

DEVELOPMENT  
CONSTRUCTION  
SPECIFICATION

C221

**PIPE DRAINAGE**



## SPECIFICATION C221 - PIPE DRAINAGE

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**PIPE DRAINAGE**

Contract No. ..

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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 should be read in conjunction with specification C220 - **Associated Specifications**  
STORMWATER DRAINAGE - GENERAL.
3. The work to be executed under this Specification consists of supply of pipes and pipe arches, bedding, installation and backfilling. **Extent of Work**

#### C221.02 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) Council Specifications

C213	-	Earthworks
C220	-	Stormwater Drainage – General
C223	-	Drainage Structures
C230	-	Subsurface Drainage - General
C271	-	Minor Concrete Works

##### (b) Australian Standards

AS 1141.11	-	Particle size distribution by dry sieving.
AS 1254	-	Unplasticized 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 1289.4.3.1	-	Determination of the pH value of a soil - Standard method.
AS 1289.4.4.1	-	Determination of the electrical resistivity of sands and granular materials.
AS 1289.4.6.1	-	Compaction control test - Density index method for a cohesionless material.
AS 1289.5.4.1	-	Compaction control test – Dry density ratio, moisture variation and moisture ratio
AS 1397	-	Steel sheet and strip - Hot-dipped zinc coated or aluminium/zinc coated.
AS 1646	-	Elastomeric seals for waterworks purposes.
AS 1650	-	Hot-dipped galvanised coatings on ferrous articles.
AS 1761	-	Helical lock-seam corrugated steel pipes.
AS 1762	-	Helical lock-seam corrugated steel pipes - Design and installation.
AS 2032	-	Code of practice for installation of UPVC pipe systems.
AS 2041	-	Corrugated steel pipes, pipe arches and arches.
AS 2042	-	Corrugated steel pipes, pipe arches and arches - Design and installation.
AS 2105	-	Inorganic zinc silicate paint.
AS 3725	-	Loads on buried concrete pipes.
AS 3887	-	Paints for steel structures – Coal tar epoxy.
AS 4058	-	Precast concrete pipes
AS 4139	-	Fibre reinforced concrete pipes and fittings.
AS/NZS 2566.1	-	Buried flexible pipelines, structural design.

- AS/NZS 3750.9 - Organic zinc-rich primer.
- AS/NZS 3750.15 Inorganic zinc silicate paint.
- AS/NZS ISO 9001: 2000 Quality systems – Requirements.

**(c) RTA Test Methods**

- T102 - Pretreatment of Samples of Road Materials by Compaction.
- T166 - Determination of Relative Compaction.

**(d) NSW Government Legislation**

- Occupational Health and Safety Act, 2000.

**(e) Other**

- Resource NSW Specification for Supply of Recycled Material for Pavements, Earthworks and Drainage June 2003.

