

## SECTION 701 - UNDERGROUND STORMWATER DRAINS

##This section cross-references Sections 173, 175, 610, 619, 632, 687, 689, 703 and 709. If any of the above sections are relevant, they should be included in the specification. If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent:

### 701.01 GENERAL

This section covers the requirements for the supply, delivery, transport, and installation of underground stormwater drains, referred to as culverts, together with the construction of inlet and outlet structures (endwalls, catchpits, basins, etc.), erection of marker posts, and the removal and/or relaying of existing culverts, as shown on the drawings or as specified.

### 701.02 STANDARDS

Materials, design and construction of underground stormwater drains shall comply with the requirements of relevant Australian Standards including:

AS 1646	Elastomeric seals for waterworks purposes
AS 1761	Helical lock-seam corrugated steel pipes
AS 1762	Design and installation of helical lock-seam corrugated steel pipes
AS 1683	Methods of testing for elastomers
AS/NZS 2041	Buried corrugated metal structures
AS 3972	General purpose and blended cements
AS 4058	Precast concrete pipes (pressure and non pressure)
AS 4139	Fibre-reinforced concrete pipes and fittings.

Section 175 details the relevant references to these documents.

### 701.03 DEFINITIONS

**Culvert:** An underground stormwater drain consisting of pipes, arch or box sections.

**Precast Reinforced Concrete Pipes:** Pipes manufactured from Portland cement-based concrete or geopolymer binder-based concrete as specified in Section 703. In the context of the manufacture of reinforced concrete pipes, portland cement concrete and geopolymer binder concrete are equivalent products.

### 701.04 MATERIALS

#### (a) Precast Reinforced Concrete Box Culverts

Precast reinforced concrete box culverts shall comply with the requirements of Section 619.

#### (b) Precast Reinforced Concrete Pipes

##### (i) General

Portland cement-based conventional precast reinforced concrete pipes shall comply with the requirements of AS 4058.

Geopolymer binder-based precast reinforced concrete pipes shall comply with the requirements of AS 4058 and this section, except that the concrete used shall comply with the requirements of Section 703 for geopolymer concrete with compressive strengths appropriate to the nominated load class performance requirements.

Precast reinforced concrete pipes covered by this section shall be used for drainage not subject to internal pressure and the required sizes and load classes shall be as shown on the drawings.

Rubber ring joints shall comply with the requirements of AS 1646.

The clear cover to steel reinforcement shall be based on normal environments and shall not be less than shown in Table 3.1 of AS 4058.

Aggregates for precast reinforced concrete pipes shall comply with the requirements of Section 703.

Pressure pipes shall be as specified on the drawings and in this section.

(ii) Additional Requirements

Additional routine sampling and testing of precast reinforced concrete pipes shall include ultimate load, water absorption, cover to steel reinforcement, dimensional accuracy and joint assembly in accordance with the requirements of AS 4058.

The design diameter as defined in AS 4058 shall not be less than 95% of the nominal size shown on the drawings for all classes of pipes up to and including Class 4.

(c) Fibre-Reinforced Concrete (FRC) Rigid Pipes

(i) General

FRC rigid pipes shall comply with the requirements of AS 4139 and shall have a design life of 100 years.

FRC rigid pipes shall comply with the rigid pipe strength requirements of Clause 11.1(a) of AS 4139, with the load regression factor (R) determined in a manner consistent with the design life of 100 years.

FRC rigid pipes may be supplied in diameter sizes up to and including 750 mm.

FRC rigid pipes shall be used for drainage and the required sizes, load classes and installation conditions shall be as shown on the drawings.

The FRC rigid pipe jointing shall consist of flexible elastomeric, double V-ring joints in accordance with AS 1646 and an external collar in accordance with AS 4139 Appendix M figure M1 (b)(i). Flush or butt joints shall only be used for the first pipe when extending existing pipes.

(ii) Additional Requirements

Further to the requirements of AS 4139 the following tests shall be undertaken:

(1) One pipe per 100 pipes or part thereof of each size and class shall be load tested in accordance with Clause 10.1 of AS 4139.

