



**WESTERN AUSTRALIA**

**SPECIFICATION**

**221**

**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.

<b>Amendment Sequence No.</b>	<b>Key Topic addressed in amendment</b>	<b>Clause No.</b>	<b>Amendment Code</b>	<b>Author Initials</b>	<b>Amendment Date</b>
1	Flush or Butt Joints	221.07 (b) (ii) 1	A	SR	09/08/01
2	Steel Pipes and Pipe Arches	221.09 - 221.18	O	SR	09/03/01
3	Backfill – Steel Pipes	221.26 (1) Items 4 & 5	O	SR	09/03/01
4	Pay Items (Pipe Culverts)  Bituminous Spraying  Sprayed Concrete	221.27	O	SR	09/03/01



## SPECIFICATION 221 - PIPE CULVERTS

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**PIPE DRAINAGE**

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## SPECIFICATION 221 : PIPE DRAINAGE

### GENERAL

#### 221.01 SCOPE

- |   |                                  |
|---|----------------------------------|
| <p>1. This Specification covers the supply and installation of pipe culverts and pipe arches for stormwater drainage.</p>   | <b>Scope</b>                     |
| <p>2. This Specification should be read in conjunction with the specification for STORMWATER DRAINAGE - GENERAL.</p>  | <b>Associated Specifications</b> |
| <p>3. The work to be executed under this Specification consists of supply of pipes and pipe arches, bedding, installation and backfilling.</p>                                  | <b>Extent of Work</b>            |
| <p>4. Requirements for quality control and testing, including maximum lot sizes and minimum test frequencies, are cited in the Specification Part for Quality Requirements.</p> | <b>Quality</b>                   |

#### 221.02 REFERENCE DOCUMENTS

- |   |   |
|---|---|
| <p>1. Documents referenced in this Specification are listed in full below whilst being cited in the text in the abbreviated form or code indicated.</p> | <b>Documents<br/>Standards<br/>Test Methods</b> |
|---|---|

##### (a) Council Specifications

- |     |   |                               |
|-----|---|-------------------------------|
| 213 | - | Earthworks                    |
| 220 | - | Stormwater Drainage - General |
| 223 | - | Drainage Structures           |
| 230 | - | Subsurface Drainage - General |
| 271 | - | Minor Concrete Works          |

##### (b) Australian Standards

- |               |   |   |
|---------------|---|---|
| AS 1141.11    | - | Particle size distribution by dry sieving.  |
| AS 1141.51    | - | Unconfined compressive strength of compacted materials.                               |
| 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 1289.5.4.1 | - | Compaction control test - Dry density ratio, moisture variation and moisture ratio    |
| AS 1289.4.3.1 | - | Determination of the pH value of a soil - Electrometric method.                       |
| AS 1289.4.4.1 | - | Determination of the electrical resistivity of a soil - 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 1646       | - | Elastomeric seals for waterworks purposes.  |
| 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       | - | Buried corrugated metal structures.   |

## PIPE DRAINAGE

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AS/NZS 2566.1 -	Buried flexible pipelines, structural design
AS 3725 -	Loads on buried concrete pipes
AS/NZS 3750.9	Organic zinc-rich primer.
AS/NZS 3750.15	Inorganic zinc silicate paint.
AS 3887 -	Paints for steel structures - Coal tar epoxy.
AS 4058 -	Precast concrete pipes (pressure and non-pressure).
AS 4139 -	Fibre reinforced concrete pipes and fittings.
AS/NZS 4680 -	Hod-dip galvanised (zinc) coatings on fabricated ferrous articles.
AS/NZS ISO 9002	Quality systems - Model for quality assurance in production, installation and servicing.

### (c) AASHTO Standard

M190	Bituminous coated corrugated metal culvert pipe and pipe arches.
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## COMMON REQUIREMENTS

### 221.03 GENERAL

1. Pipes and/or pipe arches shall not be placed in position until the Contractor has produced documentary evidence to the Superintendent that the pipes and/or pipe arches conform to the requirements of the Drawings and this Specification. This action constitutes a **HOLD POINT**. The Superintendent's approval of the documentary evidence complying with the Manufacturer's Quality Plan and AS/NZS ISO 9002 is required prior to the release of the hold point.

**Conformance**

**HP**

2. Where a Contractor wishes to use drainage pipe other than the pipes described in clauses 221.04 to 221.22 inclusive, the Contractor shall submit, for approval by the Superintendent, full details in accordance with AS/NZS 2566.1 of the characteristics of the pipe materials and embedment and design loads together with certification from the manufacturer of its suitability and quality for use in each particular application. Certification of the suitability of any pipe will address the deflection, strength, buckling and any other considerations appropriate to the particular application. This action constitutes a **HOLD POINT**. The Superintendent's approval of the submitted details is required prior to the release of the hold point.