**GENERAL REQUIREMENTS**

**C221.03 GENERAL**

- |  |  |
|--|--|
| <p>1. Pipes and/or pipe arches shall not be placed in position until the Developer has produced documentary evidence to Council's Development Engineer that the manufacture of the products to be used in the works has complied with the manufacturer's Quality Plan in accordance with ISO 9001:2000.</p>  | <p><b>Compliance with Quality Plan</b></p> |
| <p>2. Documentation shall comprise a conformance certificate to AS 4058 or AS 4139 as appropriate for each batch of pipes or pipe arches to be included in the works</p>   | <p><b>Certification</b></p>                |
| <p>3. At the time of manufacture, each unit shall be marked with:</p> <ul style="list-style-type: none"> <li>(a) Class and size</li> <li>(b) Manufacturer's name</li> <li>(c) Date of casting</li> </ul>   | <p><b>Marking</b></p>                      |
| <p>4. All necessary steps shall be taken to drain the excavation to allow the foundation, the bedding and any backfilling to be compacted to the specified relative compaction.</p>  | <p><b>Excavation Drainage</b></p>          |
| <p>5. Culverts shall be installed within 10mm of the grade line and within 10mm of the horizontal alignment specified on the Drawings. Any culvert that is not within these tolerances shall be re-laid.</p>   | <p><b>Tolerances</b></p>                   |
| <p>6. At the discharge end of culverts terminating at pits and headwalls a 3m length of 100mm diameter subsurface drain shall be laid in the trench a maximum of 100mm above the invert level of the culvert and discharging through the wall of the pit or headwall at a grade that permits free draining into the pit or headwall. The subsurface drainage pipe shall be sealed at the upstream end and shall be enclosed in a seamless tubular filter fabric in accordance with Specification C230 - SUBSURFACE DRAINAGE.</p> | <p><b>Subsurface Drain</b></p>             |
| <p>Backfilling for culverts shall be undertaken in accordance with the requirements of the Occupational Health and Safety Act 2000.</p>  | <p><b>Safety</b></p>                       |
| <p>8. Where it is proposed to travel construction plant in excess of 5 tonnes gross mass over culverts, the Contractor shall design and provide adequate protective measures for the crossings and shall submit the proposals to Council's Development Engineer for prior approval.</p>  | <p><b>Construction Plant Movement</b></p>  |

**REINFORCED CONCRETE AND FIBRE REINFORCED CONCRETE PIPES**

**C221.04 PIPES**

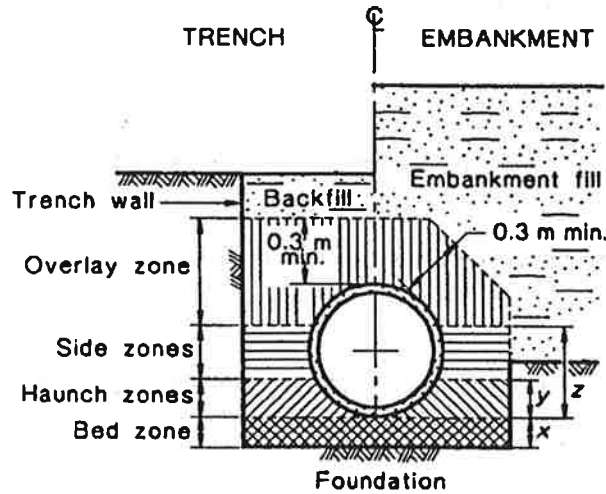
- |  |  |
|--|--|
| <p>1. Reinforced concrete pipes shall comply with AS 4058 and shall be of the class and size as shown on the Drawings.</p>   | <p><i>Reinforced<br/>Concrete Pipes</i></p>  |
| <p>2. Fibre reinforced concrete drainage pipes shall comply with AS 4139 and shall be of the class and size as shown on the Drawings.</p>  | <p><i>Fibre<br/>Reinforced<br/>Pipes</i></p> |
| <p>3. Unless specified otherwise, joints shall be of the flexible type and the pipes shall have special sockets incorporating rubber ring joints complying with AS 1646 and as recommended by the manufacture.</p> | <p><i>Joints</i></p>                         |

**C221.05 EXCAVATION AND INSTALLATION**

- |   |   |
|---|---|
| <p>1. Unless otherwise indicated on the Drawings or approved by Council's Development Engineer, the formation shall be completed to subgrade level and the pipes then installed in the normal trench condition.</p>   | <p><i>Formation to<br/>Subgrade<br/>Level</i></p> |
| <p>2. Installation shall be in accordance with this Specification, AS3725 and AS3725 Supplement 1 for Type HS3 support.</p>   |   |
| <p>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.</p>   | <p><i>Normal Trench<br/>Conditions</i></p>        |
| <p>4. Pipes laid in wide trench conditions will be deemed to be in embankment conditions. Wide trench conditions apply when, for a single pipe, the width of trench, <math>W \geq D + 1</math> metre where D is the pipe diameter. For multi-cell pipes wide trench conditions apply when the width of trench, <math>W \geq \Sigma D + \Sigma S + 1</math> metre where S is the square spacing between the pipelines.</p> | <p><i>Wide Trench<br/>Conditions</i></p>          |
| <p>5. Pipes shown on the drawings to be laid in trench conditions shall not be placed under embankment conditions without a design check for compliance of the pipe strength in accordance with AS 3725.</p>  | <p><i>Design Check</i></p>                        |
| <p>6. All trenching shall be benched or supported in accordance with the requirements of Workcover and the relevant Australian Standards</p>  |   |

