -5
600 mm	+ or -5
150 mm	+ or -2

Table C247.1 - Aggregate Grading Deviation Limits**(c) Durability**

- Any fraction of any constituent and any fraction of combined aggregate shall conform to the following requirements:- **Tolerances**
 - Wet Strength - AS 1141.22 - Shall not be less than 50 kN.
 - 10 per cent Fines Wet/Dry Variation - AS 1141.22 - Shall not exceed 35 per cent.

(d) Storage

- Storage and handling facilities shall be such as to prevent the aggregates becoming intermixed or mixed with foreign materials, and to prevent segregation occurring. **Facilities Required**
- The area surrounding the storage facilities and mixing plant shall be so constructed that delivery vehicles, loaders and trucks shall not be capable of introducing foreign matter to the aggregates at any time. If foreign matter is introduced or the area reaches a condition where, in the opinion of the Principal Certifying Authority, foreign matter may be introduced to the aggregates, production of concrete and delivery of materials shall cease until the condition is corrected to the satisfaction of the Principal Certifying Authority. **Introduction of Foreign Matter**

QUALITY REQUIREMENTS OF CONCRETE**C247.10 CEMENT AND FLYASH CONTENT**

- When a cement and flyash blend is nominated the minimum Portland cement content shall be 90 kilograms per yielded cubic metre of concrete and the minimum flyash content shall be 100 kilograms per yielded cubic metre of concrete. **Minimum Content**

C247.11 COMPRESSIVE STRENGTH

- The compressive strength of concrete shall be determined in accordance with AS1012.9. The minimum compressive strength at 7 days shall be 4MPa and at 28 days shall not be less than 5MPa for flyash blended cement. The maximum compressive strength at 28 days shall be less than 15MPa, with the exception that where the nominated mix demonstrates a 28 day shrinkage less than 400 microstrains, then the concrete achieving a strength less than 20MPa shall be accepted. **Compressive Strength**

C247.12 SHRINKAGE

- The drying shrinkage of the nominated mix, determined by Test Method T321 shall not exceed 450 microstrain after three weeks air drying. The drying shrinkage at the nominated slump plus 10 mm shall be taken as the average of the reading or readings within 5 per cent of the median of the three readings obtained in accordance with Test Method T321. **Shrinkage Limit**

C247.13 CONSISTENCY

1. The Contractor's nominated slump, determined in accordance with AS 1012.3, Method 1, shall be neither less than 25 mm nor more than 40 mm for mechanically placed concrete and shall be neither less than 50 mm nor more than 65 mm for hand placed concrete. *Slump Tolerances*

C247.14 AIR CONTENT

1. If an air entraining agent is used, the air content of the fresh concrete, determined in accordance with AS 1012.4, Method 2, shall be neither less than 3 per cent nor more than 7 per cent when discharged from the transport vehicle ready for placement. *Air Content Tolerances*

DESIGN AND CONTROL OF CONCRETE MIXES**C247.15 GENERAL**

1. The Contractor shall submit, for approval by the Principal Certifying Authority, details of the concrete mix or mixes and the materials, including source, to be used for each of mechanically placed and hand placed subbase, including nominated slump and moisture condition of the aggregates (oven dry, saturated surface dry, or other specified moisture content) on which the mix is based. Each such mix shall be known as a 'nominated mix'. *Nominated Mix*
2. The Contractor shall provide a Certificate from a laboratory with appropriate NATA registration stating that each nominated mix and its constituents meet the requirements of this Specification. All relevant test results shall accompany the Certificate. All phases of any particular test must be performed at one laboratory. The certificate shall confirm that the required testing has been carried out in the twelve month period before the date of submission to the Principal Certifying Authority. *Certificate of Compliance with Specification*
3. In the tests supporting the above certification, the compressive strength gain curve shall be submitted showing the compressive strengths at ages 3, 7, 10 and 28 days determined in accordance with AS1012.9. Each of the results shall be based on three specimens of concrete produced from a batch of the nominated mix. The compressive strength shall be the average of individual results within 1.0 MPa of the median. *Compressive Strength Determination*
4. These details shall be submitted at least 21 days before using the nominated mix in the work. *Submission of Details*

C247.16 VARIATIONS TO APPROVED MIXES

1. The Contractor shall not make any changes to the approved mix, its method of production or source of supply of constituents without the prior written approval of the Principal Certifying Authority. *Approval required to vary mix*
2. Where changes to an approved mix are proposed, the Contractor shall provide details of the nominated mix and materials, in accordance with Clause C247.15. If the variations to the quantities of the constituents in the approved mix are less than 10 kilograms for Portland cement, 20 kilograms for other cementitious material and 5 per cent by mass for each other constituent, except admixtures, per yielded cubic metre of concrete, the Principal Certifying Authority may approve the changes without new trials being carried out. *Contractor's Responsibility*
3. Notwithstanding these tolerances, the minimum cement content shall be 90 kilograms per yielded cubic metre of concrete, the minimum flyash content shall be 100 kilograms per yielded cubic metre of concrete. *Minimum Constituent Quantities*

CONFORMANCE FOR CONCRETE STRENGTH AND THICKNESS

C247.17 CONCRETE CYLINDERS

(a) Test Specimens

1. Test specimens for determining the compressive strength of concrete shall be standard cylinders complying with AS 1012.8. The Contractor shall supply a sufficient number of moulds to meet the requirements for the frequency of testing specified in this Clause and shall also arrange for a laboratory with appropriate NATA registration to conduct the sampling of fresh concrete and the making, curing, delivery and testing of specimens. Copies of test results shall be forwarded to the Principal Certifying Authority. **Contractor's Responsibility**
2. Samples of concrete for testing shall be taken in accordance with AS 1012.1. The selection of the batches to be sampled shall be taken randomly. The specimens shall be moulded from each sample so that they are as identical as practicable. **Sampling**
3. The method of making and curing specimens shall be in accordance with AS 1012.8 with compaction by internal vibration.
4. The Contractor shall mark the specimens for identification purposes. **Marking**
5. Specimens shall be inspected, capped and crushed in accordance with AS 1012.8 and AS 1012.9.

(b) Frequency of Moulding of Test Specimens

1. Test specimens shall be moulded as follows:- **Moulding of Cylinders**
 - (i) For the determination of the compressive strength at twenty-eight days.
For each lot of up to 50 cubic metres of concrete placed at the one time: One pair of specimens
 - (ii) For the determination of the compressive strength at seven days.
For each lot of up to 50 cubic metres of concrete placed at the one time: One pair of specimens
 - (iii) For the determination of compressive strength for any early testing as deemed necessary by the Contractor.
For each lot of up to 50 cubic metres of concrete placed at the one time: One pair of specimens
2. A lot is defined as a continuous pour of up to 50 cubic metres of concrete placed in the subbase. **Lot Size**

C247.18 COMPRESSIVE STRENGTH OF CONCRETE

(a) General

1. The compressive strength of the concrete represented by a pair of specimens moulded from one sample shall be the average compressive strength of the two specimens. **Determination of Strength**
2. At the time of approving the mix design, the Principal Certifying Authority shall nominate whether 7 day or 28 day compressive strength or both shall be the acceptance criteria for strength.

(b) Adjustment of Test Compressive Strength for Age of Specimen

1. Should any specimen be tested more than 28 days after moulding the equivalent 28 day compressive strength shall be the test compressive strength divided by the factor applying to the age of the specimen at the time of the test shown in Table C247.2. For intermediate ages the factor shall be determined on a pro-rata basis. **Strength Age Factor**

Age of Specimen at time of test (days)	Factor
28	1.00
35	1.02
42	1.04
49	1.06
56	1.08
70	1.10
84	1.12
112	1.14
140	1.16
168	1.18
196	1.20
224	1.22
308	1.24
365 or greater	1.25

Table C247.2 - Concrete Age Conversion Factors

(c) Conformance for Compressive Strength

1. If the compressive strength of test cylinders for any lot is less than the criteria specified in Clause C247.11, the lot represented by the test cylinders shall be removed and replaced. **Limits**

2. In case of non-conformance the Contractor may request permission of the Principal Certifying Authority to core the in situ subbase for testing of the actual compressive strength to represent the particular lot. The locations for testing shall be nominated by the Principal Certifying Authority. Such locations may be determined by the use of a nuclear density meter, or any alternative method. Testing shall be carried out at the request of the Contractor. Subbase concrete failing to reach the required in situ compressive strength shall not be retested for at least 72 hours after the determination of the value of the in situ compressive strength. **Non-conformance and Coring**

C247.19 SPECIMENS CUT FROM THE WORK

1. Specimens cut from the work shall be tested in a NATA registered laboratory nominated by the Contractor. Specimens shall be in the form of cylindrical cores of hardened concrete. **Test Specimens**
2. Cores shall be secured, accepted, cured, capped and tested in accordance with AS 1012. 14 with the following amendments:- **Specimen Characteristics**
 - (a) The requirement that the concrete shall be at least 28 days old before the core is removed shall not apply. However, concrete must have hardened enough to permit removal without disturbing the bond between the mortar and the coarse aggregate.
 - (b) The preferred dimension for cores shall be 100 mm diameter but in no case shall the diameter be less than 75 mm or two and one half times the nominal size of the coarse aggregate, whichever is the greater.
 - (c) When inspected in the uncapped state, cores shall be rejected if any diameter departs by more than 5 mm from the mean diameter.
 - (d) Cores shall be rejected where the length of the core when ready for capping is less than the diameter. The test strength determined shall be adjusted for form by a factor in accordance with Table C247.3.
 - (e) Wet Conditioning only shall be used.

Length/Diameter Ratio of Core	Adjustment Factor
1 :1	0.89
1.5:1	0.965
2 :1	1.00
NOTE: For intermediate form ratios, the factor shall be determined by interpolation	

Table C247.3 - Core Strength Factor

- Core cutting shall be carried out by the Contractor in the presence of and at the locations nominated by the Principal Certifying Authority. The frequency of coring shall be such that a core is taken to represent each lot or the area of subbase placed between any two consecutive construction joints whichever is the lesser. The lot represented by each core shall be nominated by the Contractor at the time of sampling and duly recorded prior to testing. **Frequency of Coring**
- Cores shall be despatched to arrive at the testing laboratory within 24 hours of the core being cut from the subbase. Wet curing shall commence within 24 hours of the receipt of the cores. **Curing of Cores**
- The method of restoration shall be approved by the Principal Certifying Authority.

C247.20 ACCEPTANCE OF CORED CONCRETE FOR COMPRESSIVE STRENGTH

- Concrete shall achieve an in situ compressive strength of 5MPa within 28 days of placement. **Strength Requirement**
- If the specimen cut from the subbase reaches 4MPa for in situ compressive strength, base paving may proceed. **Core Strength**

C247.21 CONFORMANCE FOR THICKNESS

(a) General

- No thickness measurements will be carried out if the surface of the subbase is within the level tolerances as specified in Clause C247.32(b). **Conforming Tolerances**
- If scabbling is required to achieve the level tolerance limits, the Principal Certifying Authority may order thickness checks to be carried out. Where the survey ground model of the subgrade is available, subbase thickness shall be calculated from levels taken on a 5m grid on the plan area. Alternatively, the Principal Certifying Authority may authorise coring and measurement at the edges of the layer. **Thickness Measurement**
- Thickness measurements shall be rounded off to the nearest 5mm.

(b) Thickness Below Specification

- After making due allowance for the tolerances, subbase which is more than 20mm below the theoretical thickness shall be rejected and removed from the site. **Remove and Replace**
- Subbase which is 20mm or less below the theoretical thickness may be accepted by the Principal Certifying Authority providing that it represents isolated sections within a lot and such sections comprise less than 10 per cent of the area of the lot. **Acceptance**

PRODUCTION, TRANSPORT AND CONSISTENCY OF CONCRETE

C247.22 PRODUCTION AND TRANSPORT OF CONCRETE

1. At least four weeks before commencing work under this Specification, the Contractor shall submit, for the information of the Principal Certifying Authority, details of the proposed methods of handling, storing and batching materials for concrete, details of proposed mixers and methods of agitation, mixing and transport. **Contractor's Responsibility**

C247.23 HANDLING, STORAGE AND BATCHING MATERIALS

1. The methods of handling, storing and batching materials for concrete shall be in accordance with AS 1379, with the following additional requirements:- **Methods**
 - (a) Certificates of Calibration issued by a recognised authority shall be made available for inspection by the Principal Certifying Authority, as evidence of the accuracy of the scales.
 - (b) Cementitious material shall be weighed in an individual hopper, with the cement weighed first.
 - (c) The moisture content of the aggregates shall be determined at least daily immediately prior to batching. Corresponding corrections shall be made to the quantities of aggregates and water.
 - (d) Where a continuous type mixer is employed, the components shall be measured by a method of continuous weighing approved by the Principal Certifying Authority, except for liquids which may be measured by volume or flow rate meter.

C247.24 MIXERS AND AGITATION EQUIPMENT

1. Details of proposed mixers and agitation methods shall be in accordance with the plant and equipment sections of AS 1379, with the following additional requirement that in Appendix A of AS 1379 the maximum permissible difference in slump shall be 10mm. **Requirements**

C247.25 MIXING AND TRANSPORT

1. Mixing and transport methods shall be in accordance with the production and delivery sections of AS 1379, with the following additional requirements:- **Methods**
 - (a) The mixer shall be charged in accordance with the manufacturer's instructions.
 - (b) For the purpose of conducting mixer uniformity tests in accordance with Appendix A of AS 1379 on a split drum mixer producing centrally mixed concrete, the whole of the batch shall be discharged into the tray of a moving vehicle. The concrete shall then be sampled from the tray of the vehicle at points approximately 15 per cent and 85 per cent along the length of the tray.
 - (c) For truck-mixed concrete, addition of water in accordance with the batch production section of AS 1379 shall be permitted only within ten minutes of completion of batching and within 200m of the batching facilities. The delivery docket must clearly indicate the amount of water added, but in no circumstance shall the water : cement ratio be exceeded. Mixing of the concrete shall be completed at that location.
 - (d) After addition of the cement to the aggregate, concrete shall be incorporated into the work within:-
 - (i) One and a half hours, where transported by truck mixer or agitator
 - (ii) One hour, where transported by non-agitating trucksMeans of verification, satisfactory to the Principal Certifying Authority, of the times of addition of cement to the aggregate shall be provided.

The times within which the concrete shall be incorporated into the work may be reduced if the Principal Certifying Authority considers the prevailing weather, mix

type, or materials being used warrant such a change.

- (e) The size of the batch in an agitator vehicle shall not exceed the manufacturer's rated capacity nor shall it exceed 80 per cent of the gross volume of the drum of the mixer

C247.26 MAXIMUM MIXING TIME

1. Where by reason of delay, it is necessary to hold a batch in the mixer, mixing may be continued for a maximum of ten minutes except for split drum mixers where the maximum shall be five minutes. *Batch in Mixer*
2. For longer periods, the batch may be held in the mixer and turned over at regular intervals, subject to the time limits specified for incorporation of the concrete into the work not being exceeded. *Long Delays*

C247.27 CONSISTENCY

1. The consistency of the concrete shall be such as to allow the production of a dense, non-segregated mass with bleeding limited so as to prevent bleed water flowing over the slab edge under the conditions of placement. If bleed water does so flow, the Contractor shall cease paving until the consistency of the mix is adjusted to prevent flow or the mix is redesigned and approved by the Principal Certifying Authority. The edge produced shall maintain its shape and shall not sag or tear. *Requirements*
2. The Contractor shall provide all equipment, materials and labour for consistency testing and shall carry out tests in the presence of the Principal Certifying Authority.
3. The consistency of the concrete shall be checked by use of a slump cone in accordance with AS 1012.3, Method 1. The test shall be made on concrete samples obtained in accordance with AS 1012.1. *Test Method*
4. Check tests shall be done on each truckload of concrete. *Check Tests*

PLACING AND FINISHING CONCRETE SUBBASE

C247.28 GENERAL

1. At least one week before commencing work under this Specification, the Contractor shall submit as part of the Quality Plan, for the information of the Principal Certifying Authority, full details of the equipment and methods proposed for placing and finishing the concrete subbase together with a paving plan showing proposed paving widths, sequence and estimated daily outputs. *Contractor's Responsibility*
2. The Contractor shall give the Principal Certifying Authority two days written notice of the intention to commence construction of the subbase on any section of work. *Written Notice*
3. The surface on which concrete subbase is to be placed shall be clean and free of loose or foreign matter and in damp condition. *Surface Conditions*
4. Concrete shall not be placed either during rain or when the air temperature in the shade is below 5°C or above 38°C. *Air Temperature Limits*
5. The temperature of the concrete placed in the work shall be neither less than 10°C nor more than 32°C. *Concrete Temperature Limits*

C247.29 RATE OF EVAPORATION

1. Should the Contractor elect to use an evaporation retarder to prevent excessive moisture loss, application shall be by fine spray after all finishing operations, except minor manual bull-floating, are complete. *Evaporation Retarder*
2. The Contractor shall be responsible for measuring and recording concrete temperature and *Contractor's*

wind velocity at the point of concrete placement, and for continuously measuring and recording air temperature and relative humidity daily, at the site throughout the course of the work. The Contractor shall provide and maintain all equipment and shall provide suitable personnel necessary for all such measuring and recording. **Responsibility**

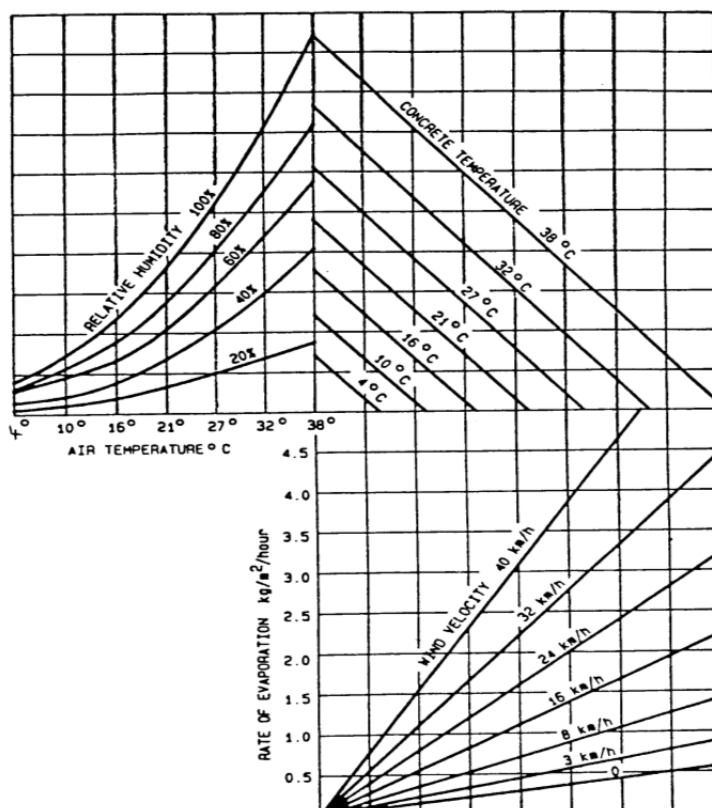


Figure C247.1 - Rate of Evaporation

The graph shows the effects of air temperature, humidity, concrete temperature and wind velocity together on the rate of evaporation of water from freshly placed and unprotected concrete.

Example:

- with air temperature at 27°C
- with relative humidity at 40%
- with concrete temperature at 27°C
- with a wind velocity of 26km/h the rate of evaporation would be 1.6 kg/m²/hour.

To determine the evaporation rate from the graph, enter the graph at the air temperature (in this case 27°C), and move vertically to intersect the curve for relative humidity encountered - here 40%. From this point move horizontally to the respective line for concrete temperature - here 27°C. Move vertically down to the respective wind velocity curve - in this case interpolating for 26km per hour - and then horizontally to the left to intersect the scale for the rate of evaporation.

C247.30 MECHANICAL PAVING

1. The mechanical paver shall be a self-propelled machine with a gross operating mass of not less than 4 tonnes per lineal metre of paved width. It shall be capable of paving at a speed of one metre per minute or less as required to enable the continuous operation of the paver and obtain the required degree of compaction. It shall include the following features:- **Paving Machine Requirements**
 - (a) An automatic control system with a sensing device to control line and level to the specified tolerances.
 - (b) Means of spreading the mix uniformly and regulating the flow of mix to the vibrators without segregation of the components.
 - (c) Internal vibrators capable of compacting the full depth of the concrete.

- (d) Adjustable extrusion screed and/or conforming plate to form the slab profile and produce the required finish on all surfaces.
 - (e) Capability of paving in the slab widths or combination of slab widths and slab depths shown on the Drawings.
2. The mechanical paver shall spread, compact, screed and finish the freshly placed concrete in such a manner that a minimum of finishing by hand will be required. A dense and homogeneous concrete with a surface exhibiting low permeability shall be provided. **Concrete Finish**
 3. Surface texture shall be steel screed or float finish except that a hessian dragged finish shall be provided where the subbase is to be overlain by asphaltic concrete.
 4. The supporting surface for the tracks of the paver, curing machine and any other equipment in the paving and curing train shall be in a smooth and firm condition. **Supporting Surface**
 5. Once spreading commences, the concrete paving operation shall be continuous. The mechanical paver shall be operated so that its forward progress shall not be stopped due to lack of concrete. If disruptions occur for any reason, the Principal Certifying Authority may direct that a construction joint be formed before the recommencement of paving operations. **Continuity of Paving Operation**

C247.31 HAND PLACING

1. Forms shall be so designed and constructed that they can be removed without damaging the concrete and shall be true to line and grade and braced in a substantial and unyielding manner. Forms shall be mortar tight and debonded to ensure non-adhesion of concrete to the forms. **Formwork**
2. Concrete shall be delivered in agitator trucks and shall be deposited uniformly in the forms without segregation. The concrete shall be compacted by poker vibrators and by at least two passes of a hand-guided vibratory screed traversing the full width of the slab on each pass. Any build up of concrete between the forms and vibratory screed shall be prevented. **Placing in Forms**
3. If disruptions occur for any reason, the Principal Certifying Authority may direct that a construction joint be formed before the recommencement of paving operations. **Disruption,**
4. A dense and homogeneous concrete with a surface exhibiting low permeability shall be provided. **Concrete Finish**
5. Surface texture shall be steel screed or float finish except that a hessian dragged finish shall be provided where the subbase is to be overlain by asphaltic concrete.

C247.32 ALIGNMENT AND SURFACE TOLERANCES

(a) Horizontal Alignment Tolerance

1. The outer edges of the subbase shall be square to the subgrade and shall be constructed 50mm wider than the plan position of the base formation with a tolerance of "25mm. **Outer Edge Location**
2. Where an edge of a slab is to form a longitudinal construction joint line, the allowable horizontal alignment tolerances shall comply with Clause C247.36 **Longitudinal Construction Joint**

(b) Surface Tolerances

1. The level at any point on the top of the subbase shall not vary by more than 0 mm above or 20 mm below that shown on the Drawings or as directed by the Principal Certifying Authority. Where the concrete is found to be above the level tolerance, it shall be removed. Where the concrete is found to be below level tolerance, it shall be made up with base concrete. **Surface Levels**
2. The top surface of the subbase shall also not deviate from a 3 m straightedge, laid in any direction, by more than 5 mm. **Surface Levels**

C247.33 CURING

1. The subbase shall be cured by the use of one of the following:

Curing Compounds

 - (a) Chlorinated rubber curing compound complying with AS 3799 Class C Type 1D or resin-based curing compound complying with AS 3799 Class B, Type 1D or Type 2, if an asphalt base is used, or
 - (b) White pigmented wax emulsion curing compound complying with AS 3799 Class A Type 2, if a concrete base is used, or
 - (c) Bitumen emulsion Grade CRS/170 complying with AS 1160 for either asphalt or concrete base.
2. The Contractor shall submit, for the information of the Principal Certifying Authority, a current Certificate of Compliance for the curing compound from an Australian Laboratory, approved by the Principal Certifying Authority, showing an Efficiency Index of not less than 90 per cent when tested in accordance with Appendix B of AS 3799.

Efficiency Index
3. The curing compound shall be applied using a fine spray immediately following texturing at the rate stated on the Certificate of Compliance or at a minimum of 0.2 litres per square metre, whichever rate is the greater. Bitumen emulsion shall be applied at a minimum rate of 0.35 litres of residual bitumen per square metre. When applied with a hand lance the rates should be increased by 25 per cent.

Application
4. The average application rate shall be checked by the Contractor and certified to the Principal Certifying Authority by calculating the amount of curing compound applied to a measured area representative of a lot and nominated by the Principal Certifying Authority.

Application Rate
5. The curing membrane shall be maintained intact for seven days after placing the concrete. Any damage to the curing membrane shall be made good by hand spraying of the affected areas.

Curing Period
6. Equipment and materials for curing operations shall be kept on site at all times during concrete pours.

Equipment on Site

C247.34 PROTECTION OF WORK

1. The Contractor shall ensure that the temperature of the concrete does not fall below 5°C during the first twenty-four hours after placing. The Contractor shall provide, for the information of the Principal Certifying Authority, details of procedures and equipment proposed to be used for the protection of sections recently placed in the event of low air temperatures. If the Contractor fails to maintain the temperature of the concrete at or above 5°C and if, in the opinion of the Principal Certifying Authority, the concrete exhibits any deficiencies, due to failure to comply with this Specification, the concrete shall be rejected.

Temperature Control
2. The Contractor shall protect the work from rain damage and shall provide, for the information of the Principal Certifying Authority, detailed proposals of procedures and equipment to be used for such protection.

Rain Protection
3. Neither traffic nor construction equipment, other than that associated with testing, shall be allowed on the subbase until the strength of the subbase has reached at least 4.0 MPa. Thereafter, only construction equipment necessary for the following operations shall be permitted to traffic the subbase:-

Traffic Restrictions

 - (a) Bond-breaker and spall treatment and
 - (b) Concrete or asphalt paving.
4. Notwithstanding the above, any damage caused to the subbase by the Contractor's operations shall be rectified to the Principal Certifying Authority's satisfaction.

Damage Restoration

JOINTS

C247.35 TRANSVERSE CONSTRUCTION JOINTS

1. Transverse construction joints shall:
 - be provided only at discontinuities in the placement of concrete determined by the Contractor's paving operations.
 - be constructed normal to the edge line and to the dimensions shown on the Drawings.
 - not deviate from a 3 m straightedge placed along the joint by more than 10 mm.
 - be smooth across the joint.

C247.36 LONGITUDINAL CONSTRUCTION JOINTS

1. Longitudinal construction joints shall:
 - be formed no closer than 300mm of the base longitudinal joints as shown in the Drawings, unless directed otherwise by the Principal Certifying Authority.
 - not deviate from the plan or nominated position at any point by more than 20 mm.
 - not deviate from a 3 m straightedge placed along the joint by more than 10 mm, having made due allowances for any planned curvature.
 - be smooth across the joint.

BOND BREAKER AND SPALL TREATMENT

C247.37 GENERAL

1. Subbase to be covered by concrete base shall be provided with a wax emulsion bond breaker. *Bond Breaker*
The wax emulsion shall comply with AS 3799 Class A Type 2.
2. Where the base consists of asphaltic concrete, no bond breaker shall be used. In this case *No Bond Breaker*
bond is essential and wax emulsion curing compounds shall not be permitted.
3. Subbase with spalled areas shall be treated, where directed by the Principal Certifying Authority, prior to application of the bond breaker or asphaltic concrete. *Spalled Areas*

C247.38 PREPARATION OF SUBBASE

1. Immediately prior to any spalled area treatment and the application of bond breaker, the subbase surface shall be cleaned to the satisfaction of the Principal Certifying Authority of all loose, foreign and deleterious material. *Subbase Preparation*

C247.39 TREATMENT OF SPALLING

1. Where directed by the Principal Certifying Authority, spalled areas shall be treated before the application of the bitumen bond breaker or asphaltic concrete by infilling with 6 : 1 sand/cement mortar to provide a surface flush with the surrounding concrete. The area shall be wetted and sprinkled with neat cement before screeding the mortar into the patches. *Method*
2. A spalled area, if directed to be treated, shall have such treatment completed no earlier than five working days before the application of the bond breaker. Treated spalled areas damaged by the Contractor or others shall be made good by the Contractor. *Spalling Repair Time*

C247.40 APPLICATION OF BOND BREAKER

1. The wax emulsion used as bond breaker should be the same as used for curing compound. *Wax Emulsion*
This second application shall be applied at a minimum rate of 0.2 litres per square metre and not earlier than 72 hours before the placement of the base concrete.
2. The method of application shall conform to the requirements of Clause C247.33.

C247.41 TREATMENT OF UNPLANNED CRACKS

1. The Principal Certifying Authority shall direct treatment of unplanned cracks whose width exceeds 0.3mm. This may take the form of applying an approved 300mm minimum width geotextile backed polymer modified bitumen strip (reference AUSTROADS Guide to Geotextiles) over the crack prior to placement of the first asphalt base layer or concrete base, or an extra application of wax emulsion for a width of 300mm along the crack when a concrete base is required.
2. The Contractor shall install the Stress Alleviating Membrane strip in accordance with the manufacturer's instructions.