**Buried Flexible Pipes, Submit for Approval**

**HP**

3. 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**

4. Culverts shall be installed within 10mm of the grade line and within 10mm of the horizontal alignment specified on the Drawings or directed by the Superintendent. The Contractor shall relay any culvert which is not within these tolerances.

**Tolerances**

5. Excavation and backfilling for culverts shall be undertaken in a safe manner and in accordance with all statutory requirements.

**Safety**

6. Where the Contractor proposes 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 the Superintendent for prior approval. This action constitutes a **HOLD POINT**. The Superintendent's approval of the protective measures is required prior to the release of the hold point.

**Construction Plant Movement**

**HP**



**PECAST REINFORCED CONCRETE AND FIBRE REINFORCED CONCRETE PIPES**

**221.04 PIPES**

1. Precast reinforced concrete pipes shall comply with AS 4058 and shall be of the class and size as shown on the Drawings.

**Precast Reinforced Concrete Pipes**

2. Fibre reinforced concrete drainage pipes shall comply with AS 4139 and shall be of the class and size as shown on the Drawings.

**Fibre Reinforced Pipes**

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 manufacturer.

**Joints**

**221.05 EXCAVATION**

1. Unless otherwise indicated on the Drawings or approved by the Superintendent, the formation shall be completed to subgrade level and the pipes then installed in the normal trench condition.

**Formation to Subgrade Level**

2. For normal trench conditions, the pipe shall be laid in an excavated trench with bedding as specified in Clause 221.06. The trench shall be excavated to a width 1.4 times the external diameter of the pipe, or to the external diameter of the pipe plus 300mm on each side, whichever is the greater.

**Normal Trench Conditions**

3. Care is necessary to avoid laying pipe drainage in trenches excavated to excessive width. Pipes laid in wide trench conditions will be deemed to be in embankment conditions (positive projection). Wide trench conditions apply when, for a single pipe, the width of trench,  $W \geq D + 0.6$  metre where D is the pipe diameter. For multi-cell pipes wide trench conditions apply when the width of trench,  $W \geq \Sigma D + \Sigma S + 0.6$  metre where S is the square spacing between the pipelines. This definition of wide trench conditions as equivalent to embankment conditions relates to the size and geometry of the excavation utilised at construction. Pipes shown on the Drawings to require trench conditions shall not be placed under embankment conditions until the Contractor has produced documentary evidence of a design check confirming compliance of the pipe strength in accordance with AS3725. This action constitutes a **HOLD POINT**. The Superintendent's approval of the documentary evidence is required prior to the release of the hold point.

**Wide Trench Conditions**

**Design Check**

**HP**

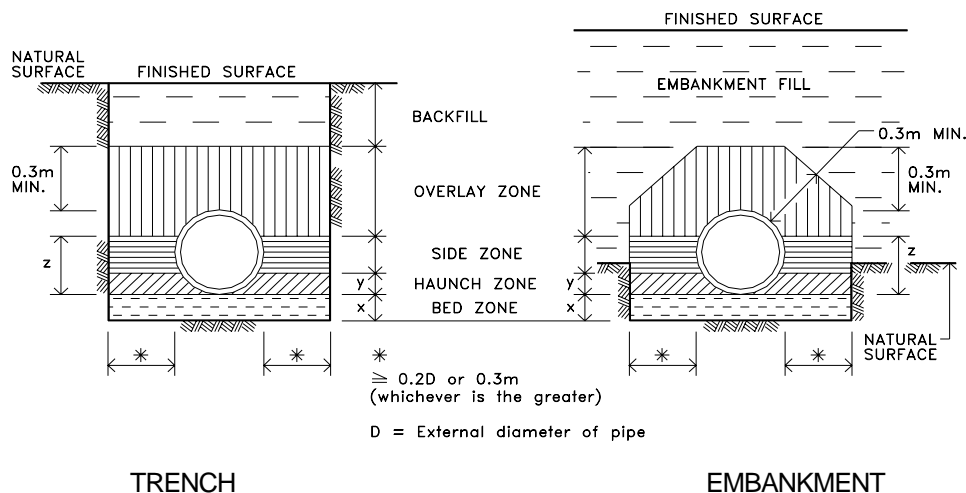
**221.06 BEDDING**

1. Bedding shall be in accordance with this Specification, AS3725 and AS3725 Supplement 1 for the pipe support types as shown on the Drawings. Where the pipe support type is not shown on the Drawings, the support type shall be HS3 unless otherwise approved by the Superintendent.