**C221.06 BEDDING**

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



where,  $Z \geq 0.7D$   
 $Y = 0.3D$   
 $X = 100$  for  $D \leq 1500$   
 $X = 150$  for  $D > 1500$   
 $D =$  External 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**

Material complying with Resource NSW specification as Class D10 may also be used as bedding material, with the exception of pipelines covered by AS3725.

Sieve size mm	Weight passing %	Weight passing %
	Bed and Haunch Zones	Side Zones
75		100
19	100	
9.5		50 - 100
2.36	50 - 100	30 - 100
0.60	20 - 90	15 - 50
0.30	10 - 60	
0.15	0 - 25	
0.075	0 - 10	0 - 25

**Table C221.2**  
**Bedding Material Grading Limits**

4. The Contractor shall advise Council's Development Engineer of the source of bedding material and test results prior to importing the material. **Source**



- |  |                                   |
|--|-----------------------------------|
| <p>5. Each layer shall be compacted to the relative compaction specified before the next layer is commenced.</p>   | <b>Layers</b>                     |
| <p>6. 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 Council's Development 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).</p> | <b>Moisture Content</b>           |
| <p>7. 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 All material shall be compacted in layers not exceeding 150 mm compacted thickness. The top of the bedding material shall be shaped accurately to house the pipe.</p>   | <b>Compaction Requirements</b>    |
| <p>8. Where the impermeability of the natural ground and the slope of the drainage line is such that erosion of bedding material is considered by Council's Development Engineer to be a likely problem, Council's Development Engineer may specify cementitious stabilisation of the bedding material used in the bedding and haunch zones.</p>   | <b>Cementitious Stabilisation</b> |

**C221.07 INSTALLATION**

**(a) General**

- |  |                               |
|--|-------------------------------|
| <p>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.</p>   | <b>Positioning of Pipes</b>   |
| <p>2. In the case of pipes 1,200mm 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 1,200mm. 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.</p> | <b>Stiffening of Culverts</b> |
| <p>3. Lifting holes in all pipes shall be sealed with a 3:1 sand: cement mortar before the commencement of backfilling or preferably with a precisely fitting bung supplied by the manufacturer.</p>   | <b>Seal Lifting Holes</b>     |

**(b) Joints in Reinforced Concrete Pipes**

**(i) Rubber Ringed Joints**

- |  |                               |
|--|-------------------------------|
| <p>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.</p>   | <b>Clean and Dry Material</b> |
| <p>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 forced home by means of a bar, lever and chain, or other method approved by Council's Development Engineer.</p> | <b>Procedure</b>              |
| <p>3. The joint shall be tested to ensure that the rubber ring has rolled evenly into place.</p>   | <b>Joint Test</b>             |

**(ii) Flush or Butt Joints**

1. Flush or butt joints shall be used only where required to extend existing culverts. If pipes with flush or butt joints are required, the ends of the pipes shall be butted together. The joints shall be sealed with proprietary rubber sleeves, supplied and installed in accordance with the manufacturer's recommendations.

*Jointing*

**(c) Joints in Fibre-Reinforced Cement Pipes**

**(i) New 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*

**(ii) Direct Side Connections to Other Pipes**

1. Direct side connections to other pipes shall be as detailed on the Drawings.

**(d) Concrete Bulkheads**

*Concrete Bulkheads*

1. Concrete bulkheads shall be constructed at intervals of 7.5 metres on stormwater lines with a grade steeper than 20%. For reinforced concrete pipes of 2.44 metres length, concrete bulkheads shall be located at every third joint.