(2) One pipe per 50 pipes or part thereof of each size and class shall be tested for internal diameter, wall thickness, pipe length, squareness of ends, and straightness in accordance with the dimension and tolerance requirements of Clause 9 of AS 4139.

(3) Testing for restrictions on chemical content (acid-soluble chloride and sulphate ions) as described in Section 6.1.7 of AS 4139 shall be at 6 monthly intervals.

The design diameter as defined in AS 4139 shall not be less than 95% of the nominal size shown on the drawings for all classes of pipes.

(d) Buried Corrugated Metal Culverts

Buried corrugated metal culverts shall be designed and constructed in accordance with the requirements of Section 632, AS 1761, AS 1762 and AS/NZS 2041.

(e) Bedding and Backfill Materials

Materials used for bedding and selected backfill shall be free from perishable matter and lumps and shall conform with the requirements of Table 701.041 and Table 701.042 below.

Ordinary backfill shall be free from perishable matter and shall conform with the requirements of Table 701.041.

**Table 701.041**

Material	Sieve Size - AS (mm)				
	75.0	37.5	19.0	2.36	0.075
	Percentage Passing (by mass)				
Bedding	-	-	100	-	5-40
Selected Backfill	-	100	-	-	5-40
Ordinary backfill	100	-	-	40-100	-

**Table 701.042**

Test	Test Value
Plasticity Index (Max.)	20

(f) Concrete

Cast-in-place concrete edgings, paths and other surfacings shall comply with the requirements of Section 703.

(g) Mortar

Mortar used in the laying of box culvert sections or as jointing for pipes shall comply with the requirements of Clause 610.32.

(h) Marker Posts

Marker posts shall comply with the requirements of Section 709.

**701.05 CONFORMITY WITH DRAWINGS**

The Contractor shall set out the drainage work in accordance with the drawings.

**HP Prior to commencement of excavation for the culverts the Contractor shall confirm the position of all culverts with the Superintendent.**

The culverts constructed shall be constructed true to line and level.

Where it is necessary to modify the line or levels of drainage lines shown on the drawings the Superintendent shall be notified of the proposed design change prior to excavation for the drainage lines. The design change notice shall include certification by the designer that the change complies with the design requirements.

Unless specified otherwise the tolerance on location of pipes compared to the design or a change to the design notified in accordance with this clause shall be:

- (a) offset of entry pits required to match lines of kerbs or barriers  $\pm 20$  mm
- (b) plan location of pits other than offsets to kerb lines or barriers  $\pm 100$  mm
- (c) invert level of pipes at pits  $\pm 50$  mm
- (d) departure from design grade of pipe runs  $\pm 10$  mm in 10 m provided minimum grade is not less than 1:250

**The location of each run of underground drainage shall be verified by a survey certificate prior to backfilling the culverts and shall be recorded progressively on the Contractor's as-constructed drawings.**

#### **701.06 STOCKPILING OF MATERIALS**

Materials shall not be stockpiled or stored on any carriageway or footpath without the consent of the Superintendent.

#### **701.07 PROVISION FOR DRAINAGE DURING CONSTRUCTION**

The Contractor shall provide for the safe discharge of seepage, and stormwater at all times during the construction of any culvert, and for the effective de-watering of excavations. Before obstructing any waterway, channel, culvert, or pipe, the Contractor shall make provision for temporary diversion of flow, and obtain prior written approval from the relevant waterway authority.

#### **701.08 INSTALLATION OF CULVERTS IN FILLS UNDER CONSTRUCTION**

Before laying any single row or multiple row culvert in fill, the fill shall first be constructed and compacted to subgrade level or to a level 0.3 m above the top of the proposed culvert, whichever is the lower, for a distance of not less than 6 m clear on either side of the proposed trench. The trench shall then be excavated through this fill as provided in Clause 701.10 and the culvert installed.