SUBGRADE BEAMS**C247.42 GENERAL**

1. Subgrade beams shall be provided below the subbase at expansion joints and isolation joints in the concrete base as shown in the Drawings or as directed by the Principal Certifying Authority. They shall extend the full length of joints unless otherwise indicated on the Drawings. *Scope*

C247.43 EXCAVATION

1. Excavation for subgrade beams shall be to the dimensions shown on the Drawings. All loose material shall be removed and the vertical faces trimmed to neat lines. The bottom of the trench shall be recompact, where required, to the degree of consolidation of the adjacent undisturbed material. *Excavation Standards*
2. Excavated material shall be legally disposed of by the Contractor. *Disposal of Excavated Materials*

C247.44 CONCRETE

1. Concrete in subgrade beams shall comply with the requirements of the Specification for MINOR CONCRETE WORKS. The minimum compressive strength at 28 days shall be 32MPa. *Compressive Strength*

C247.45 STEEL REINFORCEMENT

1. Steel reinforcement shall be of the type and size shown on the Drawings and shall be supplied and installed in accordance with the Specification for PLAIN OR REINFORCED CONCRETE BASE. *Type and Size*

C247.46 CONSTRUCTION AND PROTECTION

1. Subgrade beams shall be constructed before construction of the subbase. The top surface of the subgrade beam shall be level with the top of the subgrade. Any loose subgrade material shall be recompact to the correct level. If the contractor elects to remove any loose material, the voids shall be filled with mortar or concrete and screeded to provide a surface flush with the top of the subgrade beam and the surrounding subgrade. *Timing and Type of Finish*

2. A steel float shall be used to produce a smooth surface finish, free of any texture.
3. The subgrade beams shall be protected from damage by plant, motor vehicles and the paving operation. Any damage shall be made good by the Contractor. *Damage Protection*

C247.47 CURING

1. The top surface of the subgrade beam shall be cured in accordance with Clause C247.33 *Curing* before placing the subbase.

C247.48 BOND BREAKER

1. The top surface of the subgrade beam shall be treated with a bond breaker which shall consist of a further application of curing compound neither less than twenty-four hours nor more than seventy-two hours before placing of subbase concrete. *Time of Placement*

LIMITS AND TOLERANCES

C247.50 SUMMARY OF LIMITS AND TOLERANCES

1. The tolerances applicable to the various clauses in this Specification are summarized in Table C247.4 below:

Item	Activity	Tolerances		Spec Clause
1.	Materials for Concrete			
	a. Misshapen Particles	2 : 1 ratio	< 35 percent	C247.09a
	b. Aggregates Grading	Deviation from submitted sample not greater than Table C247.1		C247.09b
	c. Durability	Wet Strength 10% Fines	> 50 kN < 35 percent	C247.09c
2.	Concrete			
	a. Shrinkage	Drying Shrinkage <450 microstrain		C247.12
	b. Consistency	Mechanically placed: >25mm<40mm Hand Placed: >50mm <65mm		C247.13
	c. Air Content	Min 3, Max 7 percent		C247.14
	d. Thickness	Concrete shall be removed if thickness >20mm below specified thickness.		C247.21
	e. Mixing and Transport	After addition of cement to the aggregate, concrete shall be incorporated into the work within: (i) One and a half hours where transported by truck mixer or agitator. (ii) One hour where transported by non agitating trucks.		C247.25

Item	Activity	Tolerances	Spec Clause
	f. Placing	Concrete shall not be placed when the air temperature in the shade is less than 5°C or >38°C. Temperature of concrete shall be >10°C but <32°C.	C247.28
		Concrete shall not be placed when the Rate of Evaporation exceeds 0.5kg per square metre per hour.	C247.29
3.	Alignment and Surface Tolerances		
	a. Horizontal Alignment	Outer edges not to deviate from plan position by more than 25mm.	C247.32
	b. Surface	Level on top surface to be no more than +0mm or -20mm to that shown on the drawings.	C247.32
		The top surface shall not deviate from a 3m straightedge laid in any direction by more than 5mm.	C247.32
4.	Joints		
	a. Transverse Construction	Shall not deviate from a 3m straight-edge placed along the joint by more than 10mm.	C247.35
	b. Longitudinal Joint	(i) Shall not deviate from the plan or nominated position at any point by more than 20mm.	C247.36
		(ii) Shall not deviate from a 3m straightedge placed along the joint by more than 10mm after allowing for any curvature.	
5.	Bond Breaker		
	a. Wax Emulsion	Minimum 0.2 litres per square metre, not earlier than 72 hours before placement of base.	C247.40

Table C247.4 - Summary of Limits and Tolerances

DEVELOPMENT CONSTRUCTION SPECIFICATION

C248

PLAIN OR REINFORCED CONCRETE BASE

AMENDMENT RECORD FOR THIS SPECIFICATION PART

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part. The clause numbering and context of each clause are preserved. New clauses are added towards the rear of the specification part as special requirements clauses. Project specific additional script is shown in the specification as italic font.

The amendment code indicated below is 'A' for additional script 'M' for modification to script and 'O' for omission of script. An additional code 'P' is included when the amendment is project specific.

Amendment Sequence No.	Key Topic addressed in amendment	Clause No.	Amendment Code	Author Initials	Amendment Date

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SPECIFICATION C248 PLAIN OR REINFORCED CONCRETE BASE

GENERAL

C248.01 SCOPE

1. The work to be executed under this Specification consists of the construction, by mechanical or hand placement of plain or reinforced concrete base, slab anchors and terminal slabs to the dimensions and levels shown on the Drawings and in accordance with the provisions of the Contract.
2. The work also includes the construction of reinforced concrete approach slabs at bridge abutments and traffic signal approach slabs where specified on the Drawings. *Approach Slabs*

C248.02 THICKNESS AND LEVELS OF BASE

1. The base thickness and levels shall be shown on the Drawings.

MATERIALS FOR CONCRETE

C248.04 CEMENT

1. Cement shall be Type GP Portland cement complying with AS 3972 and shall be from a source included in the New South Wales Government Cement Quality Assurance Scheme. *NSW QA Scheme*
2. When submitting details of the nominated mix in accordance with Clause C248.19 the Contractor shall nominate the brand and source of the cement. On approval of a nominated mix by the Principal Certifying Authority, the Contractor shall use only the nominated cement in the work. *Nominated Brand and Source*
3. Documentary evidence of the quality and source of the cement shall be furnished by the Contractor to the Principal Certifying Authority upon request at any stage of the work. *Proof of Quality*
4. If the Contractor proposes to use cement which has been stored for a period in excess of three months from the time of manufacture, a re-test shall be required to ensure the cement still complies with AS 3972, before the cement is used in the work. *Storage Time*
6. Cement shall be transported in watertight containers and shall be protected from moisture until used. Caked or lumpy cement shall not be used. *Transport and Storage*

C248.05 FLYASH

1. Flyash shall be from a source included in the New South Wales Government Cement Quality Assurance Scheme. The use and quality of flyash shall comply with AS 3582.1. *NSW QA Scheme*
2. When submitting details of the nominated mix in accordance with Clause C248.19, the Contractor shall nominate the powerhouse source of the flyash. The Contractor shall use only flyash from the nominated powerhouse. *Source*
3. Documentary evidence of the quality and source of the flyash shall be furnished by the Contractor to the Principal Certifying Authority. *Documentary Evidence*

C248.06 WATER

1. Water used in the production of concrete shall be potable and free from materials harmful to concrete or reinforcement. *Quality*

C248.07 ADMIXTURES

1. Chemical admixtures and their use shall comply with AS 1478. Admixtures shall not contain calcium chloride, calcium formate, or triethanolamine or any other accelerator. Admixtures or combinations of admixtures other than specified below, shall not be used. An air-entraining agent shall be included in the mix and the air content of the concrete shall comply with Clause C248.13. **Quality and Use**
2. Fresh concrete with an air content not complying with Clause C248.13 shall be rejected. **Excess Air Content**
3. During the warm season, (October to March inclusive), a lignin or lignin-based ('ligpol') set-retarding admixture (Type Re or Type WR Re) approved by the Principal Certifying Authority shall be used to control slump within the limits stated in Clause C248.12. The dosage shall be varied to account for air temperature and haul time in accordance with the manufacturer's recommendations. A copy of the NATA endorsed Certificate of Compliance with AS 1478 for Type Re or Type WR Re shall be submitted to the Principal Certifying Authority, together with the proposed 'dosage chart' in accordance with Clause C248.19. **Retarder for Warm Season**
4. During the cool season, (April to September inclusive), only a lignin or lignin based set-retarding admixture containing not more than 6 per cent reducing sugars (Type WR Re complying with AS 1478) may be used in the mix. If the Contractor proposes to vary the admixture between the warm and cool seasons such variation shall constitute a proposed change to an approved mix for the purposes of Clause C248.21. **Retarder for Cool Season**
5. When submitting details of the nominated mix in accordance with Clause C248.19, the Contractor shall nominate the proprietary source, type and name for each admixture to be used. Documentary evidence of the quality shall be furnished by the Contractor to the Principal Certifying Authority upon request at any stage of the work. **Source and Type**

C248.08 AGGREGATES**(a) General**

1. At least 40 per cent by mass of the total aggregates in the concrete mix shall be quartz sand. Quartz sand is aggregate having a nominal size of less than 5 mm and shall contain at least 70 per cent quartz, by mass. Where present, chert fragments will be regarded as 'quartz' for the purpose of this specification, but the ratio of chert to quartz shall not exceed unity. **Quartz Sand Content**
2. When submitting details of the nominated mix in accordance with Clause C248.19, the Contractor shall nominate the sources of aggregate to be used in the concrete and shall submit details of the geological type of each aggregate. **Source and Type**

(b) Fine Aggregate

1. Fine aggregate shall consist of clean, hard, tough, durable, uncoated grains uniform in quality. Fine aggregate shall comply with AS 2758.1 in respect of bulk density, water absorption (maximum 5 per cent), material finer than 2 micrometres, and impurities and reactive materials. The sodium sulphate soundness, determined by AS 1141.24, shall not exceed the limits in Table C248.1. **Quality**

Australian Standard Sieve	Per Cent Loss by Mass
4.75mm to 2.36mm	4
2.36mm to 1.18mm	6
1.18mm to 600mm	8
600mm to 300mm	12

Table C248.1 - Sodium Sulphate Soundness Limits

2. In the case of a blend of two or more fine aggregates, the above limits shall apply to each constituent material. **Blending**
3. The grading of the fine aggregate, determined by AS 1141.11, shall be within the limits given in Table C248.2. **Grading**
4. When submitting details of the nominated mix the Contractor shall submit to the Principal Certifying Authority a NATA Certified Laboratory Test Report on the quality and grading of the fine aggregate proposed to be used. The grading shall be known as the "proposed fine aggregate grading". **Proposed Grading**
5. If the Contractor proposes to blend two or more fine aggregates to provide the proposed grading then Test Reports for each constituent material shall be submitted separately and the Principal Certifying Authority advised of the proportions in which the various sizes and constituents are to be combined. The fine aggregate from each source and the combined aggregate shall comply with the requirements of this clause. **Test for Each Constituent**
6. The grading of the fine aggregate used in the work shall not deviate from that of the proposed grading by more than the amounts in Table C248.2. **Grading Deviation**

Australian Standard Sieve	Proportion Passing (% of Mass of Sample)
9.50mm	100
4.75mm	90 - 100
2.36mm	65 - 95
1.18mm	40 - 80
600mm	24 - 52
300mm	8 - 25
150mm	1 - 8
75mm	0 - 3

Table C248.2 - Fine Aggregate Grading

(c) Coarse Aggregate

1. Coarse aggregate shall consist of clean, crushed, hard durable rock, metallurgical furnace slag or gravel. Coarse aggregate shall comply with AS 2758.1 in respect of particle density, bulk density, water absorption (maximum 2.5 per cent), material finer than 75 micrometres, weak particles, light particles, impurities and reactive materials, iron unsoundness and falling or dusting unsoundness. In all other respects, the coarse aggregate shall comply with this Specification. If required, coarse aggregate shall be washed to satisfy these requirements. **Quality**
2. The grading of the coarse aggregate, determined by AS 1141.11, shall be within the limits given in Table C248.3. **Grading**
3. When submitting details of the nominated mix the Contractor shall submit to the Principal Certifying Authority a NATA Certified Laboratory Test Report on the quality and grading of the coarse aggregate proposed to be used. The grading shall be known as the "proposed coarse aggregate grading". **Proposed Grading**
4. If the Contractor proposes to blend two or more coarse aggregates to provide the proposed grading then Test Reports for each constituent material shall be submitted separately and the Principal Certifying Authority advised of the proportions in which the various sizes and constituents are to be combined. The coarse aggregate from each source and the combined aggregate shall comply with the requirements of this clause. **Test for Each Constituent**
5. The grading of the coarse aggregate used in the work shall not deviate from that of the proposed grading by more than the amounts in Table C248.3. **Grading Deviation**

Australian Standard Sieve	Proportion Passing (% of Mass of Sample)
26.50 mm	100
19.00 mm	95 - 100
13.20 mm	(Design)
9.50 mm	25 - 55
4.75 mm	0 - 10
2.36 mm	0 - 2

Table C248.3 - Coarse Aggregate Grading

6. The coarse aggregate shall also conform to the following requirements:-

Additional Tests

- (i) Wet Strength - AS 1141.22.

Shall not be less than 80 kN for any fraction and/or constituent.

- (ii) 10 per cent Fines Wet/Dry Variation - AS 1141.22.

Shall not exceed 35 per cent for any fraction and/or constituent.

- (iii) Soundness - AS 1141.24

The loss in mass when tested with sodium sulphate shall not exceed 9 per cent for any constituent.

- (iv) Particle Shape - AS 1141.14

The proportion of misshapen particles (2:1 ratio) shall not exceed 35 per cent.

- (v) Fractured Faces - AS 1141.18.

At least 80 per cent by mass of the particles shall have two or more fractured faces.

(d) Storage

1. Storage and handling facilities shall be such as to prevent the aggregates becoming intermixed or mixed with foreign materials, and to prevent segregation occurring. **Facilities**

2. The area surrounding the storage facilities and mixing plant shall be so constructed that delivery vehicles, loaders and trucks shall not be capable of introducing foreign matter to the aggregates at any time. If foreign matter is introduced or the area reaches a condition where, in the opinion of the Principal Certifying Authority, foreign matter may be introduced to the aggregates, production of concrete and delivery of materials shall cease until the condition is corrected to the satisfaction of the Principal Certifying Authority. **Introduction of Foreign Matter**

QUALITY REQUIREMENTS OF CONCRETE**C248.09 CEMENT AND FLYASH CONTENT**

1. The minimum Portland cement content shall be 270 kilograms per yielded cubic metre of concrete. The maximum flyash content shall be 50 kilograms per yielded cubic metre of concrete. **Cement and Flyash**

C248.10 COMPRESSIVE STRENGTH

1. The compressive strength of concrete shall be determined in accordance with AS 1012.9. **Compressive Strength**
2. For accessways within private property, the minimum compressive strength at twenty-eight days shall be 25 MPa.
3. For public roads, the minimum compressive strength at twenty-eight days shall be 32 MPa.

C248.11 SHRINKAGE

1. The drying shrinkage of the nominated mix, determined by AS 1012.13, shall not exceed 450 microstrain after three weeks air drying. The drying shrinkage at the nominated slump plus 10 mm shall be taken as the average of the reading or readings within 5 per cent of the median of the three readings obtained in accordance with AS 1012.13. **Shrinkage Limit**

C248.12 SLUMP (CONSISTENCY)

1. The Contractor's nominated slump, determined in accordance with AS 1012.3, Method 1, shall be neither less than 30 mm nor more than 40 mm for mechanically placed concrete and shall be neither less than 55 mm nor more than 65 mm for hand placed concrete. **Slump Tolerance**

C248.13 AIR CONTENT

1. The air content of the concrete, determined in accordance with AS 1012.4, Method 2, shall be neither less than 4 per cent nor more than 7 per cent, when discharged from the transport vehicle ready for placement. **Tolerances**

STEEL REINFORCEMENT**C248.14 MATERIAL**

1. Steel reinforcement shall comply with the requirements of the appropriate following Australian Standards:- **Standards**
 - (a) AS 1302 Steel Reinforcing Bars for Concrete.
 - (b) AS 1303 Steel Reinforcing Wire for Concrete.
 - (c) AS 1304 Welded Wire Reinforcing Fabric for Concrete.
2. The type and size of bars shall be as shown on the Drawings. **Type and Size**
3. Steel reinforcement shall be free from loose or thick rust, grease, tar, paint, oil, mud, millscale, mortar or any other coating, but shall not be brought to a smooth polished condition. **Quality**
4. The Contractor shall supply evidence satisfactory to the Principal Certifying Authority that steel reinforcement complies with AS 1302, AS 1303 or AS 1304, as appropriate. Test certificates shall show the results of mechanical tests and chemical analysis. **Documentary Evidence**
5. Where the material cannot be identified with a test certificate, samples shall be taken and testing arranged by the Contractor. The samples shall be selected randomly and consist of three specimens each at least 1.2 m in length. **Sampling**
6. Plastic bar chairs or plastic tipped wire chairs shall be capable of withstanding a load of 200kg mass on the chair for one hour at $23 \pm 5^{\circ}\text{C}$ without malfunction. The Contractor shall demonstrate that the proposed chairs conform with these requirements. **Wire Chairs**

C248.15 BENDING

1. Reinforcement shall be formed to the dimensions and shapes shown on the Drawings. Reinforcement shall not be bent or straightened in a manner that will damage the material. Bars with kinks or bends not shown on the Drawings shall not be used. Heating of reinforcement for purposes of bending will only be permitted if uniform heat is applied. Temperature shall not exceed 450°C and the heating shall extend beyond the portion to be bent. Heated bars shall not be cooled by quenching. **Bending**

C248.16 SPLICING

1. All reinforcement shall be furnished in the lengths indicated on the Drawings. Except where shown on the Drawings, splicing of bars shall only be permitted with the approval of the Principal Certifying Authority as to the location and method of splicing. *Plan Lengths*
 The length of lapped splices not shown on the Drawings shall be as follows for unhooked bars:-

Plain bars, Grade 250	-	40 bar diameters
Deformed bars, Grade 400	-	35 bar diameters
Hard-drawn wire	-	50 bar diameters
2. Splices in reinforcing fabric shall be measured as the overlap between the outermost wire in each sheet of fabric transverse to the direction of splice. This overlap shall not be less than the pitch of the transverse wires plus 25 mm. *Splice Dimensions*
3. In welded splices, bars shall only be welded by an approved electrical method. Grade 400 deformed bars shall not be welded. *Welded Splice*
4. Welding shall comply with AS 1554.3. The welded splice shall meet requirements of tensile and bend tests specified for the parent metal. *Welding Standard*

C248.17 STORAGE

1. Reinforcement, unless promptly incorporated into the concrete, shall be stored under a waterproof cover and supported clear of the ground, and shall be protected from damage and from deterioration due to exposure. *Protection of Reinforcement*

C248.18 PLACING

1. Reinforcing bars and wire reinforcing fabric shall be accurately placed to the dimensions and details shown on the Drawings. They shall be securely held by blocking from the forms, by supporting on concrete or plastic chairs or metal hangers, as approved by the Principal Certifying Authority, and by wiring together where required using annealed iron wire not less than 1.25 mm diameter. These supports shall be in a regular grid not exceeding 1 m and steel shall not be supported on metal supports which extend to any surface of the concrete, on wooden supports, nor on pieces of aggregate. *Position*
Spacing of bar chairs
2. Tack welding instead of wire ties may be used on reinforcing steel. Cold-worked reinforcing bars shall not be tack welded. *Tack Welding*
3. The minimum cover of any bar to the nearest concrete surface shall be 50 mm unless otherwise shown on the Drawings. *Bar Cover*
4. Tie bars shall be placed in the pavement such that after placement they remain in their specified location. Tie bars shall not be placed through the finished upper surface of the pavement. Tie bars shall be placed either ahead of paving or by a bar vibrator into the edge of the joint or by an automatic tie bar inserter on the mechanical paver. Irrespective of the method of placement, tie bars extending from any side face of base concrete or gutter shall be anchored in a manner which will develop 85 per cent of the yield strength of the bar in tension. *Tie Bars*
5. Placing and fastening and support of all reinforcement in the work shall be inspected and approved by the Principal Certifying Authority before concrete is placed and adequate time shall be allowed for inspections and any corrective work which the Principal Certifying Authority may require. Notice for inspection shall not be less than twenty four hours before the intended time of commencement of concrete placement or such time as determined by the Principal Certifying Authority. *Inspection*

DESIGN AND CONTROL OF CONCRETE MIXES

C248.19 GENERAL

1. The Contractor shall submit, for approval by the Principal Certifying Authority, details of the concrete mix (or mixes) and the materials, including source, to be used for each of mechanically placed and hand placed base, including nominated slump and moisture condition of the aggregates (oven dry, saturated surface dry, or other specified moisture content) on which the mix is based. Each such mix shall be known as a 'nominated mix'. **Nominated Mix**
2. Also, the Contractor shall provide a Certificate from a laboratory with appropriate NATA registration stating that each nominated mix and its constituents meet the requirements of this Specification. All relevant test results shall accompany the Certificate. All phases of any particular test must be performed at one laboratory. The certificate shall confirm that the required testing has been carried out in the twelve month period before the date of submission to the Principal Certifying Authority. **Certified Test Results**
3. In the tests supporting the above certification, the compressive strength gain curve shall be submitted showing the compressive strengths at ages 3, 7, 10 and 28 days determined in accordance with AS1012.9. Each of the results shall be based on three specimens of concrete produced from a batch of the nominated mix. The compressive strength shall be the average of individual results within 2.0 MPa of the median. The compressive strength for 28 days shall not be less than the strength nominated. **Compressive Strength**
4. These details shall be submitted at least 7 days before using the nominated mix in the work. **Submission of Details**

C248.20 VARIATIONS TO APPROVED MIXES

1. The Contractor shall not make any changes to the approved mix, its method of production or source of supply of constituents without the prior written approval of the Principal Certifying Authority. **Approval for Mix Variation**
2. Where changes to an approved mix are proposed, the Contractor shall provide details of the nominated mix and materials, in accordance with Clause C248.19. If the variations to the quantities of the constituents in the approved mix are less than 10 kg for Portland cement and flyash and 5 per cent by mass for each other constituent, except admixtures, per yielded cubic metre of concrete the Principal Certifying Authority may approve the changes without new trials being carried out. **Contractor's Responsibility**
3. Notwithstanding these tolerances the minimum Portland cement content shall be 270 kilograms per yielded cubic metre of concrete and the maximum flyash content shall be 50 kilograms per yielded cubic metre of concrete. **Content per Cubic Metre**

CONFORMANCE OF CONCRETE STRENGTH, COMPACTION AND THICKNESS

C248.21 CONCRETE CYLINDERS

(a) Test Specimens

1. Test specimens for determining the compressive strength of concrete shall be standard cylinders complying with AS 1012.8. The Contractor shall supply a sufficient number of moulds to meet the requirements for the frequency of testing specified in this Clause and shall also arrange for a laboratory with appropriate NATA registration to conduct the sampling of fresh concrete and the making, curing, delivery and testing of specimens. Copies of test results shall be forwarded to the Principal Certifying Authority. **Contractor's Responsibility**
2. Samples of concrete for testing shall be taken in accordance with AS1012.1. The selection of the batches to be sampled shall be taken randomly. The specimens shall be moulded from each sample so that they are as identical as practicable. **Sampling**
3. The method of making and curing specimens shall be in accordance with AS1012.8 with compaction by internal vibration. **Curing**
4. The Contractor shall mark the specimens for identification purposes. **Marking**

(b) Frequency of Moulding of Test Specimens

Moulding of Cylinders

1. Test specimens shall be moulded as follows:-
 - (i) For the determination of the compressive strength at twenty-eight days.
 For each lot of up to 50 cubic metres
 of concrete placed at the one time: One pair of specimens
 - (ii) For the determination of the compressive strength at seven days.
 For each lot of up to 50 cubic metres
 of concrete placed at the one time: One pair of specimens
 - (iii) For the determination of compressive strength for any early testing as deemed necessary by the Contractor.
 For each lot of up to 50 cubic metres
 of concrete placed at the one time: One pair of specimens
2. A lot is defined as a continuous pour of up to 50 cubic metres of concrete placed. **Lot Size**

(c) Inspection, Capping and Crushing of Specimens

1. Specimens required by this Specification shall be tested at the NATA registered laboratory nominated by the Contractor.
2. Specimens shall be inspected, capped and crushed in accordance with AS1012.9. **Standards**
3. Before crushing, the mass per unit volume of the seven day specimens shall also be determined in accordance with AS1012.12 Method 2, so that the relative compaction of cores taken from the same lot of concrete base can be determined. **Mass Unit Volume**

C248.22 COMPRESSIVE STRENGTH OF CONCRETE**(a) General**

1. The compressive strength of the concrete represented by a pair of specimens moulded from one sample shall be the average compressive strength of the two specimens unless the two results differ by more than 3.0 MPa, in which case the lower result shall be taken to represent the compressive strength of the lot of concrete. *Determination of Strength*

(b) Adjustment of Test Compressive Strength for Age of Specimen

1. Should any specimen be tested more than twenty-eight days after moulding the equivalent twenty-eight day compressive strength shall be the test compressive strength divided by the factor applying to the age of the specimen at the time of the test shown in Table C248.4. For intermediate ages the factor shall be determined by interpolation. *Strength Age Factor*

Age of Specimen at time of test (days)	Factor
28	1.00
35	1.02
42	1.04
49	1.06
56	1.08
70	1.10
84	1.12
112	1.14
140	1.16
168	1.18
196	1.20
224	1.22
308	1.24
365 or greater	1.25

Table C248.4 - Concrete Age Conversion Factors**(c) Conformance for Compressive Strength**

1. If the 28 day compressive strength of test cylinders:
 - a. for private accessways is less than 25 MPa the lot represented by the test cylinders shall be removed and replaced in accordance with Clauses C248.50, C248.51 and C248.52. *Limits*
 - b. for public roads is less than 32 MPa the lot represented by the test cylinders shall be removed and replaced in accordance with Clauses C248.50, C248.51 and C248.52.
2. In case of non-conformance the Contractor may elect to core the in situ base concrete for testing of the actual compressive strength to represent the particular lot. The locations for testing shall be nominated by the Principal Certifying Authority. Such locations may be determined by the use of a nuclear density meter, or any alternative method. Testing shall be carried out at the request of the Contractor. Base concrete failing to reach the required in situ compressive strength shall not be retested for at least 72 hours after the determination of the value of the in situ compressive strength. *Coring*
3. After testing for compressive strength of cores, where required, the Principal Certifying Authority shall consider the test results and shall at his absolute discretion determine the compressive strength of the concrete to be either:- *Superintendent's Absolute Discretion*
 - (i) The average of the twenty-eight day compressive strength of the pair of specimens moulded at the time of placing; or
 - (ii) The equivalent twenty-eight day compressive strength of the core.

4. A lot is defined as a continuous pour of up to 50 cubic metres of base represented by a pair of test specimens cast from a sample of the concrete used in its construction. *Lot Size*

C248.23 CONFORMANCE FOR THICKNESS

1. Thickness measurements of the concrete base shall be determined by survey, measurements at the edges or by coring. Audit checks using a suitable probe may be carried out whilst the concrete is being placed. The readings shall be rounded off to the nearest 5mm. *Thickness Measurement*
2. Base which is below the specified thickness shall be removed and replaced in accordance with Clauses C248.50, C248.51 and C248.52. *Remove and Replace*
3. Base which is thicker than the design thickness will be acceptable provided the finish satisfies the requirements of Clause C248.31.