**Pipe Support Type**

2. Figure 221.1 and Table 221.1 indicate the dimensions of bedding and backfilling for pipes laid in trench conditions and embankment conditions for all AS3725 pipe support types..

**Bedding Dimensions**



**Figure 221.1 - Pipe Installation Conditions**

		Pipe Support Type						
		U	H1	H2	H3	HS1	HS2	HS3
Dimension (minimum)	x	75 on rock Nil on soil	100 for $D \leq 1500$ 150 for $D > 1500$	0.25 D but $>100$	100 for $D \leq 1500$ 150 for $D > 1500$			
	y	—	0.1D	0.3D	0.3D	0.1D	0.3D	0.3D
	z	—	—	—	—	$\geq 0.7D$		

D = External diameter of pipe

**Table 221.1 Pipe Installation Dimensions**

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 221.2, and a Plasticity Index, determined by AS 1289.3.3.1 of less than 6. Select fill material in the side zones, for pipe support type HS, shall also comply with Table 221.2.

**Material Requirements**

Sieve size mm	Weight passing %	
	Bed and Haunch Zones	Side Zones
75.0	—	100
19.0	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 221.2 Bedding Material Grading Limits**

4. The Contractor shall advise the Superintendent of the source of bedding material.

**Source**

5. All material shall be compacted in layers not exceeding 150mm compacted thickness except where explicitly approved by the Superintendent, for the first placed layer above the pipe crown in the overlay zone, in order to protect the pipe from

**Layers**

construction damage. Each layer shall be compacted to the relative compaction specified before the next layer is commenced.

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 the Superintendent, 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**

7. Compaction of select fill material in the bed and haunch zones shall be to the appropriate pipe support requirements shown in Table 221.3 when tested in accordance with AS 1289.5.4.1 for standard compactive effort. H3 Pipe Support includes concrete bedding. Concrete shall be grade N20 to AS3600. Pipe shall be suitably reinforced in accordance with AS3725 as standard elliptically reinforced pipe may not be adequate for H3 Pipe Support. Unless specifically selected pipes are nominated for use with H3 bedding, a design check shall be required to confirm the suitability of the proposed pipes.

**Compaction Requirements**

**Design Check**

		Pipe Support Type						
		U	H1	H2	H3	HS1	HS2	HS3
Minimum Relative Compaction %	Bed and Haunch Zones	—	50	60	Concrete	50	60	70
AS1289.5.4.1 (Standard Compaction)	Side Zones: Cohesionless	—	—	—	—	50	60	70
	Cohesive	—	—	—	—	85	90	95

**Table 221.3 Bedding Material Compaction Requirements**

8. The top 0.1Dmm of the bedding and haunch material directly under the pipe shall be placed and shaped accurately to house the pipe after compaction is achieved in the bedding and haunch zone external to the area of direct pipe support. This action constitutes a **HOLD POINT**. The Superintendent's approval of this process and of the compacted bedding and haunch zone material is required prior to the release of the hold point.

**HP**

9. Where the impermeability of the natural ground and the slope of the drainage line is such that erosion of bedding material is considered by the Superintendent to be a likely problem, the Superintendent may specify cementitious stabilisation of the bedding material used in the bedding and haunch zones.

**Cementitious Stabilisation**

**221.07 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. Lifting holes in all pipes shall be sealed with plastic preformed plugs approved by the Superintendent, or a 3:1 sand:cement mortar, before the commencement of backfilling.

**Seal Lifting Holes**

3. Bulkheads shall be constructed in accordance with the Specification for DRAINAGE STRUCTURES on all lines where the pipe gradient exceeds 5 per cent.

**Bulkheads**

4. The Contractor shall present the laid and jointed pipes for inspection by the Superintendent prior to commencement of trench backfilling. This action constitutes a **HOLD POINT**. The Superintendent's approval to the laid and jointed pipes is required prior to the release of the hold point.