2. The axis of the bulkhead shall be vertical with a minimum top width of 150 mm.

3. The top of the bulkhead shall extend to within 300 mm of the finished surface level or to the subgrade level where the pipeline is within a road pavement. On each side of the pipe at the level of the trench invert, 100 mm diameter pipes shall pass through the bulkhead to allow free draining of the trench. Such pipes shall be filled fibreglass wool or other approved filter material or a capped 1.5 metre length of sub-soil drainage line.

4. Bulkheads shall extend into trench walls and base by a minimum of 300mm.

**C221.08 BACKFILL**

1. Backfill to the side and overlay zones shall consist of Selected Backfill as defined in Table C221.2, or other material as approved by Council's Development Engineer which may include material complying with Resource NSW specification as Class D10. It shall be placed around the pipe to the dimensions shown in Figure C221.1 and compacted in accordance with the requirements in Specification C220 STORMWATER DRAINAGE - GENERAL. The remainder of the trench to the underside of the selected material zone as specified in Specification C213 EARTHWORKS shall be backfilled with material satisfying the requirements for embankment material as defined in Specification 213 EARTHWORKS. Where excavation is approved through the selected material zone, the section of trench within the select material zone shall be backfilled with selected material as defined in Specification 213 EARTHWORKS.

*Procedure*

2. Backfilling on both sides of the culvert and both sides of the wingwalls shall be carried out simultaneously. Backfilling and compaction shall commence at the pipe or wall.

*Sequence*

3. All backfilling operations shall conform to the requirements in Specification C220 - STORMWATER DRAINAGE - GENERAL.

*Associated Specification*

**STEEL PIPES AND PIPE ARCHES**

**C221.09 NESTABLE STEEL PIPE AND DRAINAGE UNITS**

- |  |                                |
|--|--------------------------------|
| 1. Nestable steel pipes and drainage units shall be supplied in accordance with AS 2041 and AS 2042 and shall be of the class and size as shown on the drawings.   | <b>Specification</b>           |
| 2. The galvanised steel sheets used in manufacture shall comply with AS 1397 for steel base grade G250 and a minimum coating Class of Z600.  | <b>Galvanised Steel Sheets</b> |
| 3. Where specified, the pipes and drainage units shall be given a protective coating over the steel, after assembly of a coal tar epoxy paint or equivalent as approved by Council's Development Engineer, to a thickness of 400 microns.  | <b>Protective Treatment</b>    |
| 4. Field cut ends shall be carefully wire brushed to remove any scale followed immediately by two coats of zinc-rich organic primer complying with AS/NZ 3750.9 or two coats of inorganic zinc silicate paint complying with AS/NZ 3750.15 | <b>Field Cuts</b>              |

**C221.10 HELICAL LOCK-SEAM CORRUGATED STEEL**

- |  |                      |
|--|----------------------|
| 1. Helical lock-seam corrugated steel pipe shall be supplied in accordance with AS 1761 and AS 1762 and shall be of the class and size as shown on the drawings.   | <b>Specification</b> |
| 2. The galvanised steel sheet used in manufacture shall comply with AS 1397 for steel based grade G250 and a minimum coating Class of Z600.  |                      |
| 3. Unless otherwise approved by Council's Development Engineer, no part of the pipe shall incorporate steel strips which have been joined by welding. Field cut ends shall be carefully wire brushed to remove any scale followed immediately by two coats of inorganic zinc silicate paint complying with AS/NZ 3750.15. Pipes and coupling bands shall be given a protective hot-dip coating of bitumen on both sides to AASHTO standard M190 or equivalent as part of the process of manufacturing. |                      |