#### **701.09 CONSTRUCTION LOADING ON CULVERTS**

Until the minimum compacted thickness of cover specified in Table 701.091 below for a particular range of axle or track loading has been provided over any culvert, construction traffic shall not be permitted to cross that culvert. A temporary embankment extending not less than 15 m on both sides of the culvert may be used to provide the necessary cover.

**Table 701.091**

Range of Axle or Track Loading (tonne)	Required Cover Thickness (Metre) (Min.)								
	Type, Size, and Class of Culvert								
	Pipe						Corrugated Metal	Box Culvert 90 kN Proof Load	
	Pipe Class								
	2		3		4				
	D<1.2m	D>1.2m	D<1.2m	D>1.2m	D<1.2m	D>1.2m	D 1200-3600 mm		
0 – 9	0.4	0.4	0.4	0.4	0.4	0.4			-
9 – 20	0.4	0.4	0.4	0.4	0.4	0.4	1.2		0.6
20 – 35	0.7	0.4	0.4	0.4	0.4	0.4	1.5	0.9	
35 – 50	0.9	0.7	0.6	0.5	0.5	0.4	1.8	1.2	
50 – 60	#	#	0.8	0.8	0.7	0.7	2.1	1.5	

# This range of loading not permissible.

D Nominal Pipe diameter

D less than 1200 mm not permitted, D more than 3600 mm as directed by the Superintendent.

### 701.10 EXCAVATION

Excavation for installation of culverts shall include all excavation necessary to prepare the culvert foundation and provide the full specified depth of culvert bedding. Where necessary the foundation shall allow for pipes with protruding sockets. Where practical, trench walls shall be vertical, with temporary protection as required.

For box culverts, the width of the trench shall be such that the clearance from the outside of the culvert to the wall of the trench is in the range 0.5 to 1.0 times the overall height of the culvert.

For pipe culverts, the width of trench at and below the level of the top of the pipe shall be such that the horizontal clearance from the outside of the pipe to the wall of the trench is within the limits shown in Table 701.101.

**Table 701.101**

Pipe Type	Nominal Pipe Diameter or Width (mm)	Horizontal Clearance to Wall of Trench	
		Min. (mm)	Max. (mm)
Corrugated Metal Culvert	All	300	1,000
Other	All	300	600

The base of the trench shall be compacted to refusal using mechanical plant.

The Contractor shall treat or replace all soft, wet or unstable material below the level required to provide the minimum specified thickness of culvert bedding, as specified in Clause 701.11. Replacement material if used, shall be compacted in accordance with Clause 701.15.

**701.11 CULVERT BEDDING**

Bedding material shall be provided and placed for the full width of the trench or, where the culvert is to be placed without trenching, to a width 0.8 m greater than the overall width of the culvert. The compacted thickness of bedding material following any shaping necessary shall be not less than:

100 mm where  $D < 1500$  mm

200 mm where  $D \geq 1500$  mm

where D is the nominal pipe diameter or culvert width.

When the sections are in position, an additional layer of bedding material shall be placed to a height equal to 30% of the nominal pipe diameter or culvert height. This material shall be placed between the pipe and the outer limits of the lower layers of bedding, and shall be compacted as specified in Clause 701.15.

**701.12 LAYING****(a) General**

Laying of pipes or box culverts shall not commence until the Contractor has verified that culvert bedding complies with the specified lines and levels and compaction requirements, and that pipes or box culverts are not damaged and comply with the requirements of Clause 701.04.

**(b) Pipe Culverts**

Rebate and socket ends of pipe sections shall be placed facing upstream and be fully entered.

The lower portion of the pipe shall be in contact with the bedding for the full length of each section. The compacted bedding shall be shaped to accommodate the joint collar and ensure that the pipe is supported along its full length.

Where applicable, the top of the pipe as marked shall be within five degrees of the vertical axis of the culvert.

Corrugated metal culverts shall be assembled and laid as specified in Clause 701.16.

The spacing for multiple row culverts shall be as shown in Table 701.121.