C248.24 RELATIVE COMPACTION OF CONCRETE

(a) Test Specimens

1. Test specimens for determining the relative compaction of the concrete placed in the work shall be cores cut from the work. Cores shall be cut from the full depth of the concrete base to the requirements of AS 1012.14, with the following exceptions:- *Cores*
- (i) The requirement that the concrete shall be at least 28 days old before the core is removed shall not apply. However concrete must be not less than three days old in the warm season and six days old in the cool season, before removal.
- (ii) The nominal diameter of the cores shall not be less than 75 mm.
2. The location of coring shall be chosen to exclude joints, steel reinforcement or tie bars from the core. The locations are not intended to be random, but are intended to ensure that the whole of the concrete base conforms to the minimum requirements of the Specification. Cores shall be marked for identification. *Location of Cores*
3. Cores shall be placed immediately either in a tank of lime saturated water or in an individual plastic bag and sealed to prevent water loss. Cores stored in plastic bags shall be kept in the shade. *Storage*
4. Cores shall not be subjected to temperatures in excess of either ambient temperature or 23°C whichever is the higher and they shall not be subjected to temperature less than 10°C, until delivered to the testing laboratory. *Temperature Control*

(b) Frequency of Coring

1. The Contractor shall take a minimum of one core specimen from each lot of concrete base represented by standard cylinders moulded in accordance with Clause C248.21. *Minimum*
2. In the case of hand-placed base concrete, two cores shall be taken to represent a section of work. A section of work shall be confined between construction joints. Hand-worked or placed base that is cast with machine-placed concrete and not separated from the machine-placed concrete shall be deemed to be part of the machine-placed concrete, and be cored and tested as part of the machine-placed concrete base. *Hand Placed Concrete*

(c) Repair of Core Holes

1. The Contractor shall clean and restore all core holes taken in the base with non-shrink cementitious concrete having a compressive strength of not less than that in the base and a maximum nominal aggregate size of 10 mm. *Contractor's Responsibility*
2. The surface of the restored hole shall be similar to the surrounding surface in texture and colour. *Surface Condition*

(d) Testing of Cores for Compaction

1. The core specimens shall be wet conditioned in accordance with AS 1012.14 for not less than 24 hours immediately prior to testing for compaction. Testing to determine mass per unit volume shall be carried out on specimens at age seven days. *Curing*
2. The relative compaction of a core specimen shall be the ratio, expressed as a percentage, of the mass per unit volume of the core specimen to the average mass per unit volume of the standard cylinders used to determine the seven day compressive strength from the same lot of concrete base. The mass per unit volume of both standard cylinders and cores shall be determined in accordance with AS 1012.12 Method 2. *Relative Compaction*

(e) Conformance for Compaction

1. If the relative compaction is less than 97.0 per cent, the lot represented by the core shall be removed and replaced in accordance with Clauses C248.50, C248.51 and C248.52. *Rejection Percentage*
2. Core specimens for compressive strength testing shall be wet-conditioned, prepared and tested in accordance with AS 1012.14. Cores obtained for compaction shall not be re-used for compressive strength testing. *Core Preparation*
3. The test strength shall be adjusted for age at test in accordance with Clause C248.22 and for length/diameter ratio in accordance with Table C248.5 by multiplying by the correction factor in Table C248.5. *Adjustment for Age*
4. If the 28 day compressive strength of the core: *Core Compressive Strength*
 - a. for private accessways is less than 25 MPa the lot represented by the test cylinders shall be removed and replaced in accordance with Clauses C248.50, C248.51 and C248.52.
 - b. for public roads is less than 32 MPa the lot represented by the test cylinders shall be removed and replaced in accordance with Clauses C248.50, C248.51 and C248.52..

Length/Diameter Ratio	Correction Factor
2.00	1.00
1.75	0.98
1.50	0.96
1.25	0.93
1.00	0.89
Table C248.5 - Correction Factors	

PRODUCTION, TRANSPORT AND CONSISTENCY OF CONCRETE**C248.25 PRODUCTION AND HANDLING OF CONCRETE**

1. At least one week before commencing work under this Specification, the Contractor shall submit, for the information of the Principal Certifying Authority, details of the proposed methods of handling, storing and batching materials for concrete, details of proposed mixers and methods of agitation, mixing and transport. *Contractor's Responsibility*
2. The methods of handling, storing and batching materials for concrete shall be in accordance with AS 1379, with the following additional requirements:- *Handling and Batching Methods*
 - (a) Certificates of Calibration issued by a recognised authority shall be made available for inspection by the Principal Certifying Authority, as evidence of the accuracy of the scales.
 - (b) Cementitious material shall be weighed in an individual hopper, with the Portland cement weighed first.

- (c) The moisture content of the aggregates shall be determined at least daily immediately prior to batching. Corresponding corrections shall be made to the quantities of aggregates and water.
3. Details of proposed mixers and agitation methods shall be in accordance with the plant and equipment sections of AS 1379, with the additional requirement that in Appendix A of AS 1379 the maximum permissible difference in slump shall be 10 mm. **Mixer Requirements**

C248.26 MIXING AND TRANSPORT

1. Mixing and transport methods shall be in accordance with the production and delivery sections of AS 1379, with the following additional requirements:- **Methods**
- (a) The mixer shall be charged in accordance with the manufacturer's instructions.
 - (b) For the purpose of conducting mixer uniformity tests in accordance with Appendix A of AS 1379 on a split drum mixer producing centrally mixed concrete, the whole of the batch shall be discharged into the tray of a moving vehicle. The concrete shall then be sampled from the tray of the vehicle at points approximately 15 per cent and 85 per cent along the length of the tray.
 - (c) For truck-mixed concrete, addition of water in accordance with the batch production section of AS 1379 shall be permitted only within ten minutes of completion of batching and within 200 m of the batching facilities. The delivery docket must clearly indicate the amount of water added, but in no circumstance shall the water : cement ratio be exceeded. Mixing of the concrete shall be completed at that location.
 - (d) Admixtures shall be separately prediluted with mixing water and shall be incorporated by a method which ensures that no adverse interaction occurs.
 - (e) After addition of the cement to the aggregate, concrete shall be incorporated into the work within:-
 - One and a half hours, where transported by truck mixer or agitator;
 - One hour, where transported by non-agitating trucks.

Means of verification, satisfactory to the Principal Certifying Authority, of the times of addition of cement to the aggregate shall be provided. The times within which the concrete shall be incorporated into the work may be reduced if the Principal Certifying Authority considers the prevailing weather, mix type, or materials being used warrant such a change.
 - (f) The size of the batch in an agitator vehicle shall not exceed the manufacturer's rated capacity nor shall it exceed 80 per cent of the gross volume of the drum of the mixer.

C248.27 MIXING TIME

1. Minimum mixing time will be as determined for the approved mix and verified when trial concrete base is constructed.
2. Where by reason of delay, it is necessary to hold a batch in the mixer, mixing may be continued for a maximum of ten minutes except for split drum mixers where the maximum shall be five minutes. **Batch in Mixer**
3. For longer periods, the batch may be held in the mixer and turned over at regular intervals, subject to the time limits specified for incorporation of the concrete into the work not being exceeded. **Long Delays**

C248.28 CONSISTENCY

1. At all times between mixing and discharge, the slump shall be within 10mm of the Contractor's nominated slump for the nominated mix for mechanically placed concrete and within 15mm thereof for hand placed concrete. **Tolerances**

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| 2. | The consistency of the concrete shall be checked by use of a slump cone in accordance with AS1012.3 Method 1. The test shall be made on concrete samples obtained in accordance with AS1012.1. | Test Method |
| 3. | The consistency of the concrete shall be checked within 30 minutes of adding cement to the aggregate. If the actual haul time exceeds 45 minutes, the consistency shall also be checked immediately prior to discharge. Concrete which is non-conforming in relation to consistency shall not be incorporated into the work. | Timing of Testing |
| 4. | Check tests shall be done on each truckload of concrete. | Check Tests |

PLACING AND FINISHING CONCRETE BASE

C248.29 GENERAL

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| 1. | At least two weeks before commencing work under this Specification, the Contractor shall submit for the information of the Principal Certifying Authority, full details of the equipment and methods proposed for placing and finishing the concrete base together with a paving plan showing proposed paving widths, sequence and estimated daily outputs. | Contractor's Responsibility |
| 2. | The Contractor shall give the Principal Certifying Authority seven days written notice of the intention to commence construction of the base on any section of work. | Written Notice |
| 3. | The subbase surface shall be clean and free of loose or foreign matter and prepared in accordance with the Specification for MASS CONCRETE SUBBASE. | Subbase Condition |
| 4. | Concrete shall not be placed nor shall any concreting work be carried out either during rain or when the air temperature in the shade is below 5°C or above 38°C. | Air Temperature |
| 5. | The temperature of the concrete at the point of discharge from transport vehicles shall be neither less than 10°C nor more than 32°C. | Concrete Temperature |
| 6. | Where required, slab anchors shall be constructed prior to construction of the base. | Slab Anchors |

C248.30 RATE OF EVAPORATION

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| 1. | When the value of Rate of Evaporation, determined from the graph in Figure C248.1, exceeds 0.50 kilograms per square metre per hour the Contractor shall take precautionary measures satisfactory to the Principal Certifying Authority for the prevention of excessive moisture loss. If, in the opinion of the Principal Certifying Authority, such precautionary measures prove to be unsatisfactory, the Contractor shall cease work while the evaporation rate is in excess of 0.50 kilograms per square metre per hour. | Evaporation Limit |
| 2. | Should the Contractor elect to use an evaporation retarder to prevent excessive moisture loss, application shall be by fine spray after all finishing operations, except minor manual bull-floating, are complete. | Use of Retarder |
| 3. | The Contractor shall be responsible for measuring and recording concrete temperature and wind velocity at the point of concrete placement, and for continuously measuring and recording air temperature and relative humidity at the site throughout the course of the work. The Contractor shall provide and maintain all equipment and shall provide suitable personnel necessary for all such measuring and recording. | Contractor's Responsibility |

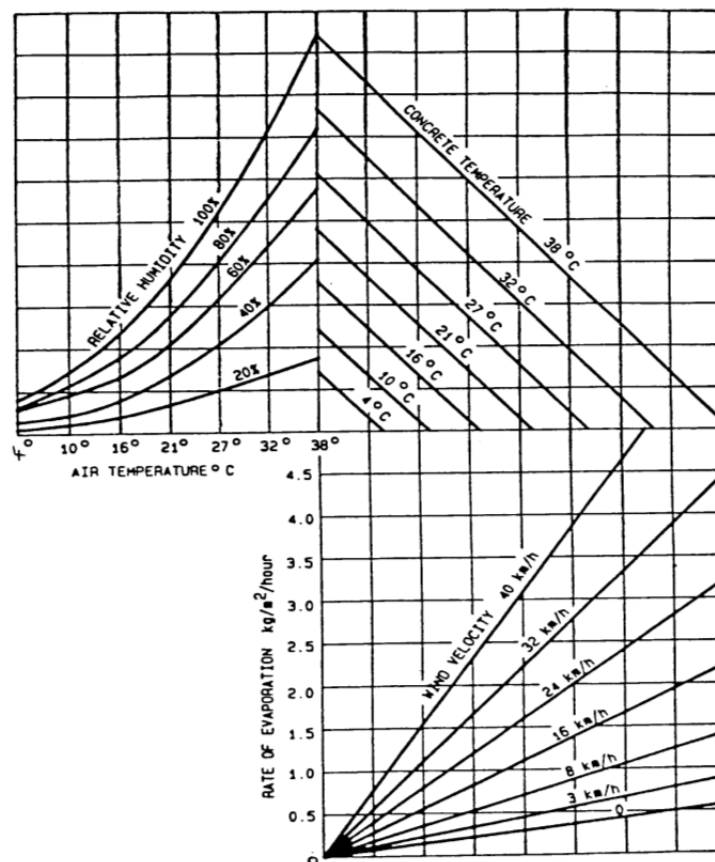


Figure C248.1 - Rate of Evaporation

The graph shows the effects of air temperature, humidity, concrete temperature and wind velocity together on the rate of evaporation of water from freshly placed and unprotected concrete.

Example:

- with air temperature at 27°C
- with relative humidity at 40%
- with concrete temperature at 27°C
- with a wind velocity of 26km/h the rate of evaporation would be 1.6 kg/m²/hour.

To determine the evaporation rate from the graph, enter the graph at the air temperature (in this case 27°C), and move vertically to intersect the curve for relative humidity encountered - here 40%. From this point move horizontally to the respective line for concrete temperature - here 27°C. Move vertically down to the respective wind velocity curve - in this case interpolating for 26km per hour - and then horizontally to the left to intersect the scale for the rate of evaporation.

C248.31 MECHANICAL PAVING

1. The mechanical paver shall be a self-propelled machine with a gross operating mass of not less than 4 tonnes per lineal metre of paved width. It shall be capable of paving at a speed of one metre per minute or less as required to enable the continuous operation of the paver and obtain the required degree of compaction. It shall include the following features:- *Paving Machine*
 - (a) An automatic control system with a sensing device to control line and level to the specified tolerances.
 - (b) Means of spreading the mix uniformly and regulating the flow of mix to the vibrators without segregation of the components.
 - (c) Internal vibrators capable of compacting the full depth of the concrete.
 - (d) Adjustable extrusion screed and/or conforming plate to form the slab profile and produce the required finish on all surfaces.
 - (e) Capability of paving in the slab widths or combination of slab widths and slab depths shown on the Drawings.
2. The mechanical paver shall spread, compact, screed and finish the freshly placed concrete in such a manner that a minimum of finishing by hand will be required. A dense and homogeneous concrete with a surface exhibiting low permeability, shall be provided. It shall be textured in accordance with Clause C248.34. *Concrete Finish*
3. The supporting surface for the tracks of the paver, curing machine and any other equipment in the paving and curing train shall be in a smooth and firm condition. *Supporting Surface*
4. Once spreading commences, the concrete paving operation shall be continuous. The mechanical paver shall be operated so that its forward progress shall not be stopped due to lack of concrete. If disruptions occur for any reason, the Principal Certifying Authority may direct that a construction joint be formed before the recommencement of paving operations. *Continuity of Paving Operation*
5. Where an interruption to paving occurs, which is likely to result in a non-monolithic concrete mass, the Contractor shall form a transverse construction joint in accordance with Clause C248.41. *Interruption to Paving*
6. Should subsequent testing at the location of an interruption indicate the presence of non-monolithic concrete, such concrete shall be removed and replaced in accordance with Clauses C248.50, C248.51 and C248.52. *Non-monolithic Concrete*

C248.32 HAND PLACING

1. Hand placement shall only be used in areas where mechanical placement is impracticable or where it has been approved by the Principal Certifying Authority prior to commencement of work. *Restriction*
2. Forms shall be so designed and constructed that they can be removed without damaging the concrete and shall be true to line and grade and braced in a substantial and unyielding manner. Forms shall be mortar tight and debonded to ensure non-adhesion of concrete to the forms. *Formwork*
3. Concrete shall be delivered in agitator vehicles and shall be deposited uniformly in the forms without segregation. The concrete shall be compacted by poker vibrators and by at least two passes of a hand-guided vibratory screed traversing the full width of the slab on each pass. Any buildup of concrete between the forms and vibratory screed shall be prevented. *Placing in Forms*
4. If disruptions occur for any reason, the Principal Certifying Authority may direct that a construction joint be formed before the recommencement of paving operations. *Disruption*
5. A dense and homogeneous concrete with a surface exhibiting low permeability, shall be provided. It shall be textured in accordance with Clause C248.34. *Concrete Finish*

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| 6. | Where an interruption to placing occurs, which is likely to result in a non-monolithic concrete mass, the Contractor shall form a transverse construction joint in accordance with Clause C248.41. | <i>Transverse Construction Joint</i> |
| 7. | Should subsequent testing at the location of an interruption indicate the presence of non-monolithic concrete, such concrete shall be removed and replaced in accordance with Clauses C248.50, C248.51 and C248.52. | <i>Non-Monolithic Concrete</i> |

C248.33 ALIGNMENT AND SURFACE TOLERANCES

(a) Horizontal Alignment Tolerance

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| 1. | The outer edges of the base shall be square to the subbase and shall not deviate from the plan position at any point by more than 10 mm. | <i>Outer Edge</i> |
| 2. | Where an edge of a slab is to form a longitudinal joint line the horizontal alignment shall not deviate from a 3 m straightedge by more than 10 mm. | <i>Longitudinal Joint Line</i> |

(b) Tolerances and Rideability

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| 1. | The tolerance on thickness of the base shall be zero below the specified thickness and in accordance with Clause C248.23 for excess thickness. | <i>Top of Base Level</i> |
| 2. | The top surface of the base shall also not deviate from a 3 m straightedge, laid in any direction, by more than 5 mm. Notwithstanding this requirement, the surface shall not pond water. | <i>Surface Level</i> |

C248.34 TEXTURING OF SURFACE

1. Texturing of the concrete surface may be effected by use of a fine broom or hessian-drag. The Contractor shall submit to the Principal Certifying Authority details of the proposed texturing method and equipment.

C248.35 CURING

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| 1. | The base shall be cured by the use of one of the following: <ul style="list-style-type: none"> (a) Chlorinated rubber curing compound complying with AS 3799 Class C Type 1D or resin-based curing compound complying with AS 3799 Class B, Type 1D or Type 2, if an asphalt wearing surface is used, or (b) White pigmented wax emulsion curing compound complying with AS 3799 Class A Type 2, if no asphalt wearing surface is used, or (c) Bitumen emulsion Grade CRS/170 complying with AS 1160 for either asphalt wearing or non-asphalt wearing surface. | <i>Compounds</i> |
| 2. | The Contractor shall submit, for the information of the Principal Certifying Authority, a current Certificate of Compliance from an Australian laboratory, approved by the Principal Certifying Authority, showing an Efficiency Index of not less than 90 per cent when tested in accordance with Appendix B of AS 3799. | <i>Efficiency Index</i> |
| 3. | The curing compound shall be applied using a fine spray immediately following texturing at the rate stated on the Certificate of Compliance or at a minimum of 0.2 litres per square metre, whichever rate is the greater. Bitumen emulsion shall be applied at a minimum rate of 0.5 litres per square metre. When applied with a hand lance the rates shall be increased by 25 per cent. | |
| 4. | The average application rate shall be checked by the Contractor and certified to the Principal Certifying Authority by calculating the amount of curing compound applied to a measured area representative of a lot and nominated by the Principal Certifying Authority. | <i>Application Rate</i> |
| 5. | The curing membrane shall be maintained intact for seven days after placing the concrete. Any | <i>Curing Period</i> |

damage to the curing membrane shall be made good by handspraying of the affected areas.

6. Equipment and materials for curing operations shall be kept on site at all times during concrete pours. *Equipment on Site*

C248.36 PROTECTION OF WORK

1. The Contractor shall ensure that the temperature of the concrete does not fall below 5°C during the first twenty-four hours after placing. The Contractor shall provide, for the information of the Principal Certifying Authority, details of procedures and equipment proposed to be used for the protection of sections recently placed in the event of low air temperatures. If the Contractor fails to maintain the temperature of the concrete at or above 5°C and if, in the opinion of the Principal Certifying Authority, the concrete exhibits any deficiencies, due to failure to comply with this Specification, the concrete shall be rejected. *Temperature Control*
2. The Contractor shall protect the work from rain damage and shall provide, for the information of the Principal Certifying Authority, detailed proposals for procedures and equipment to be used for such protection. *Rain Protection*
3. Neither traffic nor construction equipment, other than that associated with testing, sawcutting, groove cleaning or joint sealing, shall be allowed on the finished base until the joints have been permanently sealed and at least 10 days have elapsed since placing concrete, and the concrete has reached a compressive strength of at least 20MPa. *Traffic Restrictions*

JOINTS

C248.40 GENERAL

1. Joints shall be provided at locations indicated on the Drawings or as approved by the Principal Certifying Authority. *Location*

C248.41 TRANSVERSE CONSTRUCTION JOINTS

1. Transverse construction joints shall: *Location*
 - be provided only at discontinuities in the placement of concrete determined by the Contractor's paving operations.
 - not be placed closer than 1.5 m to a transverse contraction joint. Where necessary, the Principal Certifying Authority shall authorise a change in the spacing and/or skew of transverse contraction joints to ensure that sufficient clearance is obtained.
 - be constructed normal to the control line and to the dimensions and details shown on the Drawings. The tie bars shall comply with Clauses C248.14 and C248.18.
 - be smooth across the joint before texturing.
 - not deviate from a 3 m straightedge placed along the joint by more than 10 mm.
2. Prior to placing adjacent concrete the surface of the concrete shall be roughened to expose coarse aggregate. The roughened surface and the projecting reinforcement shall be washed clean and all excess water and loose material removed. *Placing Adjoining Concrete*

C248.42 TRANSVERSE CONTRACTION JOINTS

(a) General

1. Transverse contraction joints shall be continuous across the full width of the base and shall be sawn unless otherwise approved by the Principal Certifying Authority. *Details*
2. Where the concrete base is to be overlaid with asphalt wearing course, the Principal Certifying

Authority may approve the joint to be formed with a suitable plastic joint inducing system.

3. Transverse contraction joints shall be constructed normal to the control line and to the dimensions and details shown on the Drawings. Where necessary, the joint may be skewed to a maximum 1 in 12 to accommodate construction joints and slab anchors. **Skewed Joints**

(b) Sawcutting

1. The Contractor shall ensure that sawcutting be conducted between 6 and 24 hours after initial paving so as not to cause excessive ravelling of aggregate adjacent to the cut and so as to prevent cracking of the base concrete other than at the bottom of the 3 mm sawcut. The Contractor shall use the type of blade and equipment and the method of control best suited to the hardness of the concrete being sawn and shall have sufficient standby equipment available on site to maintain continuity of sawing. **Timing and Equipment**
2. The line of the transverse contraction joint shall be without any discontinuities. No edge shall deviate from a 3 m straight edge by more than 10 mm. **Tolerances**
3. The surface of the transverse contraction joint shall not exhibit more than 5 mm of vertical or horizontal edge ravelling. The length of edge ravelling shall not be more than 300 mm in any 1 m length of joint on each edge. Saw debris shall be washed from the joint and pavement immediately after sawing.
4. Sawcuts, which do not conform to the requirements of this Clause, shall be rejected by the Principal Certifying Authority. Rejected sawcuts may be repaired by a method approved by the Principal Certifying Authority. **Rejected Sawcuts**

(c) Cleaning

1. Immediately after any sawing, the sawcut shall be cleaned of all debris. The cleaning method used shall not damage the sawcut nor leave any substance deleterious to the concrete or to the adhesion of the joint sealants to be used. The method shall incorporate a pressurised liquid or liquid/air jet. Cleaning liquid shall not be gravity fed from tanks. **Debris Removed**

(d) Temporary Sealing

1. Immediately after cleaning following the second sawcut, if the transverse contraction joint is produced by a two-cut operation, the joint shall be temporarily sealed by a continuous closed-cell polyethylene backer rod of diameter shown on the Drawings or as required by the Principal Certifying Authority. **Material**
2. The top of the sealant shall be neither higher than nor more than 10 mm below the concrete surface. The backer rod shall pass over any longitudinal joint seal already in place. **Tolerance**
3. The temporary sealant shall be maintained by the Contractor until the joint is sealed permanently. Damaged or disturbed temporary sealants shall be removed, the transverse contraction joint recleaned to the satisfaction of the Principal Certifying Authority and a new temporary sealant inserted. **Maintenance**

(e) Permanent Sealing

(i) General

1. Within ten days of initial sawing and immediately on removal of the temporary sealant, the permanent sealant shall be placed in the joint. **Timing**
2. The permanent sealant shall be either a neoprene compression seal or an in situ cast silicone sealant. The Contractor shall submit for the approval of the Principal Certifying Authority, a full technical description of the proposed sealant, including its operating parameters and the method of installation recommended by its manufacturer. **Sealant Quality**

(ii) Neoprene Compression Sealants

1. Neoprene compression sealants shall comply with all the requirements of ASTM 2628. Test methods used to determine compliance with these requirements shall include Test Methods T1160, T1161 and T1163. **Standards**
2. At least two weeks before installation of the sealant, the Contractor shall submit to the Principal Certifying Authority a Certificate of Compliance from a NATA registered laboratory showing that the sealant meets all the requirements of ASTM 2628. **Certification of Compliance**
3. At the time of installation, the sides of the neoprene sealant shall be coated with a clear or concrete-coloured lubricant compound approved by the Principal Certifying Authority and complying with ASTM D-2835. The sealant shall be inserted into the joint by means of suitable equipment which shall not damage the sealant during its insertion. The maximum increase in length of the sealant after installation shall be 5 per cent of original length. Any sealant exceeding 5 per cent extension shall be rejected. The sealant shall be located in the transverse contraction joint in the design orientation without twist or buckle. **Installation**
4. The sealant shall be continuous between formed longitudinal joints. Where such a discontinuity occurs, the sealant shall be angle butt jointed by a method approved by the Principal Certifying Authority. The top of the sealant shall be neither less than 5 mm nor more than 7 mm below the surface of the base and shall overlay any longitudinal sealants. **Tolerances**

(iii) Silicone Sealants

1. Silicone sealants shall be formed using a silicone joint sealant complying with the requirements listed in Table C248.6. At least four weeks before the installation of the sealant, the Contractor shall submit to the Principal Certifying Authority a Certificate of Compliance, from a NATA registered laboratory, showing that the sealant meets all the requirements of Table C248.6. **Certificate of Compliance**
2. The silicone joint sealant shall be grey in colour and shall be stored and installed in accordance with the manufacturer's written instructions. Installation of a silicone sealant shall take place only when the side walls of the groove have been grit blasted and are surface dry. **Installation**
3. Immediately before introducing the silicone sealant into the groove, any foreign or disturbed material shall be cleaned from the joint and from the top of the backer rod by dry air jet. The backer rod shall then be depressed to the depth such that the bottom of the silicone sealant shall be at the planned location and of the correct shape. **Action Before Sealing**
4. If the backer rod is damaged in any way it shall be replaced for the full length of the joint.
5. The method to be used for permanent sealing with silicone sealant shall be approved by the Principal Certifying Authority before permanent sealing commences. Notwithstanding any approval given by the Principal Certifying Authority to a proposed method, the Contractor shall be responsible for producing a permanent seal complying with all requirements of this Specification. **Contractor's Responsibility**

Test Method	Test	Requirements
ASTM-D-792	Specific Gravity	1.1 to 1.55
MIL-S-8802	Extrusion Rate	90 to 250 g per min
MIL-S-8802	Tack Free Time	30 to 70 min
ASTM D 2240	Durometer	10 to 25
T1192 T1193	Durability	Extension to 70% Compression to 50%
ASTM C794	Adhesion to Concrete	35N minimum average peel strength
ASTM C 793-7	Accelerated Weathering at 5,000 hours	No cracks, blisters or bond loss

Table C248.6 - Silicone Joint Sealant Requirements.

C248.43 TRANSVERSE ISOLATION JOINTS

- Transverse isolation joints shall be provided at bridge approach slabs and at slab anchors where shown on the Drawings and where directed by the Principal Certifying Authority. **Location**
- Transverse isolation joints shall be continuous across the full width of the base normal to the control line and shall be constructed in accordance with the Drawings. **Construction**
- Transverse isolation joints shall not be placed closer than 2.0 m to other transverse joints. Where necessary, the Principal Certifying Authority shall authorise a change in the spacing and/or skew of adjacent transverse contraction joints to ensure that sufficient clearance is obtained. **Spacing**
- Joint filler shall consist of preformed jointing material of bituminous fibreboard and the joint sealant shall comply with the silicone sealant requirements of Clause C248.42. They shall be installed in accordance with the Drawings and in a manner conforming to the manufacturers recommendations except that reference to backer rods shall not apply. **Standards**
- The line of the isolation joint shall not deviate from a 3m straightedge more than 10mm. **Tolerance**

C248.44 LONGITUDINAL TIED JOINTS**(a) General**

- Longitudinal tied joints shall be provided at the locations shown on the Drawings or where directed by the Principal Certifying Authority. The joints shall be parallel to the control line and/or to the dimensions and details shown on the Drawings. **Location**
- Longitudinal tied joints shall be formed or induced either by sawing or by machine insertion of a crack inducer ribbon. **Formation**
- The ties shall be 12mm diameter deformed steel bars Grade 400Y, 1m long and shall be inserted in accordance with Clause C248.18. Tie bars shall be located and spaced as shown on the Drawings. All parts of any tie bar shall lie within 50mm of its designed position. Tie bars shall be omitted within 500mm of a transverse joint. The epoxy to be used when installing tie bars in existing concrete shall be hydrophilic epoxy resin. The setting system used shall develop an anchorage strength at least 85 per cent of the yield strength of the bar. **Ties**
- The line of longitudinal tied joints shall not deviate from the designed position at any point by more than 10mm. The line shall also not deviate from a 3m straightedge by more than 10mm having made due allowance for any planned curvature. **Tolerances**

5. Where the longitudinal tied joint is formed or slipformed, the joint face shall be corrugated in accordance with the details shown on the Drawings. *Corrugated Joint Face*
6. Where the multi-lane width is greater than 18m, a longitudinal isolation joint shall be constructed at each location shown on the Drawings and in accordance with Clause C248.46. *Isolation Joint*

(b) Sawn-Induced Joints

1. Sawn longitudinal tied joints shall be provided to the dimensions shown on the Drawings. Sawcutting shall comply with Clause C248.42(b). *Location*
2. Within twenty-four hours of sawing, the longitudinal tied joint shall be thoroughly cleaned of all debris and a neoprene backing rod, shall be inserted in accordance with the details shown on the Drawings. *Sealant Quality*
3. The sealant shall be coated with a lubricant-adhesive compound approved by the Principal Certifying Authority. The compound shall have a colour compatible with the pavement colour. The sealant shall be inserted into the groove by means of suitable equipment which shall not damage the sealant during insertion. The maximum increase in length of the sealant after installation shall be 10 per cent of the original length, otherwise the sealant shall be rejected. *Sealant Insertion*
4. Joints in the sealant shall be kept to a minimum and shall be cemented together by an adhesive recommended by the Manufacturer. The top of the sealant shall be neither less than 5 mm nor more than 7 mm below the surface of the base, except where the sealant is depressed to lie under the transverse joint sealant. *Sealant Joints*

(c) Ribbon-Induced Joints

1. Ribbon-induced longitudinal tied joints shall be provided to the dimensions and details shown on the Drawings. The inducer ribbon shall be machine-inserted so that the top of the ribbon does not protrude above the surface of the base, nor shall it lie below the surface of the base by more than 3 mm. *Location and Insertion*
2. The inducer ribbon shall be a minimum of 0.5 mm thick. When placed, it shall be within 5° of the vertical plane. Inducer ribbon which curls on placement and when cut in the base is found to be curved in transverse section by more than 3 mm from straight shall be rejected. *Finish*
3. At transverse construction joints, the inducer ribbon shall be carried through the joint sufficiently to allow a connection by strong stapling, or other method approved by the Principal Certifying Authority, to the inducer ribbon to be used on the other side of the joint. When a join is necessary in the inducer ribbon during paving, the inducer ribbon on the new spool shall be similarly joined to the tail of the inducer ribbon on the old spool. *Join in Ribbon*

(d) Treatment of Sawn Longitudinal Tied Joints Prior to Asphalt Overlay

1. Where asphalt surfacing over sawn longitudinal tied joints is specified, the sealant shall be depressed to a depth below the concrete surface of not less than 10 mm and, following thorough cleaning, the joint shall be sealed flush with the concrete surface with a bituminous rubber compound, approved by the Principal Certifying Authority, compatible with the narrow groove. *Bituminous Rubber Compound*

C248.45 LONGITUDINAL JOINT WITH KERB AND/OR GUTTER

1. Where kerbs and/or gutters are to be constructed within the shoulder of a concrete base, they shall be formed directly onto the concrete subbase and they may be cast either integrally with the concrete base or separately. *Form*
2. Where constructed separately, they shall be tied to the concrete base by 12mm diameter deformed steel tie bars Grade 250S or 400Y, 1000mm long at 1m centres. *Tie Bars*
3. The longitudinal joint shall be constructed parallel to the control line (parallel to the centre line for ramps) and to the dimensions shown on the Drawings. The tie bars shall be inserted in *Location*

accordance with the Drawings and Clause C248.18.