**C221.11 BOLTED STEEL PIPES, PIPE ARCHES AND SPECIAL SHAPES**

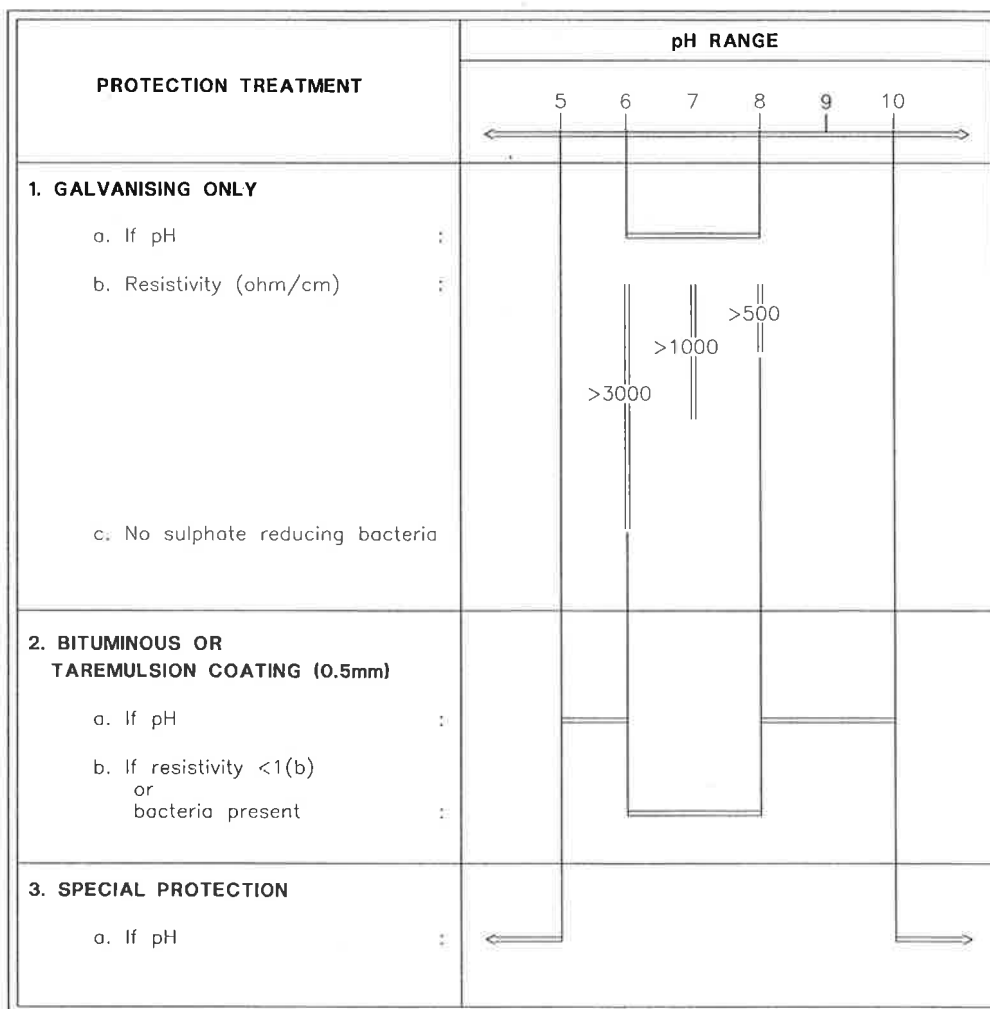
- |   |                             |
|---|-----------------------------|
| 1. Bolted steel pipes, pipe arches and special shapes shall be supplied in accordance with AS 2041 and AS 2042 and shall be of the class and size as shown on the drawings.   | <b>Specification</b>        |
| 2. Also, after assembly, all bolted steel pipes, pipe arches and special shapes shall be given a protective coating on the outside of the steel plate, of a coal tar epoxy paint complying with AS 3887 or equivalent paint approved by Council's Development Engineer. Invert plates shall be coated on the outside before they are placed on the pipe bed. The plate surface shall be cleaned and degreased with a cleaning solution recommended by the protective coating manufacturer. The protective coating shall be applied to give a uniform minimum dry thickness of 400 microns. Any coating damaged shall be recoated by first cleaning any grease, mud or other foreign matter from the affected area. The area shall then be recoated so that the minimum dry thickness of the coating is 400 microns. | <b>Protective Treatment</b> |