**Table 701.121**

Pipe Type	Corrugated Metal		Corrugated Metal Pipe Arch		Other		
	Less than 2,400	Over 2,400	Less than 3,600	Over 3,600	Less than 600	600 to 1,800	Over 1,800
Nominal Diameter (D) or Width (mm)							
Clear space between rows	D/2	1.2 m	D/3	1.2 m	0.3 m	D/2	0.9 m

**(c) Box Culverts**

Consecutive sections of box culverts shall be firmly butted together. The top sections shall be matched to the bottom sections and shall not be lapped over adjoining bottom sections.

The contact areas between the top and bottom sections shall be mortared.

Multi-row box culverts shall be laid with the sections in each row in contact with the sections in the adjacent rows.

(d) Cutting of Culverts

Where it is necessary to cut any culvert section to length or to create a penetration, cutting shall be done by machine to achieve a clean vertical face and any exposed reinforcement shall be coated with an approved epoxy treatment to prevent corrosion.

### 701.13 JOINTING

All interlocking (flush) joint reinforced concrete pipes shall be mortar jointed, or wrapped with a 200 mm wide external joint rubber band. External rubber bands shall be manufactured from natural rubber and have a minimum tensile strength of 18 MPa and a minimum elongation of 400% at break as determined in accordance with AS 1683, Method 11. Rubber band thickness shall not be less than 2 mm. In the case of internally jointed pipes 600 mm diameter and larger, the mortar shall be struck off flush with the bore of the pipe.

Rubber ring joint pipes shall be jointed with rubber rings. Rubber rings shall be kept undisturbed, clean, and free from dirt and other foreign materials and shall be stored undercover if pipes are not to be installed immediately. Rubber ring joints shall be assembled and prepared in accordance with the manufacturer's recommendations. Where rubber rings are disturbed they shall be cleaned and re-assembled prior to refitting.

### 701.14 PLACEMENT OF FILLING

(a) Unless the culvert is installed through an existing paved area, selected and ordinary backfill shall be placed as follows under, around, and above the culvert after the sections are bedded and compacted as specified in Clause 701.15.

(i) Culvert Under Area to be Paved

Where the trench has been excavated from design subgrade level or above, the trench shall be backfilled to design subgrade level with selected backfill material, and above that level with appropriate pavement material.

Where the trench is excavated from below design subgrade level the trench shall be filled with selected backfill material.

(ii) Culvert Under Area not to be Paved

The trench shall be backfilled with selected backfill material to a level 0.3 m above the top of the culvert and with ordinary backfill material above that level.

(b) Where non-trench conditions are permitted the following shall apply:

Selected backfill material shall be placed for the full width of the previously placed bedding material to a height of 0.3 m above the top of the culvert, or to subgrade level, whichever is the lower. To provide support for the selected backfill material, ordinary backfill material shall be placed simultaneously with the selected backfill material to a distance two culvert diameters clear of the culvert.

During filling, the maximum difference between filling placed on opposite sides of the culvert shall not exceed the lesser of one-quarter the height of the culvert or 0.5 m.

Filling shall not be placed within 2 m of an exposed culvert end where a further section is to be placed.

(c) Backfilling with cement stabilised sand

Where approved by the Superintendent, culverts in trenches may be backfilled to half the pipe diameter or box culvert height with 3% cement stabilised sand with a water content sufficient to ensure penetration beneath the pipe or box culvert invert without leaving free surface water.

### **701.15 REQUIREMENTS FOR TESTING AND ACCEPTANCE OF COMPACTION AND MOISTURE CONTENT**

Bedding and backfill materials shall be placed and compacted in layers not exceeding 150 mm loose thickness.

Bedding and backfill shall be assessed for compaction and or moisture in lots. The number of tests per lot shall be three. A lot shall consist of one layer of bedding or backfill for a culvert length between adjacent pits or endwalls. Notwithstanding the provisions of Section 173, a minimum of 20% of all lots for each culvert shall be tested. The calculation of density and moisture ratios shall be based on standard compactive effort.

Where the nominal size of bedding or backfill material after compaction is greater than 40 mm, the moisture ratio shall be determined on material that passes the 19.0 mm sieve.