4. The face of the longitudinal joint need not be scabbled and the joint need not be sealed. *Face of Joint*
5. The line of the longitudinal joint shall be constructed to the tolerances specified for longitudinal tied joints in accordance with Clause C248.44. *Tolerances*
6. The construction of kerb and/or gutter shall be in accordance with the Specification for OPEN DRAINS INCLUDING KERB AND GUTTER regardless of method of construction except that the strength of the concrete used in the kerb and/or gutter shall be 32 MPa. *Specification*

C248.46 LONGITUDINAL ISOLATION JOINTS

1. Longitudinal isolation joints shall be provided where shown on the Drawings and where directed by the Principal Certifying Authority. *Location*
2. The line of the longitudinal isolation joint shall not deviate from the specified position by more than 10 mm. The line of the joint shall not deviate from a 3 m straightedge by more than 10 mm. *Tolerances*
3. The joint filler shall consist of preformed jointing material of bituminous fibreboard and the joint sealant shall comply with the silicone sealant requirements of Clause C248.42. They shall be installed in accordance with the Drawings and in a manner conforming to the manufacturer's recommendations except that reference to backer rods shall not apply. *Filler and Sealant*

SLAB ANCHORS

C248.47 GENERAL

1. Slab anchors shall be constructed normal to the control line, to the dimensions and at the locations shown on the Drawings. *Location*
2. Slab anchors shall extend over the full width of the base and the associated transverse expansion joint shall not be placed closer than 2.0 m to other transverse joints. *Transverse Joint*

C248.48 EXCAVATION

1. Excavation of trenches for slab anchors shall be to the dimensions and details shown on the Drawings. *Dimensions*
2. All loose material shall be removed and the vertical faces trimmed to neat lines. The bottom of the trench shall be recompact, where required, to the degree of consolidation of the adjacent undisturbed material. *Trim and Consolidate*
3. The Contractor shall dispose of excavated material at locations approved by the Principal Certifying Authority. *Spoil*
4. Where a slab anchor is required at the junction of an existing flexible pavement, a straight sawcut to the full depth of the asphaltic concrete or bituminous seal shall be made in the flexible pavement along the joint line. Excavation of the trench shall then take place as described above without disturbance or damage to the existing flexible pavement. Any disturbance or damage to the flexible pavement shall be made good as directed by the Principal Certifying Authority. *Adjacent to Flexible Pavement*
5. A subsoil drain shall be provided at the bottom of the trench, in accordance with the Specification for SUBSOIL AND FOUNDATION DRAINS and details shown on the Drawings. *Sub-Soil Drains*

C248.49 CONCRETE

1. Concrete for slab anchors shall be produced, transported and placed in accordance with the requirements for hand-placed base concrete. **Slab Anchors**
2. Slab anchors shall be poured separately from the base slabs to the dimensions and details shown on the Drawings up to the top surface of the subbase. **Detail**
3. A transverse isolation joint shall be provided on the downhill side of the slab anchor. **Isolation Joint**
4. Steel reinforcement in slab anchors shall be of the type and size shown on the Drawings and shall be supplied and fixed in accordance with Clauses C248.14 and C248.18 of the Specification. **Steel Reinforcement**
5. Bridge approach slabs, if not in the bridge contract, shall be constructed at bridge abutments to the dimensions and details shown on the Drawings and in accordance with the requirements for base concrete. **Bridge Approach Slabs**

REMOVAL AND REPLACEMENT OF BASE**C248.50 GENERAL**

1. Where directed by the Principal Certifying Authority, rejected base shall be removed and replaced in accordance with this Clause. Rejected base, which extends more than 25 m longitudinally, shall be replaced by mechanical means unless the slabs are odd-shaped or mismatched. Replacement shall be in full slab widths between longitudinal joints and/or external edges. **Replacement Method**
2. At least seven days before the commencement of base removal, the Contractor shall submit, for the approval of the Principal Certifying Authority, details of the proposed methods of carrying out the work which shall be such as to prevent damage to the adjoining base and the underlying subbase. **Details**

C248.51 REMOVAL AND DISPOSAL OF BASE

1. At each end of the section of base to be removed, a transverse sawcut shall be made for the full depth of the base layer. Such transverse sawcuts shall be normal to the control line and not closer than 1.5 m to an existing contraction joint in the base. No oversawing into the adjoining base or underlying subbase shall be permitted. **Transverse Sawcut**
2. Longitudinal sawcuts shall be made along existing longitudinal joints to define the edges of the base section to be removed. Such longitudinal sawcuts shall not extend more than 250 mm past the transverse sawcut at each end of the section to be removed and shall not extend into the underlying subbase. **Longitudinal Sawcuts**
3. No oversawing shall be permitted on any additional internal sawcuts the Contractor may make to aid the removal of the base. **Oversawing**
4. The Contractor shall dispose of the removed base slabs at locations of his choice acceptable to the Principal Certifying Authority. **Disposal**
5. Any slab, adjoining the removed slabs, damaged by the Contractor's operations shall also be removed and replaced in accordance with this Clause. **Contractor's Responsibility**

C248.52 REPLACEMENT OF BASE

1. Before construction of the replacement base, the subbase shall be prepared and debonded in **Subbase Preparation**

accordance with the Specification for MASS CONCRETE SUBBASE.

2. All work involved in the replacement of base shall comply with the Specification, including the following additional requirements:- **Additional Requirements**
- (a) The joint faces on the adjoining slab at the transverse sawcuts shall be deeply scabbled below the top 25 mm which shall be left smooth. Tie bars shall be provided to form a transverse construction joint in accordance with Clause C248.41.
 - (b) Transverse contraction joints shall be continuous across the full width of the base containing the replaced section. The length of the joint across the full width of the base shall be sealed with the same sealant as in adjacent work and in accordance with Clause C248.42.
 - (c) The lower two-thirds of the depth of the longitudinal joint faces shall be deeply scabbled and any concrete considered to be unsound by the Principal Certifying Authority shall be removed. A crack inducer ribbon shall be attached to the surface of any formed longitudinal joint in the replacement base and tie bars provided to form a longitudinal tied joint in accordance with Clause C248.44.
 - (d) Tie bars placed into hardened concrete shall be set by the use of a hydrophilic epoxy resin. The setting system used shall develop an anchorage strength at least 85 per cent of the yield strength of the bar.
 - (e) Neither traffic nor construction equipment other than that associated with testing, sawcutting, groove cleaning or joint sealing shall be allowed on the section of base containing the replacement base until the joints have been permanently sealed and at least ten days have elapsed since placing replacement base concrete or the concrete has reached a compressive strength of at least 20MPa.

LIMITS AND TOLERANCES

C248.53 SUMMARY OF LIMITS AND TOLERANCES

1. The tolerances applicable to the various clauses in this Specification are summarized in Table C248.7 below:

Item	Activity	Tolerances	Spec Clause
1.	Aggregates		
	a. General	Mass of the total aggregates in concrete mix shall consist of at least 40% quartz sand	C248.08a
	b. Fine Aggregate		
	(i) Grading	To be within the limits as per Table C248.2 and shall not deviate from Proposed Grading by more than amounts in Table C248.2	C248.08b
	(ii) Wet Strength	Not less than 80kN for any fraction and/or constituent	C248.08c
	(iii) 10% Fines Wet/Dry Variation	Not to exceed 35% for any fraction and/or constituent	C248.08c
	(iv) Soundness	The loss in mass when tested with sodium sulphate to be less than 9% for any constituent	C248.08c

Item	Activity	Tolerances	Spec Clause
	(v) Particle Shape	The proportion of misshapen particles (2:1 ratio) to be less than 35%	C248.08c
	(vi) Fractured Faces	At least 80% by mass of the particles shall have two or more fractured faces	C248.08c
2.	Concrete Quality		
	a. Cement Content	At least 270kg per yielded cubic metre of concrete	C248.09
	b. Flyash	Not greater than 50kg per yielded cubic metre of concrete	C248.09
	c. Compressive Strength	The minimum 28 day compressive strength shall be: 32 MPa for public roads 25 MPa for accessways	C248.10
	d. Shrinkage	Not to exceed 450 microstrain after 3 weeks of air drying	C248.11
	e. Consistency	Nominated slump shall be neither less than 30mm nor more than 40mm for mechanically placed concrete. It shall be neither less than 55mm nor more than 65mm for hand placed concrete.	C248.12
	f. Air content	Shall not be less than 4% nor more than 7% when discharged from the transport vehicle ready for placement	C248.13
3.	Concrete Mixing and Transport	After addition of cement to the aggregate, concrete shall be incorporated into the work within: (i) One and a half hours where transported by truck mixer or agitator. (ii) One hour where transported by non-agitating trucks.	C248.26
4.	Concrete Placing	Concrete shall not be placed when the air temperature in the shade is below 5°C or above 38°C. The temperature of the concrete shall be neither less than 10°C nor more than 32°C.	C248.29
		Where the value of Rate of Evaporation exceeds 0.50kg per square metre per hour, the Contractor shall cease work.	C248.30
5.	Alignment and Surface		
	a. Horizontal Alignment	The outer edges of the base shall not deviate from the plan position at any point by more than 10mm.	C248.33a

Item	Activity	Tolerances	Spec Clause
	b. Surface Level	The level at any point on the top of the base shall not vary by more than +10mm or -0mm from that shown on the Drawings or as directed by the Principal Certifying Authority. The top surface of the base shall not deviate from a 3m straightedge, laid in any direction, by more than 5mm.	C248.33b
6.	Concrete Protection		
	a. Temperature	The temperature of the concrete shall not be permitted to fall below 5°C during the first twenty-four hours after placing.	C248.36
7.	Joints		
	a. Transverse Construction	The line of the transverse construction joints shall not deviate from a 3m straightedge placed along the joint by more than 10mm.	C248.41
	b. Transverse Contraction	<p>(i) May be reduced locally to a skew of 1 in 12 to accommodate construction joints and slab anchors.</p> <p>(ii) No edge shall deviate from a 3m straightedge by more than 10mm.</p> <p>(iii) The surface of the transverse contraction joint shall not exhibit more than 5mm of vertical or horizontal edge ravelling. The length of edge ravelling shall not be more than 300mm in any 1m length of joint on each edge.</p> <p>(iv) Temporary Sealing - the top of the sealant shall be neither higher than nor more than 10mm below the concrete surface.</p> <p>(v) Permanent Sealing The top of the sealant shall be neither less than 5mm nor more than 7mm below the surface of the base.</p>	C248.42
	c. Transverse Isolation	The line of the transverse expansion joint shall not deviate from a 3m straight edge more than 10mm.	C248.43

Item	Activity	Tolerances	Spec Clause
7.	d. Longitudinal Tied Joints	<p>(i) All parts of any tie bar shall be within 50mm of its designed position.</p> <p>(ii) The line of longitudinal tied joints shall not deviate from the designed position at any point by more than 10mm. The line shall also not deviate from a 3m straightedge by more than 10mm having made due allowance for any planned curvature.</p> <p>(iii) For Sawn-Induced joints, the maximum increase in length of the sealant after installation shall be 10% of the original length. The top of the sealant shall be neither less than 5mm nor more than 7mm below the surface of the base.</p> <p>(iv) For Ribbon-Induced joints, the inducer ribbon shall be a minimum of 0.5mm thick and when placed it shall be within 5° of the vertical plane.</p>	C248.44
	e. Longitudinal Isolation Joints	The line of the longitudinal isolation joint shall not deviate from the specified position by more than 10mm. The line of the joint shall not deviate from a 3m straightedge by more than 10mm.	C248.46
8.	Slab Anchors	Not placed closer than 2.0m to transverse joints (other than associated transverse expansion joints).	C248.47

Table C248.7 - Summary of Limits and Tolerances

DEVELOPMENT CONSTRUCTION SPECIFICATION

C254

SEGMENTAL PAVING

AMENDMENT RECORD FOR THIS SPECIFICATION PART

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part. The clause numbering and context of each clause are preserved. New clauses are added towards the rear of the specification part as special requirements clauses. Project specific additional script is shown in the specification as italic font.

The amendment code indicated below is 'A' for additional script 'M' for modification to script and 'O' for omission of script. An additional code 'P' is included when the amendment is project specific.

Amendment Sequence No.	Key Topic addressed in amendment	Clause No.	Amendment Code	Author Initials	Amendment Date
1	<i>Deletion of reference to 'Edge Strip'</i>	254.14	M	MB	10/10/07

SEGMENTAL PAVING

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SPECIFICATION C254 - SEGMENTAL PAVING**GENERAL****C254.01 SCOPE**

1. This Specification covers the construction of segmental paving for road pavements, medians, traffic islands, driveways, cycleways, footpaths and other pedestrian areas.
2. The work to be executed under this Specification consists of the supply, placement and compaction of segmental paving units including the provision of a sand bedding course and joint filling sand, over bound or unbound base and/or subbase layer/s.
3. This Specification should be read in conjunction with the appropriate Specifications for the construction of the base and subbase layers beneath the segmental paving, ie. FLEXIBLE PAVEMENTS, MASS CONCRETE SUBBASE.

C254.02 TERMINOLOGY

1. Concrete segmental paving units are units of not more than 0.10 square metres in gross plan area, manufactured from concrete, with plain or dentated sides, with top and bottom faces parallel and with or without chamfered edges. **Size**
2. Concrete paving units are identified by shape as being one of the following types: **Concrete Pavers**
Shape Type A
Dentated chamfered units which key into each other on four sides, are capable of being laid in herringbone bond, and by their plan geometry, when interlocked, resist the spread of joints parallel to both the longitudinal and transverse axes of the units.
3. Clay pavers shall only be used where specifically approved in the Notification of Determination of Development Consent. **Clay Pavers**
4. Clay pavers are manufactured from clay, shale or argillaceous materials which may be mixed with additives. Clay pavers may have square, bevelled (chamfered), rounded or rumbled edges. They are generally rectangular in shape, with the length twice the width, plus 2mm.
5. Clay pavers shall be Class 4. **Classification**
6. Unless otherwise approved by the Principal Certifying Authority the laying pattern of segmental paving units shall be Herringbone pattern. **Pattern**

C254.03 CHOICE OF PAVER TYPE, SHAPE, CLASS AND LAYING PATTERN

1. Unless otherwise approved by the Principal Certifying Authority, paving units for road pavements shall be Shape Type A concrete paving units, 80mm thick, and placed in Herringbone laying pattern. **Thickness**
3. If not otherwise approved by the Principal Certifying Authority, clay pavers shall be Class 4, minimum 65mm nominal thickness, and placed in a herringbone laying pattern.

MATERIALS**C254.05 GENERAL**

1. The Contractor shall submit details of all proposed segmental paving materials, including **Details Required**

bedding sand and joint filling sand. These details shall be submitted to the Principal Certifying Authority for approval supported with test results from a nominated NATA registered laboratory, confirming that the constituents comply with the requirements of this Specification.

- No material shall be delivered until the Principal Certifying Authority has approved the sources of supply. Such approval shall not relieve the Contractor of any responsibility for supplying materials that comply with this Specification. **Superintendent's Approval**

C254.06 CONCRETE SEGMENTAL PAVING UNITS

- Concrete segmental paving units shall comply with the requirements of MA57 - Specification for Concrete Segmental Paving Units and with the requirements of AS/NZS 4455. The category of paver shall be as shown on the Drawings. **Specification**
- Unless otherwise approved by the Principal Certifying Authority, concrete paving units shall be 80mm thick with a minimum 28 day characteristic compressive strength of 45MPa, as determined in accordance with MA57. **Strength**
- The abrasion resistance, tested in accordance with MA20 - Appendix D, shall conform to the recommended minimum abrasion indices contained in MA57. **Abrasion Resistance**

C254.07 CLAY SEGMENTAL PAVING UNITS

- Clay segmental pavers shall comply with the requirements of Part 1 - Specifying Clay Pavers of Paver Note 1 - 'Specifying and Laying Clay Pavers' and with the requirements of AS/NZS 4455. **Specification**
- The abrasion resistance as determined by the SCC Abrasion Test (Paver Note1) shall conform to the recommended characteristic abrasion losses contained in Paver Note 1. **Abrasion Resistance**

C254.08 BEDDING SAND

- The bedding sand shall be a well-graded sand, consisting of clean, hard, uncoated grains uniform in quality, generally passing a 4.75mm sieve. The bedding sand shall be from a single source or blended to achieve, when tested in accordance with AS 1141.11, the following grading: **Grading**

AS Sieve	% Passing
9.52mm	100
4.75	95 - 100
2.36	80 - 100
1.18	50 - 85
600mm	25 - 60
300	10 - 30
150	5 - 15
75	0 - 10

- The sand shall be of uniform moisture content when spread. It shall be covered when stored on site to protect it from rain penetration. **Protection**
- The bedding sand shall be free of deleterious soluble salts or other contaminants which may cause, or contribute to, efflorescence. **Cleanliness**

C254.09 JOINT FILLING SAND

- The joint filling sand shall be well graded passing a 2.36mm sieve, and when tested in accordance with AS 1141.11, having the following grading: **Grading**

<u>AS Sieve</u>	<u>% Passing</u>
2.36mm	100
1.18	90 - 100
600mm	60 - 90
300	30 - 60
150	15 - 30
75	5 - 10

- The sand shall be dry when spread. It shall be covered when stored on site to protect it from rain penetration. **Protection**
- The sand shall be free of deleterious soluble salts or other contaminants. **Cleanliness**
- Sand used for bedding is not suitable for joint filling.

C254.10 CONCRETE FOR EDGE RESTRAINTS

- Concrete supplied and placed for the construction of edge strips shall comply with the Specification for MINOR CONCRETE WORKS. **Specification**
- Unless otherwise indicated on the Drawings, or where the edge restraint is provided by kerb and/or gutter, the concrete used for edge restraints shall have a minimum 28-day characteristic compressive strength of 32MPa for edge restraints to paving units on road pavements and trafficable areas and 25MPa for edge restraints elsewhere. **Strength**

CONSTRUCTION

C254.11 SUBGRADE PREPARATION

- The subgrade shall be formed to the required depth below finished surface level as shown on the Drawings in accordance with the Specification for EARTHWORKS. **Levels**
- The finished subgrade foundation for the provision of subbase and/or base shall be subject to the approval of the Principal Certifying Authority. **Superintendent's Approval**

C254.12 SUBBASE

- Where shown on the Drawings a subbase or working platform shall be constructed in accordance with the relevant Specification for STABILISATION, FLEXIBLE PAVEMENTS, or MASS CONCRETE SUBBASE. **Specifications**
- The subbase shall be constructed to the specified thickness, compaction and depth below finished surface level and to the design grade and crossfalls of the finished surface. **Levels**
- The finished subbase shall be subject to the approval of the Principal Certifying Authority. **Superintendent's Approval**

C254.13 BASE

- The base shall be constructed to the specified thickness and depth below finished surface level, and to the design grade and crossfalls of the finished surface, as shown on the Drawings in accordance with the Specification for CONCRETE BASE. **Levels**
- The base course shall extend in width to at least the rear face of all new edge restraints. **Extent**
- The finished surface of the base course for road pavements to be overlain with segmental paving shall be trimmed to within + 10mm or - 10mm of design levels. The deviation from a 3m long straight edge placed anywhere and laid in any direction on the top surface of the base course for all segmental paving shall not exceed 5 mm. Sand bedding material shall **Tolerances**

not be used as a levelling material to compensate for base finishing outside the above tolerances.

4. The finished surface of the base shall drain freely without ponding. *Free Drainage*
5. The finished base shall be subject to the approval of the Principal Certifying Authority. *Superintendent's Approval*

C254.14 EDGE RESTRAINTS

1. Edge restraints in the form of Kerb and/or Gutter shall be constructed along the perimeter of all segmental paving as shown on the Drawings. Concrete Kerb and/or Gutter shall be constructed in accordance with the Specifications for OPEN DRAINS INCLUDING KERB AND GUTTER and MINOR CONCRETE WORKS. *Requirements*
2. Faces of edge restraints abutting paving units shall be vertical. Alternatively a silicone joint filler complying with Clause 248.42 (e)(iii) shall be applied between the paving unit and edge restraint.
3. Edge restraints shall be supported on compacted base and/or subbase of the thickness as shown on the Drawings. Where not otherwise specified or indicated, the minimum thickness of compacted base beneath the edge restraints shall be 100mm adjacent to road pavements and medians, and 50mm adjacent to footpaths, cycleways and driveways. *Support*
4. Unless otherwise shown on the Drawings, contraction joints, 20mm depth shall be formed every 5m of edge restraint length. *Joints*
5. After the concrete has hardened (but not less than three days after placing the spaces) the back of the edge restraint shall be backfilled with earth, compacted in layers not greater than 150mm thick, then topsoiled to meet surrounding design levels. *Backfilling*

C254.15 SAND BEDDING COURSE

1. The sand bedding course shall be spread in a single uniform layer and screeded in a loose condition to the nominated design profile and levels plus that necessary to achieve a uniformly thick nominal 20-25mm layer following final compaction of the segmental paving. *Allowance Levels*
2. Any depressions in the screeding sand exceeding 5mm shall be loosened, raked and rescreeded before laying paving units. *Depressions*
3. For the manual placing of paving units, the bedding sand shall be maintained at a uniform loose density. For mechanised laying, the bedding sand shall be uniformly and firmly, but not fully, compacted. *Compaction*
4. Screeded sand left overnight or subject to rain shall be checked for level and rescreeded where necessary before paving units are placed. The sand shall not be screeded more than two metres in advance of the laying face at the completion of work on any day. *Screeding*

C254.16 LAYING PAVING UNITS

1. Paving units shall be uniformly placed on the screeded sand bedding to the nominated laying pattern. Paving units shall be placed so that they are not in direct contact with each other and shall have uniform 3mm nominal joint widths. *Joints*
2. The first row shall be located next to an edge restraint or an established straight line, and laid at a suitable angle to achieve the required orientation of paving units in the completed pavement. *Sequence*
3. In each row, full units shall be laid first. Edge or closer units shall be neatly cut using a paver scour, or mechanical or hydraulic guillotine, and fitted subsequently. Cut pieces of *Odd Shapes*

paving units which are smaller in size than one quarter of a full block shall not be used.

4. Access chambers, drainage gullies and similar penetrations through the pavement shall be finished against the paving with a concrete surround or apron designed to suit and fit the laying pattern, otherwise complying with the requirements for edge restraints. **Penetrations**
5. Where pavers are placed over an isolation, contraction or expansion joint in an underlying concrete pavement, a joint is to be provided in the pavers. The joint shall consist of 10mm thick preformed jointing material of bituminous fibreboard. **Formed Joints**
6. Any foot or barrow traffic shall use boards overlaying paving to prevent disturbance of units prior to compaction. No other construction traffic shall be allowed on the pavement prior to compaction and provision of joint filling sand. **Construction Traffic**
7. On completion of subsequent bedding compaction and joint filling operations, no more than 10 per cent of joints along any 10 metre line along a major axis of the laying pattern shall have widths outside the range 2-4mm. **Tolerance**

C254.17 BEDDING COMPACTION

1. After laying the paving units the sand bedding shall be fully compacted and the surface brought to design levels and surface profiles by not less than two passes of a high frequency low amplitude plate compactor which covers at least 12 units. Compaction shall continue until lipping between adjoining units has been eliminated. **Compaction**
2. Any units which are structurally damaged during bedding compaction shall be removed and replaced. The pavement shall then be recompactd for at least one metre surrounding each replacement unit. **Damage**
3. The paving operations shall be arranged so that the use of the plate compactor proceeds progressively behind the laying face without undue delay, and such that compaction is completed prior to cessation of construction activity on any day. Compaction shall not be attempted within one metre of the laying face except on completion of the pavement against an edge restraint. **Progressive Compaction**
4. The finished surface level shall not vary from the design level at any point laid in any direction, by more than 5 mm. Notwithstanding this, the finished surface of the segmental paving, including where the paving abuts an edge restraint other than a drainage inlet, shall not deviate from the bottom of a 3m straight edge laid in any direction, except at grade changes, by more than 5 mm. **Finished Levels**
5. All compaction shall be complete and the pavement shall be brought to design profiles before spreading or placing sand filling in the joints. **Joint Filling**

C254.18 FILLING JOINTS

1. As soon as practicable after bedding compaction, and in any case prior to termination of work on any day, dry sand for joint filling shall be spread over the pavement and the joints filled by brooming. **Timing**
2. To ensure complete filling of the joints, both the filling sand and paving units shall be as dry as practicable when sand is spread and broomed into the joints. **Condition**
3. The pavement shall then receive one or more passes of a plate compactor and the joints then refilled with sand, with the process then repeated sufficiently to ensure that the joints are completely filled. **Process**

C254.19 PROTECTION OF WORK

1. Other than wheeled trolleys, forklifts and cluster-clamp vehicles, construction and other **Restricted Use**

traffic shall not use the pavement until bedding compaction and joint filling operations have been completed.

C254.20 OPENING TO TRAFFIC

1. As soon as practicable after the filling of joints, construction vehicles may use the pavement, and should be encouraged to traverse the greatest possible area of pavement to assist in the development of 'lock-up'. **No Tracking**
2. Excess joint filling sand shall be removed prior to opening to traffic. **Excess Sand**
3. The pavement shall then be inspected by the Contractor at regular intervals up until the expiration of the Defects Liability Period to ensure that all joints remain completely filled. **Inspections**

LIMITS AND TOLERANCES

C254.21 SUMMARY OF LIMITS AND TOLERANCES

Item	Activity	Tolerances	Spec Clause
1.	Base (a) Surface Level	Finished level of base for road pavements to be within +10mm or - 0mm of design levels.	C254.13
		Finished level of base other than for road pavements, to be within ± 10 mm of design levels.	C254.13
		The top surface of the base for all segmental paving shall not deviate from a 3m straight edge, laid in any direction, by more than 5 mm.	C254.13
2.	Laying Paving Units (a) Joint widths	No more than 10% of joints along any 10 metre line of joints along a major axis of the laying pattern shall have widths outside the range 2 - 4mm.	C254.16
3.	Completed Segmental Paving (a) Surface level	Finished surface level of pavers shall not vary from design levels by more than ± 5 mm.	C254.17
		Finished surface of pavers shall not deviate from a 3m straight edge, laid in any direction, by more than 5mm.	C254.17

Table C254.1 – Summary of Limits and Tolerances

DEVELOPMENT CONSTRUCTION SPECIFICATION

C261

PAVEMENT MARKINGS

AMENDMENT RECORD FOR THIS SPECIFICATION PART

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part. The clause numbering and context of each clause are preserved. New clauses are added towards the rear of the specification part as special requirements clauses. Project specific additional script is shown in the specification as italic font.