**C221.12 MATERIALS AND SURFACE TREATMENT OF STEEL PIPES AND PIPE ARCHES**

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|--|--|
| 1. All steel pipes and pipe arches will require an Engineer's certification that the pipe materials and surface treatments are adequate to provide for installation and in-service loading as well as corrosion protection for a satisfactory design life of 100 years unless indicated otherwise on the drawings. Such certification shall address the chemistry of the soil, groundwater, stream and backfill material as specified in Clause C221.13. |  |
|--|--|

**C221.13 MATERIAL AGAINST STEEL STRUCTURES**

1. The severity of corrosive attack on steel structures will depend on the pH value and electrical resistivity of the soil surrounding the structure and the pH value of the water in the stream.
2. Besides meeting the normal requirements of the bedding and Selected backfill materials, as specified for Reinforced Concrete and Fibre Reinforced Concrete Pipes, and the materials used for embankment construction above the steel structures and within a horizontal distance from the structure equal to the height of the filling over the structure, the pH and resistivity limits as shown in Figure C221.2 will determine the level of corrosion protection required.
3. Notwithstanding the height of fill, embankment material within 6m of the structure shall conform to these requirements.
4. The pH and electrical resistivity of the material shall be determined in accordance with AS 1289.D3.1 and AS 1289.D4.1.
5. The Developer shall nominate the sources of the various materials and submit documentary evidence from a NATA registered laboratory that the representative samples conform to the requirements of this clause and the protective treatment provided. The samples shall be pretreated in accordance with Test Method T102.



**Figure C221.2  
CORROSION PROTECTION REQUIREMENTS FOR STEEL STRUCTURES**

**C221.14 EXCAVATION AND FOUNDATION PREPARATION**

- |   |                                   |
|---|-----------------------------------|
| <p>1. Unless otherwise indicated on the drawings or approved by Council's Development Engineer, the formation shall be completed to subgrade level and the pipes then installed in the normal trench condition.</p>   | <p><b>Specification</b></p>       |
| <p>2. The trench shall be excavated to a level 75mm below the design invert and for a minimum width of 600 mm on each side of the structure.</p>  | <p><b>Trench Width</b></p>        |
| <p>3. Where unsuitable material, as determined by Council's Development Engineer, is encountered at the foundation level, it shall be removed to a depth approved by Council's Development Engineer. The additional excavation shall be backfilled with material complying with, and compacted to, the requirements for HS3 support as specified in Clause C221.06.</p>   | <p><b>Unsuitable Material</b></p> |
| <p>4. Where rock is encountered at the foundation level, the foundation shall be excavated for an additional depth of 250 mm, or 0.25 times the structure width, whichever is the lesser and for a width equal to the width of the structure. The additional excavation shall be backfilled with material complying with, and compacted to, the requirements for HS3 pipe support as specified in Clause C221.06.</p> | <p><b>Rock Foundation</b></p>     |

**C221.15 BEDDING**

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|---|---------------------|
| <p>1. Bedding shall meet the requirements of Clause C221.06. The thickness of uncompacted bedding material between the foundation and the outer surface of corrugation shall not be less than 75 mm. The uniform blanket of loose material which provides the minimum 75 mm thick bedding, shall be placed on the shaped, compacted selected material foundation to allow the corrugations of the structure invert to bed in and become filled with the material.</p> | <p><b>Depth</b></p> |
|---|---------------------|