(a) Bedding

Bedding shall be compacted to refusal using hand held mechanical equipment. Bedding material which has a swell equal to or greater than 2.5% shall be maintained at a mean moisture ratio of 92% between the completion of rolling and the placement of the overlying layer.

(b) Backfill

(i) Material of Nominal Size 40 mm or Less After Compaction

Backfill material which will have a nominal size after compaction of 40 mm or less shall be compacted to a mean value of density ratio of not less than 97%. Backfill material which has a swell equal to or greater than 2.5% shall be maintained at a mean moisture ratio of 92% between the completion of rolling and the placement of the overlying layer.

(ii) Material of Nominal Size Greater than 40 mm After Compaction

Backfill material which will have a nominal size after compaction greater than 40 mm shall be compacted using a grading, mixing, watering and rolling procedure.

Backfill material which has a swell equal to or greater than 2.5% shall be maintained at a mean moisture ratio of 92% between the completion of rolling and the placement of the overlying layer.

### **701.16 ASSEMBLY OF CORRUGATED METAL CULVERTS**

All corrugated metal culvert sections supplied by the Contractor shall be assembled in accordance with the manufacturer's assembly instructions.

Where culvert sections are supplied free to the Contractor, the following will be provided:

Manufacturer's Assembly Drawings

Schedule of Parts Supplied

General Assembly Instructions



**701.17 INSTALLATION OF CULVERTS THROUGH EXISTING PAVED AREAS**

The trench of culverts through existing paved areas shall be backfilled to the existing subgrade level with selected backfill material and the pavement restored using materials as shown below:

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Pavement Layer	Material Type	Thickness (mm)
1. ##:	##:	##:
2.		
3.		
4.		
5.		

**701.18 REMOVAL OF EXISTING CULVERTS**

(a) General

Where specified the Contractor shall remove culverts from existing paved areas.

Except where the pavement under which the culvert passes is to be abandoned, the trench shall be kept to the minimum width to allow removal of the culvert or laying a replacement.

(b) Treatment of Residual Excavation

Where a culvert has been removed and the excavation is not to be backfilled, the excavation shall be neatly trimmed to slopes not steeper than 1 in 1.5 and the ends of the trench shaped to facilitate the smooth flow of water.

Where the trench is to be backfilled, this shall be done in accordance with the provisions of Clause 701.15 and the final surface shall be shaped to conform with the adjoining profile.

(c) Pavement Restoration

Pavement restoration shall be carried out using materials as shown below:

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Pavement Layer	Material Type	Thickness (mm)
1. ##:	##:	##:
2.		
3.		
4.		
5.		

**701.19 INLET AND OUTLET STRUCTURES**

Inlet and outlet structures shall be constructed in accordance with the drawings and specification. Concrete used for the construction of inlet and outlet structures shall comply with the requirements of Section 610.

Footings shall extend to the depths shown on the drawings or as necessary to achieve a satisfactory foundation. If backfilling to the specified level is required, selected backfill material shall be used.

When the proposed foundation is unsatisfactory due to neglect or the use of inappropriate methods, no payment will be made for the work and materials necessary to provide a satisfactory foundation at the specified level.

**701.20 MARKER POSTS ~~##(strikethrough if not required):~~**

At all locations specified the Contractor shall supply and erect guide posts at the edges of the formations on the side of the culvert nearer approaching traffic.

**701.21 EXIT AND ENTRY CHANNELS**

Channels shall be excavated to facilitate the flow of water. They shall be of regular shape and sufficient area to take the flow of water without any low spots that might retain water. Any low areas shall be filled with suitable excavated material and firmly compacted.

**701.22 FLUSHING OF CULVERTS**

All culverts shall be flushed clean from end to end on completion and maintained in proper working order.

**701.23 MINIMUM TESTING REQUIREMENTS**

The Contractor shall test the bedding and backfill material at a frequency as shown in Table 701.231 to ensure that all materials comply with the specified requirements.