**HP**

## PIPE DRAINAGE

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### (b) Joints in Reinforced Concrete Pipes

#### (i) Rubber Ringed Joints

1. Before making the joint, the spigot and socket and the rubber ring shall be clean and dry. **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 forced home by means of a bar, lever and chain, or other method approved by the Superintendent. **Procedure for Rolling Rubber Rings**
3. The joint shall be tested to ensure that the rubber ring has rolled evenly into place. **Joint Test**
4. Where wedge shaped "skid" rubber rings are prescribed the Manufacturer's instructions, which include the use of lubricants, shall be followed. **"Skid" Rings**

#### (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. Flush or butt jointed pipes shall not be used unless special approval is obtained from the City of Swan. **Jointing**
2. The joints shall be sealed with proprietary rubber sleeves, supplied and installed in accordance with the manufacturer's recommendations, or other alternative method approved by the Superintendent. **Sealing**

### (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 221.07(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.

### 221.08 BACKFILL

1. Select fill material to the side zones for pipe support type HS shall be compacted to the requirements shown in Table 221.3 when tested in accordance with AS 1289.5.4.1 for standard compactive effort. **Type HS Pipe Support**
2. Ordinary fill to the side zones, for all pipe support types except type HS, and overlay zones, for all pipe support types, shall consist of Selected Backfill as defined in the Specification for EARTHWORKS. It shall be placed around the pipe to the dimensions shown in Figure 221.1. **Other Pipe Support Types**
3. 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**

4. 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 Superintendent, 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**

5. The remainder of the trench to the underside of the subgrade, or selected material zone as specified in the Specification for EARTHWORKS, shall be backfilled with material satisfying the requirements for embankment material as defined in the Specification for 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 the Specification for EARTHWORKS.

**Trench Backfill**

6. When compacted 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. Any damage caused shall be rectified, and all costs of such rectification shall be borne by the Contractor. Backfilling and compaction shall commence at the pipe or wall so as to confine remaining uncompacted material at commencement.

**Precautions**

**Contractor's  
Cost**

## UPVC PIPES

### 221.19 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 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 221.06.

3. Trench backfill material shall satisfy the requirements for embankment material as defined in the Specification for EARTHWORKS.

### 221.20 EXCAVATION AND BEDDING

1. Unless otherwise indicated on the Drawings or approved by the Superintendent, the formation shall be completed to subgrade level and the pipes then installed in the normal trench condition.

**Formation to  
Subgrade  
Level**

2. Figure 221.3 and Table 221.4 indicate the dimensions of bedding and backfilling for pipes laid in trench conditions and embankment conditions, unless otherwise indicated on the Drawings.

**Bedding  
Dimensions**

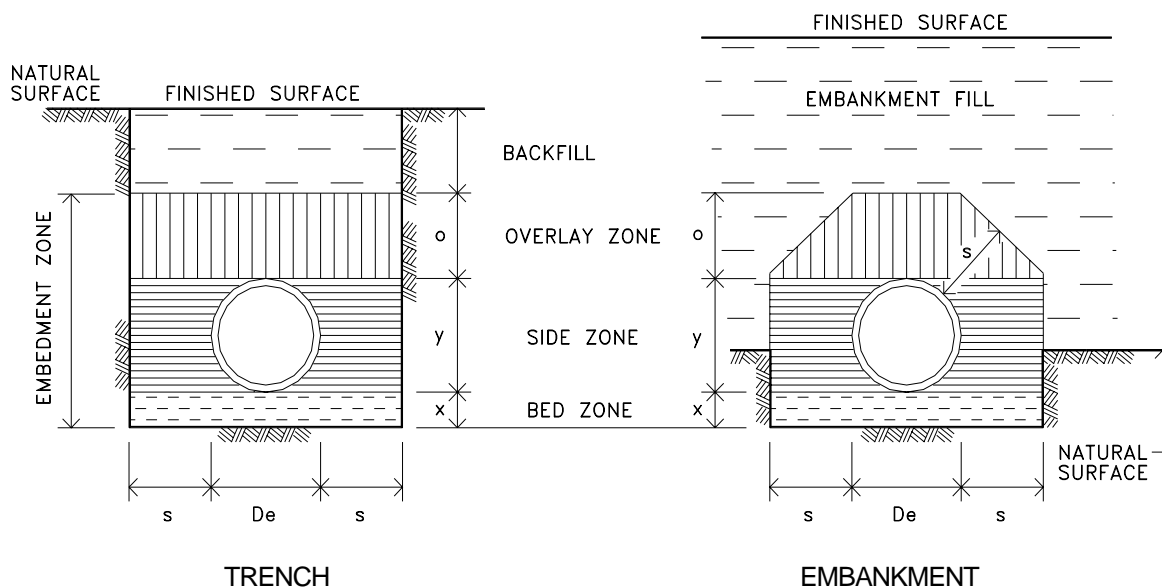


Figure 221.3 - Pipe Installation Conditions

Extreme External Dia (De)mm	Minimum Dimensions (mm)			
	x	s	o	y
≥75 ≤150	75	100	100	Pipe dia.
>150 ≤300	100	150	150	Pipe dia.
>300 ≤450	100	200	150	Pipe dia.