**C221.16 INSTALLATION**

- |   |   |
|---|---|
| <p><b>(a) General</b></p> <p>1. The assembly of all corrugated steel pipes and pipe arches as well as helical lock-seam corrugated steel pipes shall be carried out in accordance with the manufacturer's recommendations. These recommendations shall be submitted to Council's Development Engineer before assembly or laying of the culverts is commenced.</p> <p>2. If deemed necessary after consultation with the manufacturer, temporary bracing of corrugated steel pipes or pipe arches shall be carried out in accordance with the manufacturer's recommendations.</p>  | <p><b>Manufacturer's Recommendations</b></p> <p><b>Temporary Bracing</b></p>                      |
| <p><b>(b) Joints</b></p> <p>1. Corrugated steel pipes or pipe arches shall be joined in accordance with the manufacturer's recommendations and AS 2042.</p> <p>2. Where helical-lock seam corrugated steel pipes are to be joined, both ends of the join shall be rerolled with four annular corrugations of pitch 68mm. Coupling of the re-rolled ends shall be made in accordance with AS 1761 by using semi-corrugated bands. Where specified, rubber ring joint seals shall be used in conjunction with the coupling bands.</p> <p>3. All joints or lap joints in pipes or pipe arches (excluding rubber ring joint coupling bands) shall be covered with strips of filter fabric material to prevent loss of sand backfill or bedding into the pipe.</p> | <p><b>Method</b></p> <p><b>Ends to be Rerolled</b></p> <p><b>Filter Fabric Cover Material</b></p> |

**C221.17 BACKFILL**

<p>1. Compaction of the material in the side support and overlay zones shall comply with the requirements of clause 221.06 except that the required relative compaction in the side support and overlay zones shall be 95 per cent (AS 1289.5.4.1 standard compaction). Backfill shall be placed around the steel pipe or structure, to a minimum dimension equal to the pipe width on both sides. Selected backfill material as defined in Specification C213 EARTHWORKS shall be placed around the steel pipe or structure to a minimum width of 500mm and in accordance with the provisions of Clause C221.08 except that the maximum size of any particle shall not exceed 25mm.</p>	<p><b>Selected Material</b></p>
<p>2. All material shall be compacted in layers not exceeding 150 mm compacted thickness. Each layer shall be compacted to the relative compaction specified before the next layer is commenced.</p>	<p><b>Layers</b></p>
<p>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 Council's Development 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).</p>	<p><b>Moisture Content</b></p>
<p>4. The remainder of the trench to the underside of the subgrade, or selected material zone as specified in Specification C213 EARTHWORKS, shall be backfilled with material satisfying the requirements for embankment material as defined in Specification C213 EARTHWORKS. Where excavation is approved through the selected material zone, the section of trench within the select material zone shall be backfilled with selected material as defined in Specification C213 EARTHWORKS.</p>	<p><b>Trench Backfill</b></p>
<p>5. Shape checking of the culvert during backfilling operations is required to ensure that on completion of backfilling, the vertical and horizontal centreline dimensions of the pipe or structure shall not vary from the manufacturer's specified dimensions by more than plus or minus 2 per cent for pipes and pipe arches.</p>	<p><b>Distortion of Structure Shape</b></p>
<p><b>C221.18 INVERT PROTECTION OF CORRUGATED STEEL PIPES AND PIPE ARCHES</b></p>	
<p>1. Where shown on the Drawings, the invert of corrugated steel pipes and pipe arches shall be protected using sprayed concrete.</p>	<p><b>Sprayed Concrete</b></p>
<p>2. The sprayed concrete shall be placed to a thickness of not less than 100mm over the crest of the corrugations and to a width such that the bottom third of the pipe circumference is covered symmetrically about the invert of the pipe.</p>	<p><b>Depth and Width</b></p>
<p>3. All foreign material shall be removed from the surface to be protected. Where corrosion has occurred all loose scale shall be removed.</p>	<p><b>Scale Removal</b></p>
<p>4. The production, application and curing of sprayed concrete shall be in accordance with the Specification for MINOR CONCRETE WORKS.</p>	<p><b>Associated Specification</b></p>
<p>5. The sprayed concrete shall be reinforced with fabric of hard drawn steel wire 4mm diameter with 200mm square mesh. The fabric shall be securely supported at a central location within the sprayed concrete.</p>	<p><b>Sprayed Concrete Reinforcement</b></p>
<p>6. Laps in fabric shall be 300mm and a cover of 50mm of sprayed concrete shall be provided to the fabric at all edges.</p>	<p><b>Laps in Fabric</b></p>
<p>7. Immediately after placement of the sprayed concrete, all free water shall be removed and the surface coated with cement slurry.</p>	<p><b>Cement Slurry Application</b></p>
<p>8. No water shall be allowed to flow over the surface of the sprayed concrete for twenty-four hours after the placement of sprayed concrete.</p>	<p><b>Water Flow</b></p>