**Table 701.231**

Test	Minimum Frequency of Testing
Grading	One per 1000 tonnes or part thereof
Plasticity Index	One per 1000 tonnes or part thereof

**701.24 INSPECTION OF DRAINAGE LINES BENEATH PAVEMENTS**

**HP** *Unless approved otherwise by the Superintendent, all drainage lines constructed beneath pavements shall be inspected, after completion of earthworks to subgrade level and prior to construction of pavement layers, by an independent testing organisation using closed circuit television (CCTV). Reporting of the CCTV inspections shall be in accordance with WSA 05-2013 – Conduit Inspection Reporting Code of Australia, published by Water Services Association of Australia.*

The report shall be provided to the Superintendent, with a copy of the CCTV record and a summary of the location of any defects detected by the survey. Any sections of damaged pipe shall be removed and replaced prior to construction of the pavement layers and a further CCTV survey shall be undertaken to verify correction of the defects.

**701.25 REPAIRS TO DAMAGED PIPES AND BOX CULVERTS****(a) Steel Reinforced Concrete Pipes**

Any steel reinforced concrete pipes that have cracks wider than 0.2 mm or are damaged prior to laying and backfilling shall be rejected.

Where inspections after backfilling identify any of the following defects they shall be notified as a non-conformance:

- cracks wider than 0.5 mm
- spalling of concrete
- exposed reinforcement
- joints that are not fully engaged.

Any pipes with defects greater than the following limits shall be removed and replaced:

- longitudinal cracks greater than 2 mm
- circumferential cracks around the full circumference with width greater than 3 mm or with lateral displacement of the cracked sections exceeding 3 mm
- circumferential cracks around part of the circumference with width greater than 4 mm
- penetrations with area greater than 400 mm<sup>2</sup>
- pipe joints that are separated.

The Superintendent may agree to accept pipes with defects as noted above subject to demonstration that repairs will ensure that pipes will operate effectively for their design life. Consideration will only be given to products and procedures with proven performance and to the following types of treatments:

- hot sprayed epoxy coatings for cracks not wider than 4 mm with no lateral displacement
- fibre glass reinforced epoxy sleeving for cracks not wider than 4 mm with lateral displacements up to 3 mm
- spalled concrete, exposed steel reinforcement and penetrations shall be treated as patch repairs and repaired with polymer modified cementitious repair materials in accordance with the requirements of Section 689.

**The Contractor shall submit details of proposed rectification treatments including manufacturer's product specifications and warranties, the area and thickness of repair treatment, detailed repair procedures, and inspection and test plans.**

***HP No repairs shall be undertaken without the Superintendent's approval of the repair materials and procedures.***

All repairs shall be inspected using CCTV to verify compliance with the repair specifications.

**(b) Fibre-Reinforced Concrete (FRC) Rigid Pipes**

Any FRC rigid pipes that have cracks wider than 0.1 mm or are damaged prior to laying and backfilling shall be rejected.

Where inspections after backfilling identify any of the following defects they shall be notified as a non-conformance:

- cracks wider than 0.1 mm
- any other type of defect
- joints that are not fully engaged.

FRC rigid pipes subject to such non-conformance shall be removed and replaced, unless the Superintendent approves repairs to be undertaken in accordance with the FRC pipes manufacturer's repair procedures and materials.

(c) Other Types of Pipes

Other types of pipes which exhibit defects or are otherwise damaged prior to laying and backfilling shall be rejected.

Where inspections after backfilling identify any defects, such pipes shall be removed and replaced, unless the Superintendent approves repairs to be undertaken in accordance with the manufacturer's repair procedures and materials.

(d) Box Culverts

Box culverts which do not comply with the requirements of Clause 619.14 prior to laying and backfilling shall be rejected and removed from the site.

Where inspections after backfilling identify defects which do not comply with the requirements of Clause 619.14, such culverts shall be removed and replaced, unless the Superintendent approves repairs to be undertaken in accordance with the requirements of Section 610, and Section 687 for crack repairs and Section 689 for conventional patch repairs.

SUPERSEDED