The amendment code indicated below is 'A' for additional script 'M' for modification to script and 'O' for omission of script. An additional code 'P' is included when the amendment is project specific.

Amendment Sequence No.	Key Topic addressed in amendment	Clause No.	Amendment Code	Author Initials	Amendment Date

PAVEMENT MARKINGS

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SPECIFICATION C261 : PAVEMENT MARKINGS**GENERAL****C261.01 SCOPE**

1. The work to be executed under this Specification consists of the setting out, supply and application of pavement marking paint, thermoplastic pavement marking material, pavement marking tape and raised pavement markers as shown on the Drawings and in accordance with this Specification.

C261.03 TYPE OF MARKINGS

1. Details of the various types of pavement markings and devices are generally in accordance with the requirements of as 1742.2. **Standard**

C261.04 TYPES OF MATERIALS TO BE APPLIED

1. The materials shall be applied as follows: **Locations for Use**
 - (a) Pavement Marking Paint
Permanent markings on all wearing surfaces. Temporary markings, other than on the final wearing surfaces. Traffic islands and kerbs where specified.
 - (b) Thermoplastic Pavement Marking Material
Permanent markings where explicitly indicated on the Drawings.
 - (c) Pavement Marking Tape
Temporary markings on final wearing surfaces.
 - (d) Reflective Glass Beads
To be applied to all painted and thermoplastic markings.
 - (e) Raised Pavement Markers
To be installed as permanent and temporary markings as shown on the Drawings.

C261.05 MATERIAL QUALITY

1. The Contractor shall submit to the Principal Certifying Authority NATA Registered Laboratory Test Reports, at least seven days before work is scheduled to commence, on the quality of the materials, including paint, glass beads, raised pavement markers and thermoplastic material proposed for use. **Contractor's Responsibility**
2. Only materials conforming to the requirements of the referenced Specifications/Standards shall be used. **Quality Requirements**

C261.06 SETTING OUT

1. The Contractor shall set out the work to ensure that all markings are placed in accordance with the Drawings. **Contractor's Responsibility**
2. The locations of pavement markings shall not vary by more than 20mm from the locations shown on the Drawings. **Tolerance**

C261.07 SURFACE PREPARATION

1. Pavement markings shall only be applied to clean dry surfaces. The Contractor shall clean the surface to ensure a satisfactory bond between the markings and wearing surface of the pavement. *Clean Dry Surface*
2. Pavement marking shall not be carried out during wet weather or, if in the opinion of the Principal Certifying Authority, rain is likely to fall during the process. *Wet Weather*
3. Where raised pavement markers are specified for pavements having a concrete wearing surface, the full area under each raised pavement marker shall be lightly scabbled to remove fine mortar material (laitance).. *Scabbling*

C261.08 PROVISION FOR TRAFFIC AND PROTECTION OF WORK

1. The Contractor shall provide for traffic, in accordance with the Specification for CONTROL OF TRAFFIC, while undertaking the work and shall protect the pavement markings until the material has hardened sufficiently so that traffic will not cause damage. *Contractor's Responsibility*

C261.09 MAINTENANCE OF PAVEMENT MARKINGS

1. The Contractor shall be responsible for the maintenance, and replacement if necessary, of raised pavement markers and all pavement marking during the contract period and the contract defects liability period. *Responsibility in Contract Period*

PAVEMENT MARKING PAINT**C261.10 MATERIALS**

1. Paint shall comply with the requirements of AS 4049.1 or AS 4049.3 as directed by the Principal Certifying Authority. In this Specification, the term 'paint' shall mean 'pavement marking paint'. *Paint Quality*
2. Glass beads shall comply with the requirements of AS 2009 for drop-on beads.. *Glass Beads Quality*

C261.11 MIXING OF PAINT

1. All paint shall be thoroughly mixed in its original container before use to produce a smooth uniform product consistent with the freshly manufactured product. *Uniform Product*

C261.12 APPLICATION OF PAINT AND BEADS

1. All longitudinal lines shall be sprayed by an approved self-propelled machine. The two sets of lines forming a one-way or two-way barrier line pattern shall be sprayed concurrently. *Longitudinal Lines*
2. Hand spraying with the use of templates to control the pattern and shape shall be permitted for transverse lines, symbols, legends, arrows and chevrons. *Hand Spraying*
3. The paint shall be applied uniformly and the wet film thickness shall be neither less than 0.35 mm nor more than 0.40 mm. *Paint Thickness*
4. Glass beads shall be applied by air propulsion to the surface of all longitudinal lines at a net application rate of 0.30 kilograms per square metre immediately after application of the paint. The actual application rate shall be set to overcome any loss of beads between the bead dispenser and the sprayed line. *Beads for Longitudinal Lines*

5. Glass beads shall be similarly applied to all other paint markings at a net application rate of 0.30 kilograms per square metre immediately after application of the paint by a method approved by the Principal Certifying Authority. *Beads for other Markings*
6. Pavement markings shall be straight or with smooth, even curves where intended. All edges shall have a clean, sharp cut off. Any marking material applied beyond the defined edge of the marking shall be removed leaving a neat and smooth marking on the wearing surface of the pavement. *Pavement Marking Finish*
7. The lengths of longitudinal lines shall not vary by more than 20mm from the lengths shown in AS 1742.2. The widths of longitudinal lines shall not vary by more than 10mm from the widths shown in AS 1742.2. *Longitudinal Line Tolerances*
8. The lengths and widths of transverse lines shall not vary by more than 10mm from the lengths and widths shown in AS 1742.2. *Transverse Line Tolerance*
9. The dimensions of arrows, chevrons, painted medians, painted left turn islands and speed markings shall not vary by more than 50mm from the dimensions shown on the Drawings or in AS 1742.2 as appropriate. Arrows and speed markings shall be placed square with the centreline of the traffic lane. *Arrows, Chevrons Tolerance*

C261.13 FIELD TESTING

1. The thickness of the wet film applied to the road pavement shall be checked by the method described in C261.12. *Paint Application*
2. The application rate of glass beads applied to the surface of the markings shall be checked by the method described in C261.12. *Beads Application*

Volume of glass beads (ml) required in 10 seconds of operation				
Road Speed km/h	Line Widths			
	75mm	100mm	125mm	150mm
8	371	495	619	742
13	603	804	1006	1207
16	742	990	1238	1484
NOTE: <ol style="list-style-type: none"> 1. Tolerance of +10% shall be permissible when measuring the above volume. 2. When two or more glass bead dispensers are to be used, each dispenser shall be checked separately to make up the totals shown. 3. Glass beads weigh approximately 1.53 grams per millilitre. 				

THERMOPLASTIC PAVEMENT MARKING MATERIAL

C261.14 MATERIALS

1. Thermoplastic pavement marking material shall comply with the requirements of AS 4049.2. *Thermoplastic Quality*
2. In this Specification, the term 'thermoplastic material' shall mean 'thermoplastic pavement marking material'. *Definition*

- | | | |
|----|---|-------------------------------------|
| 3. | Glass beads shall be incorporated in thermoplastic material, in the proportion of 10 per cent of the total mass, as part of the aggregate constituent and shall comply with the requirements of AS 2009, Intermix type. | <i>Glass Bead Proportion</i> |
| 4. | Glass beads for surface application shall comply with the requirements of AS 2009, Drop-on beads.. | <i>Glass Bead Quality</i> |
| 5. | Tack coat material shall be to the manufacturer's specification as approved by the Principal Certifying Authority. | <i>Tack Coat</i> |

C261.15 PREPARATION OF THERMOPLASTIC MATERIAL ON SITE

- | | | |
|----|---|-----------------------|
| 1. | Immediately before application, the thermoplastic material shall be uniformly heated in a suitable oil bath kettle to the temperature recommended by the manufacturer. The thermoplastic material shall not be heated above the temperature recommended by the manufacturer. The thermoplastic material shall not remain molten for more than six hours for hydrocarbon resins and four hours for wood and gum resins. Should over-heating occur and/or the time expire for molten materials, then the thermoplastic material shall be discarded. | <i>Heating</i> |
|----|---|-----------------------|

C261.16 APPLICATION OF THERMOPLASTIC MATERIAL AND BEADS

- | | | |
|----|---|--|
| 1. | Where the wearing surface of the pavement is smooth or polished, a tack coat of material may be required by the Principal Certifying Authority and shall be applied in accordance with the recommendations of the thermoplastic manufacturer. The tack coat shall be applied immediately before the application of the thermoplastic material in accordance with the directions of the manufacturer of the thermoplastic material and the manufacturer of the tack coat material. | <i>Tack Coat Requirement</i> |
| 2. | All longitudinal lines shall be sprayed by a self-propelled machine approved by the Principal Certifying Authority. The two sets of lines forming a one-way or two-way barrier line shall be sprayed concurrently. The thermoplastic material shall be applied uniformly and the cold film thickness shall be 2.0mm with a tolerance of plus or minus 0.5mm. | <i>Longitudinal Lines</i> |
| 3. | Glass beads shall be applied by air propulsion to the surface of all longitudinal lines at a net application rate of 0.30 kilograms per square metre immediately after application of the thermoplastic material. The actual application rate shall be set to overcome any loss of beads between the bead dispenser and the sprayed line. | <i>Beads for Longitudinal Lines</i> |
| 4. | All transverse lines, symbols, legends and arrows shall be screeded. The screeded thermoplastic material shall be applied using a mobile applicator, approved by the Principal Certifying Authority, and templates to control the pattern. | <i>Screed</i> |
| 5. | The thermoplastic material for transverse lines, symbols, legends and arrows shall be applied uniformly and the cold film thickness shall be 3.5mm with a tolerance of plus or minus 1.5mm. The surface finish shall be smooth. | <i>Tolerance</i> |
| 6. | Glass beads for other than longitudinal lines shall be uniformly applied to screeded markings at a net application rate of 0.30 kilograms per square metre immediately after application of the thermoplastic material by a method approved by the Principal Certifying Authority. | <i>Beads for Other Markings</i> |
| 7. | Pavement marking shall be straight or with smooth, even curves where intended. All edges shall have a clean, sharp cut off. Any marking material applied beyond the defined edge of the marking shall be removed leaving a neat and smooth marking on the wearing surface of the pavement. | <i>Pavement Marking Finish</i> |
| 8. | The lengths of longitudinal lines shall not vary by more than 20mm from the lengths shown in AS 1742.2. The widths of longitudinal lines shall not vary by more than 10mm from the widths shown in AS 1742.2. | <i>Longitudinal Line Tolerances</i> |
| 9. | The lengths and widths of transverse lines shall not vary by more than 10mm from the lengths | <i>Transverse Line</i> |

and widths shown in AS 1742.2.

Tolerances

10. The dimensions of arrows, chevrons, painted medians, painted left turn islands and speed markings shall not vary by more than 50mm from the dimensions shown on the Drawings or in AS 1742.2 as appropriate. Arrows and speed markings shall be placed square with the centreline of the traffic lane.

***Arrows,
Chevrons,
Tolerance***

C261.17 FIELD TESTING

1. The thickness of the cold film of thermoplastic material applied to the road pavement shall be checked by measurement, using a micrometer, of the thickness of thermoplastic material applied to a metal test plate.
2. The application rate of glass beads applied to the surface of the markings shall be checked by the method described in Annexure C261B.

***Thickness of
Thermoplastic
Material***

***Glass Beads
Application Rate***

PAVEMENT MARKING TAPE

C261.18 MATERIALS

1. Pavement marking tape shall be a strippable type of tape, such as 'Staymark - Detour Grade', or equivalent tape approved by the Principal Certifying Authority.

Brands

C261.19 APPLICATION OF PAVEMENT MARKING TAPE

1. The method of application of pavement marking tape, including surface preparation, shall be in accordance with the manufacturer's recommendations.

***Manufacturer's
Recommendation***

C261.20 REMOVAL OF PAVEMENT MARKING TAPE

1. When directed by the Principal Certifying Authority, the Contractor shall remove pavement marking tape in accordance with the manufacturer's recommendations.

***Manufacturer's
Recommendation***

RAISED PAVEMENT MARKERS

C261.21 MATERIALS

1. Raised pavement markers, both reflective and non-reflective, shall comply with AS 1906.3 and shall have the dimensions shown on the Drawings.
2. The adhesive used for attaching the raised pavement markers to the wearing surface of the pavement shall be a hot melt bitumen adhesive or an equivalent product approved by the Principal Certifying Authority.

Standard

***Bitumen
Adhesive***

C261.22 INSTALLATION OF RAISED PAVEMENT MARKERS

1. Raised pavement markers shall be fixed to the wearing surface of the pavement using a hot melt bitumen adhesive or an equivalent product. The adhesive shall be freshly heated to the Manufacturer's instructions and thoroughly mixed. The adhesive shall not be allowed to cool and be reheated prior to use.
2. The adhesive shall be spread uniformly over the underside of the raised pavement marker to a depth of approximately 10 mm. The raised pavement marker shall be pressed down onto the pavement surface in its correct position and shall be rotated slightly until the adhesive is squeezed out around all edges of the marker. The raised pavement marker shall not be

***Adhesive
Quality***

Method

disturbed until the adhesive has set.

3. On rough surfaces, such as newly laid coarse sprayed bituminous seals, and where directed by the Principal Certifying Authority, an initial pad of adhesive of diameter 20mm larger than the diameter of the base of the raised pavement marker, shall be provided. The adhesive shall be applied to fill the irregularities in the pavement surface to produce a flat, smooth surface flush with the upper stone level. The adhesive pad shall be allowed to set. Additional adhesive shall be applied to the pavement, as described above, and then the raised pavement marker shall be pressed down onto the adhesive pad on the pavement surface to ensure good adhesion.

Rough Surfaces

REMOVAL OF PAVEMENT MARKINGS

C261.23 GENERAL

1. The Contractor shall remove pavement markings, no longer required, from the wearing surface of pavements without significant damage to the surface.
2. The method of removal shall be approved by the Principal Certifying Authority before commencement of the work.

***Undamaged
Pavement***

Removal Method

LIMITS AND TOLERANCES

C261.24 SUMMARY OF LIMITS AND TOLERANCES

1. The tolerances applicable to the various clauses of this Specification are as follows:

Item	Activity	Tolerances	Spec Clause
1.	Location of Markings	± 20mm from specified location	C261.06
2.	Longitudinal Lines		C261.12
	(a) Length	± 20mm from lengths shown in AS 1742.2	C261.16
	(b) Width	± 10mm from widths shown in AS 1742.2	C261.12 C261.16
3.	Transverse Lines		
	(a) Length)	± 10mm from lengths and widths shown in AS 1742.2	C261.12
	(b) Width)		C261.16
4.	Arrows, Chevrons, Painted Medians, Speed Markings etc.	± 50mm from the dimensions shown in AS 1742.2	C261.12 C261.16
5.	Application of Paint		
	(a) Film Thickness	>0.35mm <0.40mm	C261.12
6.	Application of Thermoplastic		
	(a) Longitudinal Lines - Cold Film Thickness	2.0mm ± 0.5mm	C261.16
	(b) Transverse Lines, Symbols, Arrows etc. Cold Film Thickness	3.5mm ± 1.5mm	C261.16
7.	Glass Beads		
	(a) Volume used in operation	0.30 kg/sq m + 10%	C261.12 C261.16

Table C261.2 - Summary of Limits and Tolerances

DEVELOPMENT CONSTRUCTION SPECIFICATION

C263

GUIDE POSTS

AMENDMENT RECORD FOR THIS SPECIFICATION PART

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part. The clause numbering and context of each clause are preserved. New clauses are added towards the rear of the specification part as special requirements clauses. Project specific additional script is shown in the specification as italic font.

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Amendment Sequence No.	Key Topic addressed in amendment	Clause No.	Amendment Code	Author Initials	Amendment Date

GUIDE POSTS

C263.01	SCOPE	267
C263.03	MATERIALS.....	267
CONSTRUCTION	268
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C263.05	PROTECTIVE TREATMENT OF TIMBER GUIDE POSTS	268
C263.06	ERECTION OF GUIDE POSTS.....	268
C263.07	DELINEATORS.....	269

SPECIFICATION C263 : GUIDE POSTS

GENERAL

C263.01 SCOPE

1. The work to be executed under this Specification consists of the setting out, supply of all materials and erection of guide posts at the locations shown on the Drawings or as directed by the Principal Certifying Authority in areas where street lighting is not provided.

C263.03 MATERIALS

(a) General

1. Guide Posts shall be of timber or flexible (driveable or non-driveable) post conforming to the requirements of this specification. The Contractor shall supply details of the proposed flexible guidepost including the manufacturer's recommended installation procedure, technical specifications and test certificates for approval by the Principal Certifying Authority. *Posts*

(b) Timber Posts

1. Timber posts shall be cut from Select Grade hardwood and conform with AS 2082. All surfaces shall be smooth and free from obvious saw marks. *Quality*
2. The posts shall be of rectangular cross-section having dimensions of 100mm x 50mm and shall be 1,400mm in length. The tops of the guide posts shall be sloped so that one 100mm edge is 10mm lower than the opposite edge. *Dimensions*

(c) Flexible Posts

1. Flexible guide posts shall be made to a design, and from a material, which provides the properties of strength, flexibility, impact resistance and durability. The material shall be mould resistant, solvent resistant, heat resistant and fire retardant. *Properties*
2. The surface of the posts shall have a gloss or semi-gloss white finish. The surface shall be smooth and easily cleaned. *Surface Finish*
3. The flexible posts shall be 1400mm in length and shall have one face of 100mm width. *Dimensions*
4. Flexible posts shall have certification of compliance with the following physical properties and performance characteristics when subjected to the referenced tests:
 - the composition of the posts shall not vary beyond commercially accepted limits from the composition stated by the manufacturer at the time of tendering. Testing, in accordance with AS 1580.101.1, shall be carried out under standard ambient conditions of temperature $23 \pm 2^{\circ}\text{C}$ and relative humidity 45 per cent to 75 per cent.
 - the mass of any individual post shall not vary more than ± 3 per cent from the mass of 20 sample posts.
 - resistance to accelerated weathering - when tested in accordance with AS 1580.483.1, shall be free from crazing and blistering. The degree of chalking and colour change shall not fall below a rating of 6 when tested in accordance with AS 1580.481.1.11 and 12, and the loss of gloss shall not exceed 20 gloss units (egg shell gloss) when evaluated in accordance with AS 1580.602.2.
 - resistance to heat - the post shall be conditioned at $60^{\circ}\text{C} \pm 1\text{C}$ for 2 hours in an oven. The conditioned post shall be bent 180° at the midpoint four times within 2 minutes of removal from oven. The deflection of the top of the post shall be no greater than 50mm, 30 seconds after the fourth bend.
 - resistance to impacts after accelerated ageing - the test post shall be kept in an oven for 28 days at 50°C , then removed and allowed to cool. The test post shall then be conditioned in a cold box for 2 hours at 10°C , then removed and placed in a suitable

holder and supported horizontally by both ends. Using a guide tube, a steel ball of mass 1.03kg is allowed to fall on the test post in 5 successive impacts on the same spot within one minute of removal from the cold box. The post shall show no evidence of fracture, cracking or splitting.

- resistance to vehicle impacts - the posts shall be manufactured from an impact resistant material and be so designed that an installed post is capable of returning to its original shape and remaining serviceable after being subjected to the following series of direct impacts by a typical passenger sedan at temperatures between 15°C and 30°C.

Posts shall be capable of withstanding a series of 10 bumper bar impacts at 60km/h and 5 bumper bar impacts at 100km/h directed at 90° to the front face of the guidepost. The impacting vehicle shall suffer little or no damage during the impact test series.

The posts to be tested shall be installed in accordance with the recommendations of the manufacturer, and shall be furnished complete with attached delineators.

(d) Delineators

Standard

1. Corner-cubed delineators, conforming to AS 1906.2 shall be attached to each post.
2. The delineators shall be neither less than 80mm nor more than 85mm diameter.

Diameter

CONSTRUCTION

C263.04 GENERAL

1. The Contractor shall at all times conform to the requirements of the Specification for **Traffic Control** CONTROL OF TRAFFIC.
2. Where the shoulder is in embankment or at natural surface level, the guide posts shall be placed near the outer edge of the shoulder and at a uniform distance, minimum 1m, from the pavement edge line. Where the shoulder is located in a cutting, the guide posts shall be placed on the road pavement side of the table drain, and minimum 1m from the pavement edge line, in such a manner as not to impede the flow of water in the drain. **Positioning**
3. Guide posts shall be erected at the locations shown on the Drawings. **Location**
4. Underground services laid in proximity to the guide posts shall be located prior to erection of posts, all care shall be taken not to damage such services.

C263.05 PROTECTIVE TREATMENT OF TIMBER GUIDE POSTS

1. The portion of the guide post below ground level shall be dipped in creosote, conforming to AS 1143, heated to 90°C for a minimum period of one hour. **Creosote**
2. All timber above ground level shall be painted with pink primer and any holes, cracks, or other surface imperfections in the timber, shall be stopped with white putty. This work shall be followed by painting with a white undercoat and a white enamel finishing coat. **Painting**
3. Painted surfaces shall be thoroughly dry before the second coat is applied. Paints shall be handled and applied in accordance with the manufacturer's directions. **Dry Surfaces**
4. All paints shall be of the best quality, durable and suitable for exterior application on timber surfaces. **Paint Quality**

C263.06 ERECTION OF GUIDE POSTS

1. Guide posts shall be set vertically in the ground to a depth of approximately 500mm. In order to offset shoulder irregularities this depth shall be varied so as to give uniform display of guide posts to a height of approximately 900mm above ground level, with the tops evenly graded. **Details**

Each guide post shall be erected with the 100mm axis at right angles to the centre line of the road.

2. Allowance shall be made in the height of guide posts above the ground for the effects of superelevation and other road geometry in order to keep the guide posts within the range of the beam of vehicle headlights. **Vertical Alignment**
3. Backfilling shall be compacted in layers of depth not more than 150mm for the full depth of the guide posts up to ground level. The density of the compacted backfilling shall not be less than that of the adjacent undisturbed ground. Guide posts shall be firm in the ground to the satisfaction of the Principal Certifying Authority. **Backfilling**
4. Flexible guideposts, when installed in the ground in accordance with the recommendations of the manufacturer, shall resist overturning, twisting and displacement from wind and impact forces. **Flexible Guideposts**
5. All necessary steps shall be taken to prevent people and stock from stepping into the post holes during the erection of the guide posts. **Contractor's Responsibility**

C263.07 DELINEATORS

1. 'Corner Cubed' delineators, complying with AS 1906.2, shall be attached to each guide post using one way, anti-theft screws. In the case of Flexible posts, the delineators shall be glued or otherwise fastened to the post in such a manner that they are not dislodged or rendered inactive under vehicular impact. **Fixing**
2. The delineators shall be mounted so that the top of the reflector is 50mm below the top of the guide post. **Position**
3. The delineators shall be so arranged that drivers approaching from either direction will see only red delineators on their left side and white delineators on their right side. **Arrangement**

DEVELOPMENT CONSTRUCTION SPECIFICATION

C271

MINOR CONCRETE WORKS

AMENDMENT RECORD FOR THIS SPECIFICATION PART

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part. The clause numbering and context of each clause are preserved. New clauses are added towards the rear of the specification part as special requirements clauses. Project specific additional script is shown in the specification as italic font.

The amendment code indicated below is 'A' for additional script 'M' for modification to script and 'O' for omission of script. An additional code 'P' is included when the amendment is project specific.

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SPECIFICATION C271 MINOR CONCRETE WORKS

GENERAL

C271.01 SCOPE

1. The Work to be executed under this Specification consists of the supply and placement of concrete, including sprayed concrete, and ancillary requirements like excavation, preparation of foundations, forming up, placement of reinforcement and backfilling for work shown on the Drawings but not having individual Specifications. These works include New Jersey type barriers, drainage pits and other supplementary structures, headwalls, box culverts, box culvert base slabs, driveways, footpaths, median toppings, retaining walls, footings, paving edge strips and works of a similar nature.
2. The work also includes supply and placement of sprayed concrete and miscellaneous minor concrete work for water and sewerage construction such as valve chambers, thrust and anchor blocks, bulkheads, pumping stations, bedding, encasement and cast-in-situ access chambers.

EXCAVATION AND FOUNDATIONS

C271.03 GENERAL

1. The subgrade, or subbase where specified, shall be formed at the required depth below the finished surface levels shown on the Drawings. Rock foundations shall be neatly excavated to form a bed for the concrete, and shall be thoroughly scraped and cleaned. Soil foundation shall, as far as possible, be excavated neatly from the solid material to coincide with the under-surface of the concrete, or of the subbase material (where specified). *Foundations*
2. All soft, yielding or other unsuitable material shall be replaced with sound material approved by the Principal Certifying Authority, and the subgrade shall be compacted to provide a minimum relative compaction of 100 per cent as determined by AS 1289.5.4.1 for standard compactive effort. If the subgrade is dry it shall be sprinkled with as much water as it will readily absorb, before the concrete is placed. *Unsuitable Material*
3. The Contractor shall supply all necessary sheeting and bracing to safely support the excavation in accordance with Statutory requirements. The excavation shall be kept free of water. *Shoring*

C271.04 NEW JERSEY TYPE BARRIERS, DRIVEWAYS AND FOOTPATHS

1. For New Jersey type barriers, driveways and footpaths a subbase of approved quality and of minimum 150mm compacted thickness, unless otherwise shown on the Drawings, shall be placed over the subgrade. The surface shall then be checked for uniformity, line and level, and all irregularities shall be made good. *Subbase*
2. The subbase material shall be compacted to provide a minimum relative compaction as determined by AS 1289.5.4.1 of 95 per cent for compactive effort or 95 per cent for modified compactive effort as appropriate. *Compaction*
3. The finished subbase shall not deviate more than 12mm under a straight edge 3 metres long, subject to any necessary allowance on vertical curves. *Subgrade and Subbase Tolerances*

C271.06 RETAINING WALLS, HEADWALLS AND WINGWALLS

1. In the case of rock foundations for retaining walls, headwalls and wingwalls, the excavation shall be carried into the rock for a minimum depth of 150mm. Where cut-off walls are to be *Rock Foundations*

provided, the depth of cut-off in rock foundations may be reduced to 100mm.