NOTE: Where multiple pipes are laid side by side, the minimum distance between the pipes shall be dimension “s” for the larger of adjacent pipes.

Table 221.4 - Trench and Embedment Dimensions

3. Bedding zone material shall be placed and compacted in accordance with the requirements in Clause 221.06 except that the required relative compaction in the bedding zone shall be 95 per cent (AS 1289.5.4.1 Standard compaction).

**221.21 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 221.3.

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**

3. Bedding zone material compaction and pipeline placement prior to backfill constitutes a **HOLD POINT**. The Superintendent’s approval of the bedding, positioned and jointed pipeline is required prior to the release of the hold point.

**HP**

**221.22 BACKFILL**

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).

***Embedment  
Compaction***

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 Superintendent, 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 the Specification for EARTHWORKS, shall be backfilled with material satisfying the requirements for embankment material as defined in the Specification for 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 the Specification for EARTHWORKS.

***Trench Backfill***

**SPECIAL REQUIREMENTS**

**221.23 RESERVED**

**221.24 RESERVED**

**221.25 RESERVED**

***INSTRUCTION FOR DOCUMENT COMPILATION  
(Delete this box before printing)***

Particular situations may be documented during the design of Council projects for the use of buried flexible pipes instead of the pipes specified routinely in this Specification for PIPE DRAINAGE.

In such cases, Council's Designer shall have selected the flexible pipe type appropriate for the particular application and shall prepare the relevant technical specification clauses for supply and construction with reference to AS/NZS 2566.1, Buried flexible pipelines Part 1: Structural design. These clauses shall be inserted here.



## LIMITS AND TOLERANCES

### 221.26 SUMMARY OF LIMITS AND TOLERANCES

1. The limits and tolerances for materials and product performance related to the various clauses in this Specification are summarised in Table 221.5 below.

Item	Activity	Limits/Tolerances	Spec Clause
1.	<b>Culvert Position</b>		
	(a) Grade Line	± 10mm	221.03
	(b) Horizontal Alignment	± 10mm	221.03
2.	<b>Bedding</b>		
	(a) Bed and Haunch Zone Compaction	Table 221.3	221.06
3.	<b>Backfill - Concrete Pipes</b>		
	(a) Side and Overlay Zone Compaction	Table 221.3	221.08
6.	<b>Bedding Zone Compaction</b>	≥95%	221.20
7.	<b>Backfill - UPVC Pipes</b>		
	(a) Side and Overlay Zone Compaction	≥95%	221.21

**Table 221.5 - Summary of Limits and Tolerances**

## **MEASUREMENT AND PAYMENT**

### **221.27 PAY ITEMS**

1. Payment shall be made for all the activities associated with completing the work detailed in this Specification on a Schedule of Rates basis in accordance with Pay Item 221(a).
2. A lump sum price for this item shall not be accepted.
3. If any item for which a quantity of work is listed in the Schedule of Rates has not been priced by the Contractor, it shall be understood that due allowance has been made in the prices of other items for the cost of the activity which has not been priced.
4. Subsoil drains at pits and headwalls are measured and paid in accordance with this Specification and not in the Specification for SUBSURFACE DRAINAGE - GENERAL.
5. Selected material around pipes, trench backfill in embankment material to the underside of the selected material zone and selected material backfill within the selected material zone where approved, is measured and paid in accordance with this Specification and not in the Specification for EARTHWORKS.
6. Sprayed concrete invert protection is measured and paid in accordance with this Specification and not in the Specification for MINOR CONCRETE WORKS.
7. Miscellaneous minor concrete work not included in the pay items in this specification shall be in accordance with pay items described in the Specification for MINOR CONCRETE WORKS.
8. Bulkheads are measured and paid in accordance with the Specification for DRAINAGE STRUCTURES.

### **Pay Item 221(a) PIPE CULVERTS**

1. The unit of measurement shall be the linear metre measured along the centreline of each particular type, class and size of stormwater drainage pipe culvert and shall be the plan length between centres of gully pits or faces of headwalls.
2. The schedule rate shall include:
  - Supply
  - Survey and setting out
  - Bedding
  - Jointing (including connections)
  - Subsoil drains at pits and headwalls
  - Temporary bracing and strutting
  - Selected material backfilling
  - Embankment material trench backfilling