## UPVC PIPES

### C221.19 CULVERT MATERIALS

1. Unplasticised PVC (UPVC) Pipes and Fittings shall be manufactured in accordance with AS 1254 and shall be of the type and size as shown on the Approved Drawings. *Specification*
2. Embedment material in the bedding, side support and overlay zones shall be in accordance with bed and haunch zone material in Clause C221.06.
3. Trench backfill material shall satisfy the requirements for embankment material as defined in Specification C213 EARTHWORKS.

### C221.20 EXCAVATION AND BEDDING

1. Unless otherwise indicated on the drawings or approved by Council's Development Engineer, the formation shall be completed to subgrade level and the pipes then installed in the normal trench condition. *Formation to Subgrade Level*
2. Figures C221.3 and Table C221.4 indicate the dimensions of bedding and backfilling for pipes laid in trench conditions and embankment conditions, unless otherwise indicated on the drawings. *Bedding Dimensions*

**Table C221.4 – Trench and Embedment Dimensions**

3. Bedding zone material shall be placed and compacted in accordance with the requirements in Clause C221.06 except that the required relative compaction in the bedding zone shall be 95 per cent (AS 1289.5.4.1 standard compaction)

### C221.21 INSTALLATION

1. Embedment of the UPVC pipe shall be in accordance with the requirements of AS/NZS 2566.1 and to the dimensions shown in Figure C221.3.
2. Pipe laying shall be in accordance with Part 7 of AS 2032 and solvent-cement pipe jointing shall be in accordance with Part 3 of AS 2032. Jointing may be performed with the pipes either in the trench or at ground level. All pipes, or jointed pipelines, shall be lowered into the trench without being dropped. Pipelines shall be placed so that joints are not strained. *Laying and Jointing*

### C221.22 BACKFILL

1. Compaction of the material in the side support and overlay zones shall comply with the requirements of clause C221.06 except that the required relative compaction in the side support and overlay zones shall be 95 per cent (AS 1289.5.4.1 standard compaction). *Embedment Compaction*
2. All material compacted in layers not exceeding 150 mm 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 Council's Development 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. The remainder of the trench to the underside of the subgrade, or selected material zone as specified in Specification C213 EARTHWORKS, shall be backfilled with material satisfying the requirements for embankment material as defined in Specification C213 EARTHWORKS. Where excavation is approved through the selected material zone, the section of trench within the select material zone shall be backfilled with selected material as defined in Specification C213 EARTHWORKS.

**Trench Backfill**



## LIMITS AND TOLERANCES

## fC221.26 SUMMARY OF LIMITS AND TOLERANCES

Item	Activity	Tolerances	Spec Clause
1.	<b>Culvert Position</b>		
	(a) Grade Line	± 10mm	C221.03
	(b) Horizontal Alignment	± 10mm	C221.03
2.	<b>Bedding</b>		
	(a) Bed and Haunch Zone Compaction	Table C221.3	C221.06
3.	<b>Backfill – Concrete Pipes</b>		
	(a) Side and Overlay Zone Compaction	Table C221.3	C221.08
4.	<b>Backfill – Steel Pipes</b>		
	(a) Side and Overlay Zone Compaction	Table C221.3, HS3	C221.17
	(b) Pipe Structure		
	(i) Horizontal and Vertical Variation	< 2% of specified dimensions	C221.17
5.	<b>Sprayed Concrete</b>		
	(a) Over crest of corrugations over bottom third of pipe circumference	> 100mm	C221.18
6.	<b>Bedding Zone Compaction</b>	≥ 95%	C221.20
7.	<b>Backfill – UPVC Pipes</b>		
	(a) Side and Overlay Zone Compaction	≥ 95%	C221.21

Table C221.5 - Limits and Tolerances

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