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| 2. | Prior to the construction of cast-in-situ concrete walls on earth foundations, the latter shall be covered by a mass concrete bedding layer at least 50mm thick and finished to a uniform surface. No forms or other materials shall be placed upon the bedding layer within a period of 48 hours after the concrete has been placed. | Earth Foundations |
| 3. | Unless otherwise specified, precast concrete wall sections shall be placed on a fresh concrete bedding layer while it is still in plastic state. In the case of soil foundations, the concrete shall be not less than 50mm thick, and where the foundation is in rock, the concrete shall be of such thickness as is required to provide a uniform surface at least 50mm above the highest points of rock. | Pre-cast Concrete |

FORMWORK

C271.07 GENERAL

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|----|---|--------------------------------|
| 1. | Formwork shall be provided in accordance with AS 3610 to produce hardened concrete to the lines, levels and shapes shown on the Drawings or specified elsewhere. It shall have adequate strength to carry all applied loads, including the pressure of fresh concrete, vibration loads, weight of workers and equipment, without loss of shape. Forms shall be mortar tight and designed to allow removal without risk of damage to the completed structure. Joints in the formwork shall be perpendicular to the main axis of the shape of the concrete. | Formwork Requirements |
| 2. | Where concrete is placed in earth excavations, side forms shall be provided to prevent contact between concrete and the insitu earth. | Side Forms |
| 3. | Design of formwork for high sections shall be such that it shall not be necessary to drop concrete freely from a greater height than 1.2 metres or to move concrete along the formwork after deposition. | Placement of Concrete |
| 4. | Formwork material used shall be sound and suitable for the purpose intended and surface finish specified. | Material |
| 5. | Provision shall be made for the accurate location and firm support of fittings, bolts, anchorages and formers of holes as shown on the drawings. Temporary fittings used for the support of the formwork shall be arranged to permit removal without damage to the concrete. The use of wires and or bolts extending to the surface of the concrete shall not be permitted except where shown on the Drawings. | Formwork Fittings |
| 6. | Forms for edges of concrete shall be filleted and for re-entrant angles chamfered as shown on the Drawings. | Edge Treatment |
| 7. | Temporary openings shall be provided where necessary for cleaning out of formwork and inspection before concreting. | Cleaning and Inspection |

C271.08 APPROVAL OF FORMWORK DESIGN

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|----|---|---------------------------|
| 1. | For box culverts and reinforced concrete retaining walls, detailed drawings, design calculations, description and/or samples of materials proposed for use shall be submitted for the Principal Certifying Authority's concurrence before manufacture of the formwork is commenced. | Approval to Design |
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C271.09 PROVISION FOR DRAINAGE

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| 1. | Where shown on the Drawings, or where directed by the Principal Certifying Authority, weepholes of 50mm diameter shall be provided in retaining walls and wingwalls. | Weep Holes |
|----|--|-------------------|

C271.10 CONSTRUCTION

1. The type and quality of material selected for formwork and the workmanship used in construction shall be such that the surface finish specified shall be obtained. Construction shall be such that the erection tolerances shall be obtainable. **Formwork Material**
2. Timber for formwork shall be well seasoned, free from defects and, where in contact with fresh concrete, free from loose knots. **Timber Requirements**
3. Timber forms for exposed surfaces shall be constructed from plywood or particle board with hardwood or approved softwood studs and wales. The plywood used for forms shall comply with AS 2271, the hardwood shall comply with AS 2082 and the particle board with AS/NZS 1859. **Timber Standards**
4. Formwork for exposed surfaces shall be made from panels having uniform widths of not less than 1m and uniform lengths of not less than 2m, except where the dimensions of the member formed are less than the specified panel dimensions. Plywood panels shall be placed with the grain of the outer plies perpendicular to the studding or joists. Where form panels are attached directly to the studding or joists the panel shall be not less than 15mm thick. Form panels less than 15mm thick, otherwise conforming to these requirements may be used with a continuous backing of dressed material of 20mm minimum thickness. All form panels shall be placed in a neat, symmetrical pattern. **Formwork Panels for Exposed Surfaces**
5. Forms for all surfaces which will be completely enclosed or permanently hidden below the ground may be constructed from dressed or undressed timber, steel, plywood or particle board. **Hidden Surfaces**
6. Mild steel form surfaces in contact with concrete shall have all bolt and rivet heads counter-sunk and all welds ground back to even and smooth surfaces. **Mild Steel Surfaces**

C271.11 ERECTION**(a) General**

- (i) Dimensions and position of forms, shall be carefully checked after the forms are erected. Forms shall be aligned accurately and the location of all fittings, hold formers, etc. checked prior to placing concrete. Departure of the forms from the surfaces shown on the drawings shall not exceed 1/300 of the space between supports for any surface visible in the completed work and 1/150 for hidden work. **Formwork Position Tolerances**
- (ii) Joints as erected shall be mortar tight. **Mortar Tight**
- (iii) The interior surface of the forms shall be treated to ensure non-adhesion of the mortar. Commercial quality form oil or grease will be acceptable, but the oil or grease used on forms against surfaces to be exposed shall not stain or discolour the concrete surface. The coating shall be uniformly spread in a thin film and any surplus shall be removed prior to placing concrete. In the case of unlined timber forms, the timber shall be thoroughly wetted before oiling. Forms shall be treated before placing reinforcement to ensure that the form release agent will not contaminate the surface of the reinforcing steel or construction joints. **Coating of Internal Surfaces**
- (iv) Formwork hardware shall be treated with a form release agent and so arranged that it may be removed from the concrete without excessive jarring or hammering. **Release Agent**

(b) Approval by the Principal Certifying Authority

- (i) Placing of concrete shall not commence until the formwork and reinforcement have been inspected and approved. **Concrete Placement**
- (ii) When an inspection is requested by the Contractor, a notice of not less than 24 hours, excluding Saturdays, Sundays and Public Holidays, shall be given to the Principal Certifying Authority. **Notice of Inspection**

MATERIALS FOR CONCRETE

C271.12 CEMENT

1. Cement shall be Type GP Portland Cement complying with AS 3972 and shall be from a source included in the New South Wales Government Cement Quality Assurance Scheme. **NSW QA Scheme**
2. When submitting details of the nominated mix in accordance with Clause C271.17, the Contractor shall nominate the brand and source of the cement. On approval of the nominated mix by the Principal Certifying Authority, the Contractor shall only use the nominated cement for the work. **Nominated Brand and Source**
3. Documentary or other acceptable evidence of the quality of the cement shall be furnished by the Contractor if required by the Principal Certifying Authority. **Proof of Quality**
4. If the Contractor proposes to use cement which has been stored for a period in excess of 3 months from the date of testing, a re-test shall be required at the Contractor's expense before the cement is used. **Storage Time**
5. All cement shall be transported in watertight containers, and shall be protected from moisture until used. Caked or lumpy cement shall not be used. **Transport and Storage**

C271.13 WATER

1. Water used in the production of concrete shall be potable and free from materials harmful to concrete or reinforcement. **Quality**
2. Water which is not potable for human beings shall not be used in reinforced concrete. **Potability**

C271.14 FINE AGGREGATE

1. Fine aggregates shall consist of clean, hard, tough, durable uncoated grains, uniform in quality, and shall conform to the requirements of AS 2758.1 in respect of bulk density, water absorption (maximum 5 per cent) material finer than 2 micrometres, impurities and reactive materials. **Quality**
2. Fine aggregates shall be evenly graded within the limits shown in Table C271.1. **Grading Requirements**

Australian Standard Sieve	Proportion Passing (% of Mass)
9.50mm	100
4.75mm	90 - 100
1.18mm	40 - 85
300mm	8 - 30
150mm	2 - 10
75mm	0 - 4

Table C271.1 - Fine Aggregate Grading

C271.15 COARSE AGGREGATE

1. Coarse aggregate shall consist of clean, hard, durable, crushed stone, crushed river gravel, screened river gravel or metallurgical furnace slag and shall conform to the requirements of AS 2758.1 in respect of particle density, bulk density, water absorption (maximum 2.5 per cent), material finer than 75 micrometres, weak particles, light particles, impurities and reactive materials, iron unsoundness and falling or dusting unsoundness. In all other respects, the coarse aggregate shall comply with this Specification. If required, coarse aggregate shall be washed to satisfy these requirements. **Quality**
2. The percentage of wear shall be determined by AS 1141.23, and the loss of weight shall not exceed 30 per cent. **Wear Test**
3. When required by the Principal Certifying Authority, coarse aggregate shall be tested for conformance for any or all of the properties set out below: **Additional Tests**
 - (i) Crushing Value - AS 1141.21
The aggregate crushing value shall not exceed 25 per cent.
 - (ii) Soundness - AS 1141.24
The loss of mass when tested with sodium sulphate shall not exceed 12 per cent.
 - (iii) Particle Shape - AS 1141.14
The proportion of mis-shapen particles (2:1 ratio) shall not exceed 35 per cent.
4. Coarse aggregate shall be evenly graded within the absolute limits shown in Table C271.2 and shall not deviate from the grading of the samples submitted under Clause C271.17 by more than shown. **Grading Requirements**

Australian Standard Sieve (mm)	Proportion Passing (% of Mass)			Deviation Proposed Grading (% of Mass of Sample)
	40mm Nominal	20mm Nominal	Extrusion Concrete	
	For Walls exceeding 150mm thickness	For all other structures		
53.0	100		100	±10
37.5	95 - 100			
26.5		100		±10
19.0	30 - 70	95 - 100		
13.2				±5
9.50	10 - 35	25 - 35		
4.75	0 - 10	0 - 10		±5
2.36	0 - 2	0 - 2		

Table C271.2 - Coarse Aggregate Gradings**C271.16 ADMIXTURES**

1. Chemical admixtures and their use shall comply with AS 1478. Admixtures shall not contain calcium chloride, calcium formate, or triethanolamine or any other accelerator. Admixtures or combinations of admixtures other than specified below, shall not be used. **Quality and Use**
2. During the warm season, (October to March inclusive), a lignin or lignin-based ('ligpol') set-retarding admixture (Type Re or Type WR Re) approved by the Principal Certifying Authority shall be used to control slump within the limits stated in Clause C271.21. The **Retarder for Warm Season**

dosage shall be varied to account for air temperature and haul time in accordance with the manufacturer's recommendations. A copy of the NATA endorsed Certificate of Compliance with AS 1478 for Type Re or Type WR Re shall be submitted to the Principal Certifying Authority, together with the proposed 'dosage chart' in accordance with Clause C271.17.

3. During the cool season, (April to September inclusive), only a lignin or lignin based set-retarding admixture containing not more than 6 per cent reducing sugars (Type WR Re complying with AS 1478) may be used in the mix. *Retarder for Cool Season*

C271.17 TESTING OF MATERIALS

1. The Contractor shall submit to the Principal Certifying Authority a copy of a NATA Certified Laboratory Test Report on the quality and gradings of the aggregates proposed to be used in the work. *Contractor's Responsibility*
2. The materials shall only be used after receipt of the Principal Certifying Authority's notification of acceptance, and then only so long as the materials accord with the specification. *Use of Material*

HANDLING AND TREATMENT OF CONCRETE

C271.18 MEASURING

1. All materials shall be measured by weight, except that:- *Measurement of Material*
 - (a) Water may be measured by volume with an approved adjustable water-measuring and discharging device, and,
 - (b) Cement may be measured by bags as packed by the manufacturer in which case batches shall be proportioned on the basis of one or more unbroken bags of cement, and for this purpose one bag of cement shall be assumed to weigh 40kg. Bulk cement shall be weighed in an individual hopper and shall be kept separate from the aggregates until the components of the batch are discharged from the batching hopper.
 - (c) Measurement by volume for smaller works may be undertaken with the prior approval of the Principal Certifying Authority.

C271.19 MEASURING BY WEIGHT, ON-SITE MIXING

1. Where concrete is to be mixed on site, and where mix control is likely to be less efficient than at a central batching plant, the weights of cement, fine and coarse aggregate shown in Table C271.3 may be used as a guide to produce the classes of concrete specified. Small changes in the proportions of fine and coarse aggregate may be required to improve density or workability of the concrete. The use of proportions shown in Table C271.3 shall not relieve the Contractor of his obligation to provide concrete of the specified compressive strength. *Mixing by Weight on Site*

MPa	Cement Kg	Fine Aggregates Kg	Coarse Aggregates Kg	Total Aggregates Kg
10	40	130	250	380
15	40	100	190	290
20	40	88	126	214

Table C271.3 - Materials in Batch containing 1 bag (40Kg) Cement

2. The proportions set out in Table C271.3 make allowance for moisture contents of aggregates of 6 per cent for fine aggregates and 1 per cent for coarse aggregates. Where the moisture content of aggregates exceeds 8 per cent or 3 per cent respectively, the proportions of the *Variation in Aggregate Moisture Content*

mix shall be changed to compensate for the excess water in the aggregate.

C271.20 MEASURING BY VOLUME, ON-SITE MIXING

- Where measurement by volume is approved, the proportions of the materials shall be such as are required to produce a mix free of voids and having the specified strength at 28 days. *Mixing by Volume on Site*
- The nominal proportions given in Table C271.4 may be used as a guide for volume batching. *Volume Batching*

MPa	Parts by Volume		
	Cement	Fine Aggregate	Coarse Aggregate
10	1	3	6
15	1	2.25	4.5
20	1	2	3

Table C271.4 - Volume Batching

- The volumes of fine and coarse aggregates for each batch shall be measured in boxes or bins. The aggregates shall be measured loose (i.e. without compaction) in the boxes and shall be struck off level. Measurements by shovels or like methods will not be permitted. Batch proportions shall be so arranged that each batch contains 1 bag of cement. One 40kg bag of cement shall be assumed to have a volume of 27.5 litres. *Batch Measurement*

C271.21 CONSISTENCY

- A sufficient quantity of water shall be added to the mix so that the consistency of the concrete is such that it can be placed in the forms, compacted and worked into all corners without permitting the ingredients to segregate, or excess free water to collect on the surface. If required by the Principal Certifying Authority, the Contractor shall determine the consistence of the concrete in accordance with AS 1012.3, Method 1. Except for extruded concrete, the nominated slump shall not exceed 80mm, plus the field tolerance of ± 15 mm. *Consistency Requirements*
- In the case of concrete placed by an extrusion machine, the water in the mix shall be only sufficient to produce a slump of 10mm to 15mm. *Extruded Concrete Consistence*

C271.22 MIXING AND DELIVERY

(a) General

- Concrete may be mixed either at the site or at a central mixing plant. All concrete shall be mixed with mechanically operated mixers. In an emergency, hand mixing may be permitted. *Mechanical Mixing*
- Any concrete which exhibits signs of segregation shall not be used. *Segregation of Concrete*

(b) Machine Mixing at Site

- The mixing of concrete shall be done in a batch mixer which will ensure a uniform distribution of the materials throughout the batch. *Mixer Requirements*
- The mixer shall be of such capacity that one or more whole bags of cement may be used per batch of concrete. The volume of the mixed material shall not exceed the manufacturer's rated capacity of the mixer. *Mixer Capacity*
- The mixing time for each batch shall not be less than 1.5 minutes after all ingredients are assembled in the mixer, and prior to any portion of the batch being removed. *Mixing Time*

- (iv) The entire contents of a batch shall be discharged from the mixer before any materials are placed therein for the succeeding batch. *Total Mix Discharge*
- (c) Mixing in an Emergency**
- (i) In the case of breakdown of the mechanical mixing equipment, hand mixing in small quantities so as to complete a section of the work or reach a suitable construction joint is permitted. *Hand Mixing*
- (ii) Hand mixing shall be done on a water-tight platform of sufficient size to allow the mixing of at least two batches simultaneously. The amount of cement used shall be 10 per cent more than the amount specified for machine mixed concrete. *Hand Mixing Conditions*
- (iii) The fine aggregate and cement shall first be mixed until a uniform colour is obtained, and then spread on the mixing platform in a thin layer. The coarse aggregate, which shall have been previously drenched with water, shall then be spread over the fine aggregate and cement in a uniform layer, and the whole mass turned over as further water is added with a rose sprinkler. After the water is added, the mass shall be turned at least three times, not including shovelling into barrows or forms, until the mixture is uniform in colour and appearance. Hand-mixed batches shall not exceed 0.25 cubic metres each. *Hand Mixing Procedure*
- (d) Ready-Mixed Concrete**
- (i) The concrete shall be mixed and delivered in accordance with the requirements of AS 1379 relating to:- *Mixing Standard and Discharge Times*
- (1) Mixing and Delivery; and
- (2) Use of Non-Agitating Equipment,
- with the exception that in (1) the time taken from the introduction of water until the concrete is completely discharged shall be not more than 1.5 hours, and in (2) not more than 30 minutes.
- (ii) The water used for flushing the chutes and for cleaning shall be discharged in an area acceptable to the Principal Certifying Authority. The chutes shall be long enough to permit delivery to the whole of the area enclosed by the forms. *Cleansing and Positioning of Chutes*

C271.23 PLACING AND COMPACTING CONCRETE

1. No concrete shall be placed during rain nor without the approval of the Principal Certifying Authority, while the air temperature is, or is likely to be within 24 hours, below 5°C or while the shade temperature exceeds 38°C. *Air Temperature Requirements*
2. The concrete shall be mixed in the quantities required for immediate use and shall be placed in position as rapidly as possible. Any concrete which has developed initial set, or which does not reach the forms within 30 minutes after the water has been added (except when transported in agitator trucks) shall not be used. *Placement within Time Limit*
3. The concrete shall be deposited in the forms, without separation of the aggregates. Concrete shall not be dropped freely from a height greater than 1.2 metres, or be deposited in large quantities at any point and moved or worked along the forms. Conveying equipment, including open troughs and chutes, where used, shall be made of metal, or have metal linings. Where used on steep slopes, troughs and chutes shall be equipped with baffles, or be placed in short lengths in such a way that the direction of flow of the concrete is changed. The concrete shall be placed in horizontal layers in one continuous operation between the ends of the work and/or construction joints. Care shall be taken to fill every part of the forms and to work the coarser aggregate back from the face. The freshly placed concrete shall be compacted by continuous spading, slicing or by vibrator units. Vibrators shall not be left in one position for more than 30 seconds, and shall not be permitted to rest on reinforcement. *Placement in Forms, Vibrating*
4. Exposed surfaces of the concrete shall be struck off and finished with a wooden float. Where shown on the Drawings corners and edges shall be left neatly rounded or chamfered. Re- *Exposed Surfaces*

entrant angles shall be neatly filleted.

5. Concrete shall not be moved after it has been in the forms for more than 10 minutes. *Initial Set*
6. In the case of concrete placed by an extrusion machine, small quantities of cement-sand slurry, comprised of two parts of plasterer's sand and one part of cement (by volume), together with sufficient water to bring it to a semi-fluid condition, shall be placed in the special receptacle in the machine, if the machine is so equipped and shall be fed onto the surface of the concrete at a rate sufficient to produce a smooth and uniform finish. *Slurry for Extruded Concrete*

C271.24 FINISHING OF UNFORMED SURFACES

(a) Surfaces other than Wearing Surfaces

1. Unformed surfaces shall be compacted and tamped so as to flush mortar to the surface, screeded off and finally dressed with a wooden float to an even surface. Care shall be taken to drain or otherwise remove promptly any water which comes to the surface. A capping of mortar will not be permitted. *Finish for Unformed Surfaces*
2. All future contact surfaces shall be left rough, with the coarse aggregate at the surface firmly embedded but not forced below the surface. *Future Contact Surfaces*

(b) Wearing Surfaces

1. Where a concrete wearing surface is shown on the drawings the concrete shall be thoroughly compacted and the surface screeded off by a vibrating screed, or hand screeded where the distance between forms perpendicular to the direction of screed is no greater than 2 metres. Immediately following compaction and screeding the concrete shall be tested for high or low spots and any necessary corrections made. The surface shall be finished true and uniform and free from any glazed or trowelled finish and shall be finally dressed with a wooden template or float, or by the use of belting in an approved manner. The departure from grade shall not exceed 5mm in any 3 metre length. *Finish for Wearing Surfaces*
2. Where an asphaltic concrete wearing surface is specified, the surface of the concrete, after being compacted, screeded and corrected, shall be dressed with a wooden float and finally broomed to produce a rough surface. *Surface to receive Asphalt*

(c) Finished Levels

1. The finished levels of concrete structures not adjacent to road pavements shall not vary more than 25mm from the specified levels. In the case of barriers, drainage pits and other structures adjacent to road pavements, the finished concrete shall not vary more than 10mm from the specified levels and alignment. Barriers, footpaths and similar shall not deviate from level or alignment by more than 5mm from a straight-edge 3 metres long, subject to any necessary allowances on vertical and horizontal curves. *Surface Tolerance*

C271.25 CURING AND PROTECTION

1. All exposed surfaces of the freshly placed concrete shall be kept moist either by the use of plastic sheeting, damp sand or commercial curing compounds, in accordance with AS 3799, for a minimum period of 3 days. During this time the work must be adequately protected from traffic and any other causes likely to damage the concrete. *Curing Requirements*

C271.26 REMOVAL OF FORMS

1. All forms shall remain in place, after placement of concrete, for minimum periods specified hereinafter. These periods may be extended by the Principal Certifying Authority if the air shade temperature falls below 10°C during the periods specified. *Walls, Sumps etc.*
Mass retaining walls, headwalls, wingwalls, gully pits,

Sumps, and similar drainage structures	48 hours	
Footpaths, driveways and similar	48 hours	
Sides of reinforced concrete walls when height of each day pour is:		
(i) under 0.6 metres	1 day	
(ii) 0.6m to 3m	2 days	
(iii) 3m to 6m	3 days	
(iv) 6m to 9m	5 days	
Supporting forms under deck slabs of culverts	10 days	
2. To permit the satisfactory finishing of barriers, forms shall be removed in not less than 12 hours nor more than 48 hours after placing concrete, depending upon weather conditions.		Barriers
3. Care shall be taken in removing forms so that the concrete will not be cracked, chipped or otherwise damaged. The use of crowbars or other levering devices exerting pressure on the fresh concrete to loosen the forms will not be permitted.		Protection of Concrete
4. No superimposed load shall be allowed on any part of a structure until the concrete has reached at least 70 per cent of the design strength.		Superimposed Load
5. Hole formers such as pipes and bars shall be removed as soon as the concrete has hardened sufficiently for this to be done without damage to the concrete.		Removal of Hole Formers

C271.27 TREATMENT OF FORMED SURFACES

1. All concrete surfaces shall be true and even, free from stone pockets, depressions or projections beyond the surface. All arises shall be sharp and true, and mouldings shall be evenly mitred or rounded. Care shall be exercised in removing forms to ensure this result.	Quality of Surfaces
2. As soon as the forms are removed from mass or reinforced concrete work, all rough places, holes and porous spots shall be repaired by removing defective work and filling with stiff cement mortar having the same proportions of cement and fine aggregate as used in the concrete, and shall be brought to an even surface with a wooden float.	Repair of Defects
3. Any tie wires or other fitments extending to outside surfaces, shall be cut back after removal of forms, to a depth of at least 40mm with sharp chisels or cutters. All cavities caused by removal of fitments or tie wires shall be wetted and carefully packed with cement mortar, as above.	Removal of the Wires
4. The surfaces of bolt cavities, tie wire holes, and all defects in concrete shall be coated prior to the placing of mortar, grout, or fresh concrete, with an approved bonding agent, in lieu of wetting with water. The method of application of such agent and the conditions in which it is to be used shall generally be as laid down by the manufacturer.	Coating with Bonding Agent

C271.28 JOINTS

1. Where horizontal construction joints are found to be necessary in walls, or cast-in-situ drainage structures the joints may be made at the base of walls and at other locations in the walls where approved by the Principal Certifying Authority. In order to provide for bond between the new concrete and the concrete which has already set, the surface on which the new concrete is to be placed shall be thoroughly cleaned of loose material, foreign matter and laitance. The surface shall be roughened or keyed and saturated with water. After any excess water has been removed, the surface shall be thinly coated with a neat cement grout.	Horizontal Construction Joint
2. Retaining walls shall be provided with vertical expansion joints as shown on the Drawings. The expansion joints shall consist of jointing material of approved quality, and of thickness shown on the drawings, and a depth sufficient to fill the joint. The jointing material shall be neatly cut to fit the surface of the concrete.	Vertical Expansion Joints

3. Where barriers are extruded or cast in place, narrow transverse vertical grooves, 20mm deep, shall be formed neatly in the surface of the freshly placed concrete to produce contraction joints for the control of cracking. The contraction joints, shall be at intervals of 3 metres. **Barrier Contraction**
4. In barriers, unless shown otherwise on the Drawings, expansion joints, 15mm in width for the full depth of the barrier, shall be constructed at intervals not exceeding 15m and where the barrier abuts against gully pits. Expansion joints shall consist of a preformed jointing material of bituminous fibreboard. **Barrier Expansion**
5. In footpaths, median toppings and driveways, unless otherwise shown on the Drawings, expansion joints, 15mm in width for the full depth of paving, shall be constructed at intervals not exceeding 15m and where the pavement abuts against gutters, pits and structures. Expansion joints shall consist of a preformed jointing material of bituminous fibreboard.
6. Unless otherwise specified, all unreinforced paving shall be provided with narrow vertical grooves, 20mm deep to induce contraction joints for the control of cracking.

C271.29 STRENGTH OF CONCRETE

1. When tested in accordance with AS 1012.9, the concrete shall have a compressive strength not less than that shown on the Drawings or if not shown shall have a compressive strength not less than that specified in Table C271.5 for the particular class of work. **Strength Requirement**
2. The strength shall be determined from the average of not less than two specimens, moulded from each class of concrete being used in the work, and selected to represent the whole of the concrete placed at the time of moulding. **Determination of Strength**
3. In general, two pairs of test specimens shall be moulded for each 15 cubic metres of concrete, or part thereof, one pair being intended for the 7 day test if required and the other pair for a 28 day test. **Moulding of Cylinders**

Use	MPa	Minimum Cement per cu metre	Coarse Aggregate Nominal Size	Cylinder Strength Required	
				7 days	28 days
		Kg	mm	MPa	MPa
Foundations, mass retaining walls	20	330	40	15	20
Mass concrete footings, pitching, linings etc.	20	330	20	15	20
Drainage structures, driveways footpaths, New Jersey barrier, miscellaneous minor concrete work	25	330	20	20	25
Reinforced concrete culverts, headwalls, base slabs, sign structure large footings, retaining walls	32	380	20	24	32
Extruded concrete	20	330	14	15	20

Table C271.5 - Concrete Strength Requirements

4. The strengths specified at 28 days shall be increased by multiplying by factors as shown in Table C271.6 for tests at ages in excess of 28 days. **Strength Age Factor**

*Age of test specimen in days of date of testing	Factor
28	1.00
35	1.02
42	1.04
49	1.06
56	1.08
70	1.10
84	1.12
112	1.14
140	1.16
168	1.18
196	1.20
224	1.22
308	1.24
365 and greater	1.25
*For intermediate ages the factor shall be determined on a pro-rata basis	

Table C271.6 - Concrete Age Conversion Factors

5. If the test specimens fail to achieve the specified strength, the Contractor may, with the approval of the Principal Certifying Authority, arrange for cores to be taken from the work. If the average strength of such cores complies with the specified requirements nominated in Table C271.5, the concrete will be accepted. **Cores and Test Acceptance**
6. If cores taken fail to satisfy the strength requirements, the concrete shall be removed. **Failure of Cores**

C271.30 SAMPLING CONCRETE

1. Equipment and facilities shall be provided by the Contractor for the taking and storage of samples of any materials or concrete being used, or intended to be used in the work. **Contractor's Responsibility**
2. Concrete test specimens shall be cylinders 300mm long and 150mm diameter, moulded concurrently in the presence of the Principal Certifying Authority or Principal Certifying Authority's representative, in accordance with AS 1012.8, from samples taken in accordance with AS 1012.1. **Moulding of Test Cylinders**

STEEL REINFORCEMENT FOR CONCRETE

C271.31 MATERIAL

1. Steel reinforcement shall comply with the requirements of the Australian Standards AS/NZS 4671:2001 – Steel Reinforcing Materials. **Standards**
2. The type and size of bars shall be as shown on the Drawings. **Type and Size**
3. Steel reinforcement shall be free from loose or thick rust, grease, tar, paint, oil, mud, millscale, mortar or any other coating, but shall not be brought to a smooth polished condition. **Quality**
4. The Contractor shall supply evidence satisfactory to the Principal Certifying Authority that steel reinforcement complies with AS/NZS 4671:2001 – Steel Reinforcing Materials - Test certificates shall show the results of mechanical tests and chemical analysis. **Documentary Evidence**
5. Where the material cannot be identified with a test certificate, samples shall be taken and

testing arranged by the Contractor. The samples shall be selected randomly and consist of three specimens each at least 1.2 m in length. Sampling and testing shall be at no cost to the Principal Certifying Authority.

6. Plastic bar chairs or plastic tipped wire chairs shall be capable of withstanding a load of 200kg mass on the chair for one hour at $23 \pm 5^{\circ}\text{C}$ without malfunction. The Contractor shall demonstrate that the proposed chairs conform with these requirements. **Bar Chairs**

C271.32 BENDING

1. Reinforcement shall be formed to the dimensions and shapes shown on the Drawings. It shall not be bent or straightened in a manner that will injure the material, and bars with kinks or bends not shown on the drawings will not be accepted. Heating of reinforcement for purposes of bending will only be permitted if uniform heat is applied. Temperature shall not exceed 450°C and the heating shall extend beyond the portion to be bent. Heated bars shall not be cooled by quenching. **Cutting and Bending**

C271.33 SPLICING

(a) General

1. All reinforcement shall be furnished in the lengths indicated on the Drawings. If splicing is required, it shall be in accordance with the provisions of AS/NZS 4671:2001 – Steel Reinforcing Materials. **Plan Lengths**

(b) Lapped Splices

1. Laps in reinforcing bars, wire or fabric shall be as shown on the Drawings. Laps not shown on the Drawings shall be as follows for unhooked bars:- **Lap Dimensions**

Plain bars, Grade R250N	40 bar diameters
Deformed bars, Grade D500L & D500N	35 bar diameters
Hard-drawn wire	50 bar diameters
2. Splices in reinforcing fabric shall be so made that the overlap, measured between outermost transverse wires of each sheet of fabric is not less than the spacing of those wires plus 25mm. **Splice Dimensions**

C271.34 MARKING

1. Bars of identical shape shall be made up in bundles of three and securely tied together by soft iron wire. Each bundle shall have a stout metal label of not less than 40mm diameter attached to it. Each metal label shall be punched with the appropriate marking in accordance with the steel list shown on the drawings. If called for on the Drawings the marking shall incorporate a prefix, and bars with different prefixes shall be stored separately. **Marking Details**

C271.35 STORAGE

1. Reinforcement shall be stored above the surface of the ground and shall be protected from damage and from deterioration by exposure. **Protection of Reinforcement**

C271.36 DELIVERY AND RECEIPT OF REINFORCEMENT

1. Unless the Contractor elects to have the reinforcement inspected at the site, no reinforcement shall be delivered to the site until all tests and inspections have been satisfactorily completed and permission to deliver has been granted by the Principal Certifying Authority. **Test Before Delivery**
2. The Contractor shall give 10 working days' notice to the Principal Certifying Authority for carrying out inspection and testing. The Principal Certifying Authority will carry out the **Notice to Test**

inspection and testing with reasonable expediency, but the Contractor shall not be entitled to an extra as a result of any delays in this connection.

C271.37 PLACING

1. Reinforcement shall be accurately placed as shown on the Drawings and shall be securely held by blocking from the forms, by supporting on concrete or plastic chairs, or metal hangers, and by wiring together at all intersections or at 0.5m centres, whichever is the greater distance, using annealed iron wire of diameter not less than 1.25mm. Steel shall not be supported on metal supports which extend to the surface of concrete, on wooden supports, or on pieces of coarse aggregate. Reinforcement shall have the minimum cover shown on the Drawings. **Reinforcement Position**
2. The Principal Certifying Authority may approve the use of tack welding instead of wire ties on reinforcing wire. Tack welding of cold-worked and hard grade bars shall not be permitted. **Tack Welding**
3. The reinforcement in each section of the work shall be approved by the Principal Certifying Authority before any concrete is deposited in the section and adequate time shall be allowed for inspections and any corrective work which may be required. Notice for inspection shall not be less than four normal working hours. **Inspection Required**
4. Splices shall be staggered where practicable and when not shown on the drawings they shall be arranged as directed by the Principal Certifying Authority. **Splices**
5. Bars forming a lapped splice shall be securely wired together in at least two places, unless welded. **Lapped Splice**
6. The clear cover of any bar, including stirrups, to the nearest concrete surface shall be as shown on the Drawings. Where not so indicated it shall be as stated below: **Bar Cover**
 - (a) Concrete normally in contact only with air
 - (i) Slabs: 40mm
 - (ii) Other than slabs: 45mm
 - (b) Concrete in contact with earth or fresh water
 - (i) Slabs of box culverts: 50mm
 - (ii) Other than culverts: 50mm

In no cases shall the cover be less than 1½ times the diameter of the bar.

BACKFILLING

C271.38 GENERAL

1. Backfilling at barriers, paving, etc, and minor concrete works shall not commence until after the concrete has hardened and not earlier than three days after placing.
2. No filling shall be placed against retaining walls, headwalls or wingwalls within 21 days after placing of the concrete, unless the walls are effectively supported by struts to the satisfaction of the Principal Certifying Authority, or when the Contractor can demonstrate that 85 per cent of the design strength of the concrete has been achieved. **Adjacent to Walls**
3. Selected backfill shall be placed against retaining walls and cast-in-place box culverts for a horizontal distance equal to one-third of the height of the wall. It shall consist of granular material, free from clay and stone larger than 50mm gauge. The Plasticity Index of this selected backfill material shall not be less than 2 or more than 12 when tested in accordance with AS 1289.3.3.1. The material shall be placed in layers not exceeding 150mm and shall be compacted to provide a relative compaction of not less than 92 per cent as determined by AS 1289.5.4.1 for modified compactive effort. **Selected Backfill**

C271.39 TREATMENT AT WEEPHOLES

1. Drainage adjacent to weepholes shall be provided by either a layer of broken stone or river gravel consisting of clean, hard, durable particles graded from 50mm to 10mm such that:

Size & Type of Backfill Material

 - (a) The maximum particle dimension shall not exceed 50mm
 - (b) No more than 5 per cent by mass shall pass the 9.5mm A.S. sieve.
2. The broken stone or river gravel, enclosed in a filter fabric suitable for drainage without scour, shall be continuous in the line of the weepholes, extend at least 300mm horizontally into the fill and extend at least 450mm vertically above the level of the weepholes.

Extent of Material
3. Alternatively the Contractor may provide a synthetic membrane of equivalent drainage characteristics. It shall be stored and installed in accordance with Manufacturer's instructions. The use of a synthetic membrane shall be subject to the Principal Certifying Authority's approval.

Synthetic Membrane

SPRAYED CONCRETE**C271.40 GENERAL**

1. Sprayed concrete is concrete pneumatically applied at high velocity on to a surface. Application may be either a wet or dry process. A sound homogeneous product shall be provided with surface finish reasonably uniform in texture and free from blemishes.

Definition
2. The minimum depth of sprayed concrete to be applied shall be 75mm.

Depth
3. Sprayed concrete lining in open drains shall be coloured to match the adjoining rock colour.

Colour
4. Sprayed concrete shall have a minimum cement content of 380 kg/m³ as discharged from the nozzle and shall have a minimum compressive strength of 25 MPa at 28 days when tested by means of 75mm diameter cores taken from in-place sprayed concrete.

Strength
5. Cores shall be secured, accepted, cured, capped and tested in accordance with AS 1012.14. Equipment and facilities shall be provided by the Contractor for the taking of cores from the work. The Contractor shall arrange for a laboratory with appropriate NATA registration for the curing and testing of the cores. Copies of test results shall be forwarded to the Principal Certifying Authority.

Test Cores
6. At least 14 days prior to applying any sprayed concrete the Contractor shall submit to the Principal Certifying Authority details of his proposed procedure, plant, materials and mix proportions. Materials shall comply with AS 3600.

Contractor's Responsibility

C271.41 TEST PANELS

1. If so required by the Principal Certifying Authority, the Contractor shall prepare at least 3 test panels for each mix proposed, in conditions similar to those in the works and in the presence of the Principal Certifying Authority. The test panels shall be made by applying a 75mm thickness of sprayed concrete to a hardboard panel approximately 750mm square. The sprayed concrete shall be applied to the panels in the same manner, using materials including steel reinforcing fabric, equipment, pressures and curing that will be used in the Works. The panels shall be submitted to the Principal Certifying Authority for examination not less than 10 days before applying concrete.

Test Panels
2. The Contractor shall cut four 75mm diameter cores from one test panel for each proposed mix approximately 48 hours after the panel has been sprayed. The cores shall be tested as for cores from in-place sprayed concrete. One core shall be compression tested at 3 days, one core at 7 days and the remaining two cores at 28 days.

Cores

3. Should any of the cores reveal defects such as lack of compaction, dry patches, voids or sand pockets or should the test panel exhibit an unacceptable surface finish, the Contractor shall modify the mix design and/or method of placement and prepare fresh test panels for testing and inspection. **Defective Core**
4. Sprayed concrete shall not be applied to the Works until the Contractor produces test panels for the approval of the Council. **Approval**

C271.42 SURFACE PREPARATION

1. Earth surfaces shall be graded, trimmed and compacted and shall be dampened prior to applying the sprayed concrete. The Contractor shall take any precautions necessary to prevent erosion when the sprayed concrete is applied. **Earth**
2. Rock surfaces shall be cleaned of loose material, mud and other foreign matter that might prevent bonding of the sprayed concrete onto the rock surface. The rock surface shall be dampened prior to applying the sprayed concrete. **Rock**
3. Corrugated steel pipes shall be cleaned of loose material, mud and any other foreign matter. **Steel Pipes**
4. The Contractor shall remove free water and prevent the flow of water which could adversely affect the quality of the sprayed concrete. **Water Flow**

C271.43 APPLICATION OF SPRAYED CONCRETE

1. Application shall begin at the bottom of the area being sprayed and shall be built up making several passes of the nozzle over the working area. The nozzle shall be held so that the stream of material shall impinge as nearly as possible perpendicular to the surface being coated. The velocity of discharge from the nozzle, the distance of the nozzle from the surface and the amount of water in the mix shall be regulated so as to produce a dense coating with minimum rebound of the material and no sagging. Rebound material shall be removed after the initial set by air jet or other suitable means from the surface as work proceeds and disposed of. **Procedure**
2. Spraying shall be discontinued if wind causes separation of the nozzle stream. **Wind Problem**
3. Concrete shall not be sprayed in air temperatures less than 5°C. **Air Temperature**
4. Construction joints shall be kept to a minimum. A joint shall be formed by placing or trimming the sprayed concrete to an angle between 30° and 45° to the sprayed concrete surface. The joint edge shall be cleaned and wetted by air-water jet before recommencing concrete spraying. **Construction Joints**
5. When spraying around reinforcement, concrete is to be sprayed behind the reinforcement before concrete is allowed to accumulate on the face of the reinforcement. **Spraying around Reinforcement**
6. Adjoining surfaces not requiring sprayed concrete shall be protected from splash and spray rebound. Splash or rebound material on these adjoining surfaces shall be removed by air-water jet or other suitable means as work proceeds. **Protection of Adjoining Surfaces**

C271.44 CURING

1. Curing shall commence within one hour of the application of sprayed concrete and may be by water or by colourless wax emulsion curing compound complying with AS 3799 and applied in accordance with manufacturer's specifications. **Commencement**
2. In water curing, the surface of the sprayed concrete shall be kept continuously wet for at least seven days. **Water Curing**

LIMITS AND TOLERANCES

C271.45 SUMMARY OF LIMITS AND TOLERANCES

1. The tolerances applicable to the various clauses in this Specification are summarized in Table C271.7 below:

Item	Activity	Tolerances	Spec Clause
1.	Subgrade (a) Relative Compaction	³ 100% (standard compactive effort)	C271.03
2.	Barriers, Footpaths etc. (a) Finished Subbase	To be trimmed and compacted so that the levels do not vary more than 12mm under a straight-edge 3 metres long.	C271.04
	(b) Relative Compaction of Subbase	95% (modified compactive effort)	C271.04
3.	Formwork (a) Position of Forms	Forms shall be aligned accurately so that departure of the forms from the surfaces specified on the Drawings shall not exceed 1/300 of the space between supports for any surface visible in the completed work and 1/150 for hidden work.	C271.11
4.	Fine Aggregate (a) Grading	To be evenly graded within the absolute limits and shall not deviate from the grading of sample aggregate as per Table C271.1.	C271.14
5.	Coarse Aggregate (a) Percentage of wear	Loss of weight shall not exceed 30%	C271.15
	(b) Crushing Value	Crushing value shall not exceed 25%	C271.15
	(c) Soundness	The loss of mass when tested with sodium sulphate shall not exceed 12%	C271.15
	(d) Particle Shape	The proportion of mis-shapen particles (2:1 ratio) shall not exceed 35%	C271.15
	(e) Grading	To be evenly graded within the absolute limits and shall not deviate from the grading of sample aggregate as per Table C271.2.	C271.15
6.	Aggregate Moisture Content	Where moisture content of fine aggregate exceeds 8%, or moisture content of coarse aggregate exceeds 3%, the proportion of mix shall be changed.	C271.19

Item	Activity	Tolerances	Spec Clause
7.	Consistency	In accordance with AS 1012.3, Method 1 the slump shall not exceed the nominated slump $\pm 15\text{mm}$.	C271.21
		In the case of concrete placed by extrusion machine, the slump will be between 10mm and 15mm.	C271.21
8.	Ready-Mixed Concrete		
	(a) Mixing & Delivery	The time taken from the introduction of water until the concrete is completely discharged shall be not more than 1.5 hours.	C271.22
		Where non-agitating equipment is used the concrete shall be completely discharged not more than 30 minutes after the addition of water.	
9.	Placing & Compacting of Concrete	Concrete shall not be placed without the approval of the Principal Certifying Authority if the air temperature within 24 hours is likely to be below 5°C or the shade temperature is likely to exceed 38°C .	C271.23
10.	Finishing of Unformed Concrete Surfaces		
	(a) Wearing Surface	To be finished true and uniform so that departure from designed grade shall not exceed 5mm in any 3 metre length.	C271.24
	(b) Finished Level	The finished levels of concrete structures not adjacent to road pavements shall not vary more than 25mm from the specified levels.	C271.24
		In the case of drainage pits and other structures adjacent to road pavements the finished concrete level shall not vary more than 10mm from the specified level and alignment.	C271.24

Table C271.7 - Summary of Limits and Tolerances

DEVELOPMENT CONSTRUCTION SPECIFICATION

CQC

QUALITY CONTROL REQUIREMENTS

AMENDMENT RECORD FOR THIS SPECIFICATION PART

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part. The clause numbering and context of each clause are preserved. New clauses are added towards the rear of the specification part as special requirements clauses. Project specific additional script is shown in the specification as italic font.

The amendment code indicated below is 'A' for additional script 'M' for modification to script and 'O' for omission of script. An additional code 'P' is included when the amendment is project specific.

Amendment Sequence No.	Key Topic addressed in amendment	Clause No.	Amendment Code	Author Initials	Amendment Date
1	<i>Reference to Deed of Agreement and Bank Guarantee removed</i>	<i>Annex A</i>	<i>M</i>	<i>MB</i>	<i>10/10/07</i>

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SPECIFICATION CQC
QUALITY CONTROL REQUIREMENTS
GENERAL

CQC1 SCOPE

1. This Specification covers the requirements for the quality control testing by the Contractor; including the minimum test frequencies to be employed to demonstrate conformance to the requirements of the technical specifications. **Testing**

CQC3 SAMPLING AND TESTING

1. Sampling shall be undertaken in a random and unbiased manner and as approved by the Principal Certifying Authority. **Sampling Locations**
2. Sampling and testing shall be carried out by a NATA registered laboratory accredited for those test methods and sampling procedures. Sampling shall be conducted by personnel from the NATA registered laboratory which has been accredited for that sampling procedure and shall be supervised by the approved signatory from that laboratory. Test results shall be reported on NATA endorsed test documentation which shall include a statement by the approved signatory certifying that the correct sampling procedures have been followed. **Sampling and Testing**

CQC5 RECORDS

1. Conformance records shall be stored and maintained such that they are readily retrievable and in facilities that provide a suitable environment to minimise deterioration or damage and to prevent loss. **Storage**
2. The Contractor shall submit all conformance records to the Principal Certifying Authority for inspection and approval. **Copies of Records**

ANNEXURE CQC-A

TESTING REPORTING AND HOLD POINTS

Serial	Item/Activity	Hold Point	Inspections / test results to be submitted to the PCA prior to approval to proceed to next activity	Notice Required
COMMENCEMENT OF WORKS ON SITE				
1	Site establishment	Pre-Construction Meeting	PCA, Contractor, Developer's Project Manager to attend Pre-Construction meeting on site. The Contractor is to: a. nominate the site supervisor for the project, b. nominate sources and suppliers of all materials, and c. provide written evidence that the Contractor has current Public Liability Insurance and Workers Compensation Insurance with Council nominated as interested party.	2 days
2	Commencement of earthworks	Soil & Water Management Measures installed Soil & Water Management Measures inspected and approved by the PCA	Field inspection by PCA. (Contractor and Developer's Project Manager to attend)	1 day
EARTHWORKS				
3	Placing fill on roads and/or lots	Stripped areas inspected and approved by PCA	Field inspection by PCA and Geotechnical Engineer	1 day
ROAD CONSTRUCTION				
4	Subbase	Service Conduit Plan submitted to PCA Subgrade Approved by PCA	Subgrade CBR & Pavement Design Compaction Density Test results Proof Roll (Contractor's site supervisor shall be in attendance) Material grading results	3 days
5	Kerb & Gutter	Subbase Approved by PCA	Compaction Density Test results Proof Roll (Contractor's site supervisor shall be in attendance) Thickness check	2 days
6	Base	Kerb & Gutter Completed Subbase approved by PCA	Compaction Density Test results Proof Roll (Contractor's site supervisor shall be in attendance) Thickness check Material Grading results	2 days
7	Seal	Base Approved by PCA	Compaction Density Test results Proof Roll (Contractor's site supervisor shall be in attendance) Thickness check Benkelman Beam Testing	2 days

SUBSOIL DRAINAGE				
8	Excavation for subsoil drainage lines	Subsoil drainage plan approved by PCA.		1 day
9	Backfill trench to subgrade level	Bedding and subsoil drainage pipe in trench inspected and approved by PCA	Field inspection Material quality results	1 day
STORMWATER PIPELINES				
10	Pipe laying	Bedding placed & compacted Manufacturer's certification for pre-cast products	Compaction Density test results for bedding Field inspection by PCA Submit manufacturer's certification for pre-cast products to PCA	1 day
11	Backfill haunch and side zone	Pipes inspected & approved by PCA	Field inspection of uncovered pipes in trench by PCA	1 day
12	Backfill to FSL or subgrade	Backfill to haunch zone approved by PCA	Field inspection by PCA Compaction Density test results for backfill	1 day
DRAINAGE STRUCTURES				
13	Place concrete for pits, headwalls or culvert base slabs	Formwork & reinforcement approved by PCA Manufacturer's certification for pre-cast products	Field inspection of formwork & reinforcement by PCA. Submit manufacturer's certification for precast units to PCA	1 day
OVERLAND FLOWPATHS				
14	Topsoil & turfing	Shape & grade approved by the PCA	Field inspection by PCA	1 day
ACCESSWAYS				
15	Place subbase course	Subgrade approved by PCA	Proof roll Compaction Density Test results where required by the PCA	1 day
16	Place formwork	Subbase inspected and approved by the PCA	Field inspection by PCA	1 day
17	Place concrete	Formwork & reinforcement inspected and approved by PCA	Field inspection by PCA	1 day
CONCRETE FOOTPATHS AND CYCLEWAYS				
18	Placing formwork	Formation boxed out	Field inspection by PCA	1 day
19	Place concrete	Formwork & reinforcement inspected and approved by PCA	Field inspection by PCA	1 day
PRACTICAL COMPLETION				
20	Practical Completion	Practical completion meeting and inspection	Field inspection by PCA. Contractor & Developer's Project Manager to attend. Work as Executed Plan to be provided.	5 days

ANNEXURE CQC-B

MINIMUM TEST FREQUENCIES

GENERAL

- The minimum test frequencies are specified in the following tables:

Contents of Annexure CQC-B

Item	Sub-Annexure	Reference Specification	Sub-Annexure Heading
1	B1	C213	Earthworks
2	B2	C220 C221 C222 C223 C224	Stormwater Drainage - Pipe Culverts, Box Culverts, Open Drains, Kerb & Gutter, Drainage Structures
3	B3	C230 C231 C232 C233	Subsurface Drainage
5	B5	C242	Flexible Pavements
6	B6	C244	Sprayed Bituminous Surfacing
7	B7	C245	Asphaltic Concrete
9	B9	C247	Mass Concrete Subbase
10	B10	C248	Plain or Reinforced Concrete Base
12	B12	C254	Segmental Paving
13	B13	C271	Minor Concrete Works
14	B14	C261	Pavement Markings

SUB-ANNEXURE B1

EARTHWORKS (SPECIFICATION C213)

ACTIVITY	KEY QUALITY VERIFICATION REQUIREMENTS	MINIMUM TEST FREQUENCY	TEST METHOD
Floor of Cuttings	Material Quality - CBR	Sufficient tests to assess the material variability with not less than 1 test per 100 lin m or 500 m ² (which ever yields the greater No of tests) AND not less than 1 test in any section of pavement	AS1289.F1.1
	Compaction (Residential, Commercial, Industrial)	1 test per 50 lin m or 250 m ² (which ever yields the greater No of tests) with not less than 2 tests in any section of pavement	AS1289.5.4.1
	Compaction (Rural)	1 test per 100 lin m or 500 m ² (which ever yields the greater No of tests with not less than 2 tests any section of pavement	AS1289.5.4.1
Foundation for Embankments and site filling	Compaction	1 test per 100 lin m or 500 m ² (which ever yields the greater No of tests) per layer with not less than 1 test in any section of pavement	AS1289.5.4.1
Lot Filling	Material Quality Compaction / Moisture Content	Level 1 Geotechnical Control	As required by Geotechnical Engineer
Embankments - General	Material Quality	Level 1 Geotechnical Control	As required by Geotechnical Engineer
	Compaction/Moisture Content	Level 1 Geotechnical Control	As required by Geotechnical Engineer
- Select Material Zone (includes subgrade)	CBR	Sufficient tests to assess the material variability with not less than 1 test per 100 lin m or 500 m ² (which ever yields the greater No of tests) AND not less than 1 test in any section of pavement	AS1289.F1.1
	Compaction/Moisture Content (Residential, Commercial, Industrial)	1 test per 50 lin m or 250 m ² (which ever yields the greater No of tests) per layer with not less than 2 tests per layer in any section of pavement	AS1289.5.1.1, AS1289.5.4.1 AS1289.5.7.1
	Compaction/Moisture Content (Rural)	1 test per 100 lin m or 500 m ² (which ever yields the greater No of tests) per layer with not less than 2 tests per layer in any section of pavement	AS1289.5.1.1, AS1289.5.4.1 AS1289.5.7.1
Fill Adjacent to Structures: Bridges, Retaining Walls and Cast-in-Situ Culverts	Material Quality - Maximum Particle Size - Plasticity Index	1 per 400m ³ * 1 per 400m ³ *	AS1289.3.3.1
	Compaction/Moisture Content	1 per layer	AS1289.5.1.1, AS1289.5.4.1 AS1289.5.7.1

* Note: or part thereof.

SUB-ANNEXURE B2

**STORMWATER DRAINAGE - PIPE CULVERTS, BOX CULVERTS, OPEN DRAINS
INCLUDING KERB & GUTTER, DRAINAGE STRUCTURES
(SPECIFICATIONS C220, C221, C222, C223, C224)**

ACTIVITY	KEY QUALITY VERIFICATION REQUIREMENTS	MINIMUM TEST FREQUENCY	TEST METHOD
Supply of Precast Units	Precast Quality	Manufacturer's documentary evidence and certification for each type/size/class per delivery	Manufacturer's Certification. Field Inspection at delivery
Foundations	Compaction		AS1289.5.4.1
	Pipe lines	1 per 50 lin m with not less than one test per section of pipeline	
	Box & Pipe Culverts	1 per 50 m2 with not less than one test	
	Arches	1 per 50 m2 with not less than one test per abutment	
	Headwalls	1 per structure	
Bedding	Material Quality		
	- Particle Size Distribution	1 per 400m ³ *	AS1141.11
	- Compaction/Moisture Content	1 per 50 lin m with not less than one test per section of pipeline	AS1289.5.7.1, AS1289.5.4.1
Selected Backfill	Material Quality		
	- Maximum Particle Size	1 per 400m ³ *	
	- Plasticity Index	1 per 400m ³ *	AS1289.3.3.1
	- Compaction/Moisture Content		AS1289.5.7.1, AS1289.5.4.1
	Pipe lines	1 per 2 layers per 50 lin m with not less than one test per 2 layers per section of pipeline	
	Box & Pipe Culverts	1 per 2 layers per 50 m2 with not less than one test	
	Arches	1 per 2 layers per 50 m2 with not less than one test	
Rock Fill for Gabions/ Wire Mattresses	Material Quality:		
	- Particle Size Distribution	1 per project	AS1141.11
	- Wet Strength	1 per project	AS1141.22
	- Wet/Dry Strength Variation	1 per project	AS1141.22

* Note: or part thereof, per lot.

SUB-ANNEXURE B3
SUBSURFACE DRAINAGE (SPECIFICATIONS C230, C231, C233)

ACTIVITY	KEY QUALITY VERIFICATION REQUIREMENTS	MINIMUM TEST FREQUENCY	TEST METHOD
Material Supply	Material Quality - Supplier's documentary evidence and certification of:		
	Pipe	1 per type/size/project	
	Filter Material		
	- Grading	1 per 400m3	AS1141.11
	- Coefficient of Permeability (Type B)	1 per 400m3	AS1289.E5.1 ASTM-D2434-68
	- Grading Variation after Treatment (Type B)	1 per 400m3	AS1141.11
	Geotextile	1 per type/project	
Bedding and Backfill of Drainage Blankets	Compaction of <ul style="list-style-type: none"> - Filter material - Selected backfill - Earth backfill 	Level 1 Geotechnical Control	As required by Geotechnical Engineer

* Note: or part thereof, per lot

SUB-ANNEXURE B5

FLEXIBLE PAVEMENTS (SPECIFICATION C242)

ACTIVITY	KEY QUALITY VERIFICATION REQUIREMENTS	MINIMUM TEST FREQUENCY	TEST METHOD
Base and Subbase Supply	Material Quality - Supplier's documentary evidence and certification		
	- Particle Size Distribution	1 per 1,000t	AS1289.3.6.1
	- Fine Particle Size Distribution Ratio	1 per 1,000t	AS1289.3.6.3
	- Liquid Limit	1 per 1,000t	AS1289.3.1.1
	- Plastic Limit	1 per 1,000t	AS1289.3.3.1
	- Plasticity Index	1 per 1,000t	AS1289.3.3.1
	- Maximum Dry Compressive Strength	1 per 5,000t	T114
	- Particle Shape	1 per 1,000t	AS1141.14
	- Aggregate Wet Strength	1 per 5,000t	AS1141.22
	- Wet/Dry Strength Variation	1 per 5,000t	AS1141.22
	- Modified Texas Triaxial Classification	1 per contract	T171
	- Unconfined Compressive Strength (Modified)	1 per 5,000t	T116
	- Unconfined Compressive Strength (Bound)	1 per mix design	T131
Placement	Geometry	1 Cross Section per 15m 10 per 100 lin m* per lane	Survey 3m Straight Edge
	Deflection Control - Benkelman Beam	maximum spacings of 10 metres (alternating wheel paths) in each lane, with not less than 4 measurements per any one length of road.	T160
	Compaction/Moisture Content (Residential, Commercial, Industrial)	1 test per 50 lin m or 250 m ² (which ever yields the greater No of tests) per layer with not less than 2 tests per layer in any section of pavement	AS1289.5.2.1, T130, AS1289.5.4.1 AS1289.5.8.1
	Compaction/Moisture Content (Rural)	1 test per 100 lin m or 500 m ² (which ever yields the greater No of tests) per layer with not less than 2 tests per layer in any section of pavement	AS1289.5.2.1, T130, AS1289.5.4.1 AS1289.5.8.1

* Note: or part thereof

SUB-ANNEXURE B6

SPRAYED BITUMINOUS SURFACING (SPECIFICATION C244)

ACTIVITY	KEY QUALITY VERIFICATION REQUIREMENTS	MINIMUM TEST FREQUENCY	TEST METHOD
Material Supply	Material Quality - Suppliers documentary evidence and certification of:		
	- Class 170 Bitumen	1 per tanker load	
	- Refinery Cutback Bitumen	1 per tanker load	
	- Polymer Modified Binder	1 per tanker load	
	- Bitumen Adhesion Agent	1 per delivery	
	- Cutback Oils	1 per delivery/tanker	
	- Aggregate Precoating Agent	1 per delivery/tanker	
	- Aggregate	1 per 400m ³	AS2758.2
Application Rates	Binder	Calculate per spray run	
	Aggregate	Calculate per spray run	

† One per Contract or change in material

* Note: or part thereof

SUB-ANNEXURE B7

ASPHALTIC CONCRETE (SPECIFICATION C245)

ACTIVITY	KEY QUALITY VERIFICATION REQUIREMENTS	MINIMUM TEST FREQUENCY	TEST METHOD
Material Supply	Material Quality - Suppliers documentary evidence and certification of:		
	<ul style="list-style-type: none"> - Coarse & Fine Aggregates <ul style="list-style-type: none"> · Grading 1 per day AS1141.11 · Moisture Content 1 per day AS1289.2.1.1 · Wet Strength) AS1141.22 · 10% Fines Wet/Dry) 1 per AS1141.22 · Particle Shape) contract AS1141.14 · Fractured Faces) or change in AS1141.18 · Resistance to Stripping) material T230 · Polishing Agg Friction Value) AS1141.41 - Mineral Filler contract or 1 per month's production - Class 170/320 Bitumen AS2341.2 <ul style="list-style-type: none"> · Viscosity at 60°C 1 per tanker load AS2341.12 · Penetration at 15°C 1 per contract or change in supplier AS2008 · Viscosity at 135°C " AS2341.14 · Flash point (°C) " AS2341.8 · Insoluble matter " AS2008 · Rolling thin film oven test " AS2341.11 <ul style="list-style-type: none"> (a) Ductility, residue, 15°C AS2341.2 (b) Viscosity, residue, 60°C or " AS2008, (c) App. viscosity, residue, 25°C " AS2341.5 · Thin film oven test (1.6mm) " AS2008 (a) Ductility, residue, 25°C AS2341.11 · Density at 15°C " AS2341.7 · Water Content and Foaming at 175°C T501 - Scrap Rubber/C170 Bitumen Mixture <ul style="list-style-type: none"> · Minimum Recovery 1 per tanker load T1180 - Polymer Modified Bitumen <ul style="list-style-type: none"> (i) SBS Modified Bitumens <ul style="list-style-type: none"> · Elasticity Recovery at 60°C 1 per tanker load T741 · Viscosity on ER at 60°C " T741 · Torsional Recovery at 25°C " T739 · Viscosity at 135°C 1 per grade per contract or change AS2341.3 · Segregation in supplier T740 · Flash Point (°C) " AS2341.14 · Softening Point (°C) " AS2341.18 · Ductility 4°C after RTFO " AS2341.10 · Penetration at 25°C " AS2341.11 ASTM, D5 (ii) EVA Modified Bitumens <ul style="list-style-type: none"> · Elasticity Recovery at 45°C 1 per tanker load T741 · Viscosity by Elastomer at 45°C " T741 T739 		

ACTIVITY	KEY QUALITY VERIFICATION REQUIREMENTS	MINIMUM TEST FREQUENCY	TEST METHOD
	<ul style="list-style-type: none"> · Torsional Recovery at 25oC · Softening Point (°C) · Viscosity at 135°C · Ductility 4°C after RTFO · Penetration at 25°C 	1 per grade per contract or change in supplier	AS2341.18 AS2341.3 AS2341.10 AS2341.11 ASTM D5
	- Bitumen Adhesion Agent	1 per contract or change in material	T230
	· Resistance to Stripping		
	- Scrap Rubber	1 per contract or change in supplier	
	<ul style="list-style-type: none"> · Grading · Shape/Length · Foaming (%) · Moisture Content (%) · Iron Content (%) · Bulk Density (%) 	" " " " "	T734 T731 T732 T733
	- Bitumen Emulsion	1 per tanker load/bulk delivery	AS1160
Mix Design	Approval of mix and NATA certification. Supplier's documentary evidence and certification	1 per mix	
Production Mix	Temperature Sampling Moisture Content Grading Binder Content Voids in Compacted Mix Maximum Theoretical Density	1 per truck load 1 per 50t 1 per 100t* 1 per 100t* 1 per 100t* 1 per 100t* 1 per 100t*	Measure AS2150 AS2891.3.1 AS2891.3.1 T601 AS1507 AS1507
Laying	Temperature Levels Surface Quality Relative Compaction/Layer Thickness	1 per truck load 1 cross section per 25m 10 per 200m* lane length 6 cores per lot 10 nuclear density tests per lot	Measure Survey 3m Straight Edge T601

* Note: or part thereof

SUB-ANNEXURE B9
MASS CONCRETE SUBBASE (SPECIFICATION C247)

ACTIVITY	KEY QUALITY VERIFICATION REQUIREMENTS	MINIMUM TEST FREQUENCY	TEST METHOD
Concrete Supply			
	Concrete/Air Temperature	1 per 50m ³	Measure
	Air Content	1 per 50m ³	AS1012.4 Method 2
	Consistency - Slump	1 per load	AS1012.3 Method 1
	Compressive Strength (7 day)	1 pair per 50m ³	AS1012.1 AS1012.8 AS1012.9
	Compressive Strength (28 day)	1 pair per 50m ³	AS1012.1 AS1012.8 AS1012.9
Placement	Thickness	5m grid on plan area	Survey and
	Geometry	1 cross section per 15m	Survey and 3m Straight Edge
Curing	Material Quality - Supplier's documentary evidence and certification	1 per production batch	AS3799 AS1160
	Application Rate	1 per 1000m ² *	
Joints	Geometry	All joints	Survey

* Note: or part thereof, per lot

SUB-ANNEXURE B10
PLAIN OR REINFORCED CONCRETE BASE (SPECIFICATION C248)

ACTIVITY	KEY QUALITY VERIFICATION REQUIREMENTS	MINIMUM TEST FREQUENCY	TEST METHOD
Concrete Supply			
	Concrete/Air Temperature	1 per 50m ³	Measure
	Air Content	1 per 50m ³	AS1012.4 Method 2
	Consistency - Slump	1 per load	AS1012.3 Method 1
	Compressive Strength (7 day)	1 pair per 50m ³	AS1012.1 AS1012.8 AS1012.9
	Compressive Strength (28 day)	1 pair per 50m ³	AS1012.1 AS1012.8 AS1012.9
Placement	Relative Compaction		
	- Machine Placed	1 per 50m ³ *	AS1012.14
	- Hand Placed	2 per 50m ³	AS1012.14
	Thickness	5m grid on plan area	Survey
	Geometry	1 cross section per 15m	Survey and 3m Straight Edge
Ride Quality	Profile Factor	All lanes	3m Straight Edge
Surface Texture	Texture Depth	2 per 50m ³	T240
Curing	Material Quality - Supplier's documentary evidence and certification	1 per production batch	AS3799 AS1160
	Application Rate	1 per 1000m ² *	
Joints	Sealant Material Quality Supplier's documentary evidence and certification	1 per prod'n batch	
	Geometry	All joints	Survey

* Note: or part thereof

SUB-ANNEXURE B12

SEGMENTAL PAVING (SPECIFICATION C254)

ACTIVITY	KEY QUALITY VERIFICATION REQUIREMENTS	MINIMUM TEST FREQUENCY	TEST METHOD
Materials Supply	Material Quality - Supplier's documentary evidence and certification of:		
	- Concrete Segmental Paving Units	1 per supplier/project	
	- Clay Segmental Paving Units	1 per supplier/project	
	- Bedding Sand · Grading	1 per supplier/project or change in material	AS1141.11
	- Joint Filling Sand · Grading	1 per supplier/project or change in material	AS1141.11
	- Joint Filler	1 per supplier/project	
Base	Geometry	One cross section per 25m	Survey
	Surface Quality	10 per 200m ² or lot	3m Straight Edge
Edge Restraints	Refer 'Minor Concrete Works'	1 per 10 lin m	Measure/Survey
Laying Paver Units	Joint Width	All joints	Measure
	Geometry	One cross section per 15m	Survey
	Surface Quality	10 per 200m ² or lot	3m Straight Edge

* Note: or part thereof, per lot

SUB-ANNEXURE B13

MINOR CONCRETE WORKS (SPECIFICATION C271)

ACTIVITY	KEY QUALITY VERIFICATION REQUIREMENTS	MINIMUM TEST FREQUENCY	TEST METHOD
Subgrade	Compaction	1 per 50 lin m and not less than one test per section	AS1289.5.4.1
Gravel Subbase Construction	Compaction	1 per 50 lin m and not less than one test per section	AS1289.5.4.1
	Subbase Geometry	1 per 25 lin m	3m Straight Edge
Steel Supply	Material Quality - Suppliers documentary evidence and certification	1 per production batch	
Ready-Mixed Concrete Supply	Material Quality - Suppliers documentary evidence and certification	1 per mix type	
	Consistency - Slump	1 per load	AS1012.3 Method 1
	Compressive Strength (7 and 28 day)	2 pairs per 15m ³	AS1012.1, AS1012.8, AS1012.9
Concrete Placement	Finished Levels	1 cross section per 15m	Survey and 3m Straight Edge
Backfilling	Material Quality		
	Maximum particle size	1 per 200m ³	T106
	Plasticity Index	1 per 200m ³	AS1289.3.3.1
	Compaction	1 per 200m ²	AS1289.5.4.1
Sprayed Concrete	Compressive Strength Cores	2 per 15m ³	AS1012.4, AS1012.9 AS1012.14
	Curing Material Quality - Supplier's documentary evidence and certification	1 per production batch	

* Note: or part thereof

Reference Documents

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D1.03 REFERENCE AND SOURCE DOCUMENTS

The following reference document list is not exhaustive and it is the responsibility of the designer to maintain awareness of amendments and changes to Australian Standards and other relevant documents.

(a) Council Specifications

All Specifications for Design and Construction, relevant Development Control Plans (DCP), including but not limited to DCP 49 and 6, and Local Area Traffic Management Plans (LATM).

(b) Australian Standards

AS 2890.1 Parking facilities: Off-street car parking

(c) State Authorities

Roads and Traffic Authority NSW - Road Design Guide

Department of Housing - Road Manual, 1987

(d) Other

AUSTROADS Guide to the Geometric Design of Rural Roads
 Guide Policy for the Geometric Design of Major Urban Roads
 Guide to Traffic Engineering Practice:
 PART 5: Intersections at Grade
 PART 6: Roundabouts
 PART 10: Local Area Traffic Management
 PART 13: Pedestrians
 PART 14: Bicycles

D2.03 REFERENCE AND SOURCE DOCUMENTS

(a) State Authorities

Roads and Traffic Authority, NSW - Sprayed Sealing Guide, 1992

(b) Other

AUSTROADS	-	Pavement Design, A Guide to the Structural Design of Road Pavements, 1992.
AUSTROADS	-	Guide to Control of Moisture in Roads
APRG No 21	-	A Guide to the Design of New Pavements for Light Traffic (A supplement to AUSTROADS Pavement Design, Jan 1998
CACA - T33	-	Cement and Concrete Association, T33 - Concrete Street and Parking Area Pavement Design, 1984
CACA - T35	-	Cement and Concrete Association, T35 - Interlocking Concrete Road Pavements, A Guide to Design and Construction, 1986
CACA - TN52	-	Cement and Concrete Association, TN52 - Single-Lane Concrete Bus Bays, 1984

D3.04 REFERENCE AND SOURCE DOCUMENTS

(a) Council Specifications

D1	-	Geometric Road Design
D2	-	Stormwater Drainage Design

(b) Australian Standards

AS1170	-	Minimum design loads on structures (SAA Loading Code)
AS1684	-	National Timber Framing Code
AS3600	-	Concrete structures
AS3700	-	Masonry in buildings (SAA Masonry Code)
AS4100	-	Steel structures

Other relevant codes and guidelines with the above

(c) Other

AUSTROADS	-	Bridge Design Code
I. E. Aust.	-	Australian Rainfall and Runoff
KD Nelson	-	Design and Construction of Small Earth Dams

D4.04 REFERENCE AND SOURCE DOCUMENTS**(a) Council Specification**

C230	-	Subsurface Drainage - General
C231	-	Subsoil and Foundation Drains
C232	-	Pavement Drains
C233	-	Drainage Mats

(b) Australian Standards

AS2439.1	-	Perforated drainage pipe and associated fittings
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(c) RTA Specifications

MR Form 1160	-	Supply and Delivery of Seamless Tubular Filter Fabric
3555	-	Slotted Fibre Reinforced Concrete Pipe for Subsurface Drainage

(d) Other

AUSTROADS	-	Guide to the Control of Moisture in Roads, 1983
ARRB-SR35	-	Australian Road Research Board, Special Report No. 35 - Subsurface Drainage of Road Structures, Gerke R.J., 1987
APRG-No 21	-	AUSTROADS Pavement Research Group, Report No. 21 - A Guide to the Design of New Pavements for Light Traffic. A Supplement to AUSTROADS Pavement Design. AUSTROADS 1998

D6.03 REFERENCE AND SOURCE DOCUMENTS**(a) Council Specifications****Construction Specifications**

C212	-	Clearing and Grubbing
C213	-	Earthworks

Design Specifications

D1	-	Geometric Road Design
D5	-	Stormwater Drain Design Code

(b) Australian Standards

AS 3798	-	Guidelines on earthworks for commercial and residential developments
AS 2870.1	-	Residential slabs and footings - Construction.

(c) Other Publications

Managing Urban Stormwater, Soils and Construction – Vol 1 - 4th Edition

D9.03 REFERENCE AND SOURCE DOCUMENTS**(a) Council Specifications**

D1	-	Geometric Road Design
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(b) Australian Standards

AS 1742	-	Manual of uniform traffic control devices
AS 2890.3	-	Bicycle parking facilities

(c) Other

AUSTROADS	-	Guide to Traffic Engineering Practice - PART 13 Pedestrians, PART 14 Bicycles
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C213.02 REFERENCE DOCUMENTS

- Documents referenced in this specification are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Council Specifications

C201	-	Control of Traffic
C211	-	Control of Erosion and Sedimentation
C212	-	Clearing and Grubbing
C220	-	Stormwater Drainage - General
C273	-	Landscaping

(b) Australian Standards

AS 1289.F1.1	-	Determination of the California Bearing Ratio of a soil - Standard laboratory method for a remoulded specimen
AS 1289.3.3.1	-	Calculation of the plasticity index of a soil
AS 1289.5.1.1	-	Determination of the dry density/moisture content relation of a soil using standard compactive effort
AS 1289.5.4.1	-	Compaction control test - Dry density ratio, moisture variation and moisture ratio.
AS 1289.5.7.1	-	Compaction Control Test (Rapid Method)
AS 3798-1990	-	Earthworks for Residential and Commercial Developments

(c) Other

EPA	-	Environmental Noise Control Manual
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C220.04 REFERENCE DOCUMENTS

- Documents referenced in this specification are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Other Council Specifications

C211	-	Control of Erosion and Sedimentation
C213	-	Earthworks
C271	-	Minor Concrete Works

(b) Australian Standards

AS 1289.5.4.1	-	Compaction control test - Dry density ratio, moisture variation and moisture ratio
AS 1289.5.7.1	-	Compaction control test (Rapid Method)
AS 3725	-	Loads on Buried Concrete Pipes

(c) Other Publications

Concrete Pipe Selection and Installation, Concrete Pipe Association of Australia

C221.02 REFERENCE DOCUMENTS

- Documents referenced in this specification are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Council Specifications

C213	-	Earthworks
C220	-	Stormwater Drainage - General
C230	-	Subsurface Drainage - General
C271	-	Minor Concrete Works

(b) Australian Standards

AS 1141.11	-	Particle size distribution by dry sieving
AS 1254	-	Unplasticised PVC (UPVC) pipes and fittings for storm or surface water applications
AS 1289.3.3.1	-	Calculation of the plasticity index of a soil
AS 1289.D3.1	-	Determination of the pH value of a soil - Standard method
AS 1289.D4.1	-	Determination of the electrical resistivity of sands and granular materials
AS 1289.E6.1	-	Compaction control test - Density index method for a cohesionless material
AS 1397	-	Steel sheet and strip - Hot-dipped zinc coated or aluminium/zinc coated
AS 1650	-	Hot-dipped galvanised coatings on ferrous articles
AS 2032	-	Code of practice for installation of UPVC pipe systems
AS 2105	-	Inorganic zinc silicate paint
AS 3725	-	Loads on buried concrete pipes
AS 4058	-	Precast concrete pipes
AS 4139	-	Fibre reinforced concrete pipes and fittings

C222.02 REFERENCE DOCUMENTS

- Documents referenced in this specification are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Council Specifications

C213	-	Earthworks
C220	-	Stormwater Drainage - General
C224	-	Open Drains, including Kerb and Gutter
C242	-	Flexible Pavements
C271	-	Minor Concrete Works

(b) Australian Standards

AS1597.1	-	Precast reinforced concrete box culverts - Small culverts
AS1597.2	-	Precast reinforced concrete box culverts - Large culverts
AS/NZS ISO 9002	-	Quality Systems - Model for Quality Assurance in Production, Installation and Servicing

(c) Other

AUSTROADS	-	Guide to Geotextiles
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C223.02 REFERENCE DOCUMENTS

- Documents referenced in this specification are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Council Specifications

C213	-	Earthworks
C220	-	Stormwater Drainage - General
C221	-	Pipe Drainage
C222	-	Precast Box Culverts
C224	-	Open Drains, including Kerb and Gutter
C271	-	Minor Concrete Works

(b) Australian Standards

AS 3996	-	Metal access covers, road grates and frames
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C224.03 REFERENCE DOCUMENTS

1. Documents referenced in this specification are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Council Specifications

C220	-	Stormwater Drainage - General
C221	-	Pipe Drainage
C222	-	Precast Box Culverts
C271	-	Minor Concrete Works

(b) Australian Standards

AS 1141.22	-	Wet/dry strength variation
AS 1289.5.4.1	-	Compaction control test - Dry density ratio, moisture variation and moisture ratio
AS 1289.5.7.1	-	Compaction control test (rapid method)
AS 1650	-	Hot-dipped galvanised coatings on ferrous articles
AS 2876	-	Concrete kerbs and channels (gutters) - Manually or machine placed

(c) Other

AUSTROADS	-	Guide to Geotextiles
Soil & Water Management Plan		

C230.04 REFERENCE DOCUMENTS

1. Documents referenced in this specification are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Council Specifications

C213	-	Earthworks
C271	-	Minor Concrete Works

(b) Australian Standards

AS 1141.11	-	Particle size distribution by dry sieving
AS 1141.22	-	Wet/dry strength variation
AS 1289.E5.1	-	Determination of minimum and maximum dry density of a cohesionless material
AS 1477	-	Unplasticised PVC (UPVC) pipes and fittings for pressure applications
AS 2439.1	-	Perforated drainage pipe and associated fittings
AS 2758.1	-	Aggregates and rock for engineering purposes - Concrete aggregates
ASTM-D2434-68	-	Test method for permeability of granular soils (constant head)

(c) Other

Soil & Water Management Plan		
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C231.03 REFERENCE DOCUMENTS

1. Documents referenced in this specification are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Council Specifications

C213	-	Earthworks
C230	-	Subsurface Drainage - General

(b) Australian Standards

AS 1289.5.4.1	-	Compaction control test - Dry density ratio, moisture variation and moisture ratio
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C233.03 REFERENCE DOCUMENTS

1. Documents referenced in this specification are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Council Specifications

C230 - Subsurface Drainage - General

(b) Australian Standards

AS 1289.5.4.1 - Compaction control test - Dry density ratio, moisture variation and moisture ratio

C242.03 REFERENCE DOCUMENTS

1. Documents referenced in this specification are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Council Specifications

C244 - Sprayed Bituminous Surfacing
 C245 - Asphalt Surfacing
 Wollongong City Council Specification for Asphaltic Concrete

(b) Australian Standards

AS 1141.14 - Particle shape, by proportional calliper
 AS 1141.22 - Wet/dry strength variation
 AS 1289.3.1.1 - Determination of the liquid limit of a soil - Four point Casagrande method
 AS 1289.3.3.1 - Calculation of the plasticity index of a soil
 AS 1289.3.6.1 - Determination of the particle size distribution of a soil - Standard method of analysis by sieving
 AS 1289.3.6.3 - Determination of the particle size distribution of a soil - Standard method of fine analysis using a hydrometer
 AS 1289.5.2.1 - Determination of the dry density/moisture content relation of a soil using modified compactive effort
 AS 1289.5.3.1 - Determination of the field density of a soil - Sand replacement method using a sand-cone pouring apparatus
 AS 1289.5.4.1 - Compaction control test - Dry density ratio, moisture variation and moisture ratio
 AS 1289.5.8.1 - Determination of field density and field moisture content of a soil using a nuclear surface moisture - density gauge - Direct transmission mode
 AS 1289.F1.1 - Determination of the California bearing ratio of a soil - Standard laboratory method for a remoulded specimen

(c) RTA Test Methods

T114 - Maximum Dry Compressive Strength of Road Materials
 T116 - Unconfined Compressive Strength - Remoulded Material
 T130 - Dry Density Moisture Relations for Mixtures of Road Materials and Cement
 T131 - Unconfined Compressive Strength
 T160 - Benkelman Beam Deflection Test
 T171 - Modified Texas Triaxial Compression Test

(d) AUSTRROADS

APRG Special Report No 21 - A Guide to the design of new pavements for light traffic - 1998

A Guide to The Structural Design of Road Pavements - 1992

C244.02 REFERENCE DOCUMENTS

- Documents referenced in this specification are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Council Specifications

C201 - Control of Traffic

(b) Australian Standards

AS 2008	-	Residual bitumen for pavements
AS 2157	-	Cutback bitumen
AS 2341.9	-	Determination of water content
AS 2758.2	-	Aggregate for sprayed bituminous surfacing
AS 3568	-	Oils for Reducing the Viscosity of Bitumen for Pavements

(c) RTA Specifications and Forms

MR466	-	Sprayed Bituminous Surfacing Cutback Chart
3253	-	Bitumen for Pavements
3258	-	Aggregate Precoating Agents
3259	-	Bitumen Adhesion Agents
3261	-	Cutback Bitumen
RTA Form 23	-	Bituminous Surfacing Daily Record

(d) Government Legislation

Bush Fires Act, 1949
Local Government Act, 1993

(e) Other

AUSTROADS - Design of Sprayed Seals (1987).

C245.02 REFERENCE DOCUMENTS

- Australian Standards and Roads and Traffic Authority Test Methods are referred to in abbreviated form; for example, AS1234 or T123. For convenience, the full titles are given below.

a. Australian Standards

AS1141	Sampling and Testing Aggregates
AS1160	Bituminous Emulsions for construction and maintenance of pavements
AS2008	Residual Bitumen for Pavements
AS2150	Asphalt (Hot Mixed)
AS2357	Mineral Fillers for Asphalt
AS2758.5	Aggregates and Rock for Engineering Purposes – Asphalt Aggregates
AS2734	Asphalt (Hot-Mixed) Paving - Guide to Good Practice
AS2891	Sampling and Testing of Asphalt
AS1742.3	Traffic control devices for works on roads

b. Council Specifications

C201 - Control of Traffic

c. Roads and Traffic Authority

RTA Traffic Control at Worksites Manual

C247.04 REFERENCE DOCUMENTS

1. Documents referenced in this specification are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Council Specifications

C248	-	Plain or Reinforced Concrete Base
C271	-	Minor Concrete Works

(b) Australian Standards

AS 1012.1	-	Sampling of fresh concrete
AS 1012.3	-	Determination of properties related to the consistence of concrete
AS 1012.4	-	Determination of air content of freshly mixed concrete
AS 1012.8	-	Making and curing concrete compression, indirect tensile and flexure test specimens, in the laboratory or in the field
AS 1012.9	-	Determination of the compressive strength of concrete specimens
AS 1012.14	-	Securing and testing cores from hardened concrete for compressive strength
AS 1141.11	-	Particle size distribution by sieving
AS 1141.14	-	Particle shape, by proportional calliper
AS 1141.22	-	Wet/dry strength variation
AS 1160	-	Bitumen emulsion for construction and maintenance of pavements
AS 1379	-	The specification and manufacture of concrete
AS 1478	-	Chemical admixtures in concrete
AS 2758.1	-	Concrete aggregates
AS 3582.1	-	Supplementary cementitious materials for use with portland cement - Flyash
AS 3799	-	Liquid membrane - forming curing compounds for concrete.
AS 3972	-	Portland and blended cements

(c) RTA Test Methods

T 321	-	Dry Shrinkage of 100 x 100 x 280mm Concrete Prisms
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C248.03 REFERENCE DOCUMENTS

1. Documents referenced in this specification are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Council Specifications

C224	-	Open Drains including Kerb and Gutter
C231	-	Subsoil and Foundation Drains
C247	-	Mass Concrete Subbase

(b) Australian Standards

AS 1012.1	-	Sampling fresh concrete
AS 1012.3	-	Determination of properties related to the consistence of concrete
AS 1012.4	-	Determination of air content of freshly mixed concrete
AS 1012.8	-	Making and curing concrete compression, indirect tensile and flexure test specimens in the laboratory or in the field
AS 1012.9	-	Determination of the compressive strength of concrete specimens
AS 1012.12	-	Determination of mass per unit volume of hardened concrete
AS 1012.13	-	Determination of the drying shrinkage of concrete for samples prepared in the field or in the laboratory

AS 1012.14	-	Securing and testing cores from hardened concrete for compressive strength or indirect tensile strength
AS 1141.11	-	Particle size distribution by dry sieving
AS 1141.14	-	Particle shape by proportional calliper
AS 1141.18	-	Crushed particles of coarse aggregates
AS 1141.22	-	Wet/dry strength variation
AS 1141.24	-	Soundness (by use of sodium sulphate solution)
AS 1160	-	Bitumen emulsions for construction and maintenance of pavements
AS 1302	-	Steel reinforcing bars for concrete
AS 1303	-	Steel reinforcing wire for concrete
AS 1304	-	Welded wire reinforcing fabric for concrete
AS 1379	-	The specification and manufacture of concrete
AS 1478	-	Chemical admixtures in concrete
AS 1554.3	-	Welding of reinforcing steel
AS 2758.1	-	Concrete aggregates
AS 3582.1	-	Supplementary Cementitious materials - flyash
AS 3799	-	Liquid membrane - forming curing compounds for concrete
AS 3972	-	Portland and blended cement

(c) RTA Test Methods

T 1160	-	Low Temperature Recovery of Preformed Polychloroprene Elastomeric Joint Seals for Bridge Structures
T 1161	-	High Temperature Recovery of Polychloroprene Elastomeric Joint Seals for Bridge Structures
T 1163	-	Resistance of Vulcanised Rubber to the Absorption of Oil
T1192	-	Adhesion of Sealant
T1193	-	Accelerated Ageing of Cured Sealant

(d) ASTM Standards

D792	-	Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement
C793	-	Test Method for Effects of Accelerated Weathering on Elastomeric Joint Sealants
C794	-	Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants
D2240	-	Test Method for Rubber Property Durometer Hardness
D2628	-	Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete
D2835	-	Specification for Lubricant for Installation of Preformed Compression Seal in Concrete Pavements

(e) US Military Specifications

MIL-S-8802	-	Sealing Compound, Temperature Resistant, Integral Fuel Tanks and Fuel Cell Cavities, High Adhesion
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C254.04 REFERENCE DOCUMENTS

- Documents referenced in this specification are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Council Specifications

C213	-	Earthworks
C224	-	Open Drains including Kerb and Gutter
C241	-	Stabilisation
C242	-	Flexible Pavements
C247	-	Mass Concrete Subbase
C271	-	Minor Concrete Works

(b) Australian Standards

AS 1141.11	-	Particle size distribution by dry sieving
AS/NZS 4455	-	Masonry units and segmental pavers

(c) Concrete Masonry Association of Australia Specifications

MA20	-	Specification for Concrete Segmental Paving Units.
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(d) Clay Brick and Paver Institute Specifications

Paver Note 1	-	Specifying and Laying Clay Pavers
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C271.02 REFERENCE DOCUMENTS

- Documents referenced in this specification are listed in full below whilst being cited in the text in the abbreviated form or code indicated:

(a) Australian Standards

AS 1012.1	-	Sampling fresh concrete
AS 1012.3	-	Determination of properties related to the consistency of concrete
AS 1012.8	-	Making and curing concrete compression, indirect tensile and flexure test specimens in the laboratory or in the field
AS 1012.9	-	Determination of the compressive strength of concrete specimens
AS 1012.14	-	Securing and testing cores from hardened concrete for compressive strength
AS 1141.14	-	Particle shape by proportional calliper
AS 1141.21	-	Aggregate crushing value
AS 1141.23	-	Los Angeles value
AS 1141.24	-	Soundness (by use of sodium sulphate solution)
AS 1289.3.3.1	-	Calculation of the plasticity index of a soil
AS 1289.5.1.1	-	Determination of the dry density/moisture content relation of a soil using standard compactive effort
AS 1289.5.2.1	-	Determination of the dry density/moisture content relation of a soil using modified compactive effort
AS 1289.5.4.1	-	Compaction control test - Dry density ratio, moisture variation and moisture ratio
AS 1302	-	Steel reinforcing bars for concrete
AS 1303	-	Steel reinforcing wire for concrete
AS 1304	-	Welded wire reinforcing fabric for concrete
AS 1379	-	The specification and manufacture of concrete
AS 1478	-	Chemical admixtures for concrete
AS/NZS 1859	-	Reconstituted wood-based panels
AS 2082	-	Visually stress-graded hardwood for structural purposes.
AS 2271	-	Plywood and blockboard for exterior use
AS 2758.1	-	Concrete aggregates
AS 3600	-	Concrete structures
AS 3610	-	Formwork for concrete
AS 3799	-	Liquid membrane-forming curing compounds for concrete,
AS 3972	-	Portland and blended cements

C263.02 REFERENCE DOCUMENTS

- Documents referenced in this specification are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Council Specifications

C201	-	Control of Traffic
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(b) Australian Standards

AS 1143	-	High temperature creosote for the preservation of timber
AS 1580	-	Paints and related materials - Methods of test
AS 1580.101.1	-	Air drying conditions
AS 1580.481.1.11	-	Exposed to weathering - Degree of chalking
AS 1580.481.1.12	-	Exposed to weathering - Degree of colour change
AS 1580.483.1	-	Resistance to artificial weathering (carbon-arc type instruments)
AS 1580.602.2	-	Measurement of specular gloss of non-metallic paint films at 20°, 60° and 85°
AS 1906.2	-	Retroreflective devices (non-pavement application)
AS 2082	-	Visually stress-graded hardwood for structural purposes

C261.02 REFERENCE DOCUMENTS

- Documents referenced in this specification are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Council Specifications

C201	-	Control of Traffic
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(b) Australian Standards

AS 1742.2	-	Traffic control devices for general use
AS 1906.3	-	Raised pavement markers (retroreflective and non-retroreflective)
AS 2009	-	Glass beads for road-marking materials
AS 4049.1	-	Solvent-borne paint - For use with drop-on beads
AS 4049.2	-	Thermoplastic road marking materials
AS 4049.3	-	Waterborne paint - For use with drop-on beads

SUMMARY SHEET

Responsible Division	Development Assessment and Certification
Date adopted by Council	25 July 2016
Date of previous adoptions	24 February 2003
Date of next review	July 2019
Authorised by	Manager Development Assessment and Certification