QUEANBEYAN PALERANG REGIONAL COUNCIL

DEVELOPMENT CONSTRUCTION SPECIFICATION

C221

PIPE DRAINAGE

VERSION 2 – June 2023

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
VERSION 1	Inspection requirements added	C221.01.5	A	KD	11/03/10
	Additional standards added	C221.02.1	A		
	Hold Point added	C221.03.1	A		
	Witness Point added	C221.03.5	A		
	Witness Point added	C221.03.6	A		
	Witness Point added	C221.03.8	A		
	Witness Point added	C221.05.1	A		
	Witness Point added	C221.05.3	A		
	Witness Point added	C221.06.4	A		
	Witness Point added	C221.06.7	A		
	Hold Point added	C221.07.5	A		
	Witness Point added	C221.14.3	A		
	Annexure added	C221 - A	A		
	Additional Class added & twin wall PE added	C221.03.9	A	CS	25/10/2017
	Min. Class 4 RCP & FRP	C221.04	A		
	Bedding zones added	C221.06.3	A		
	Backfill requirements amended	C221.08.1	M		
	Backfill requirements amended	C221.17.1	M		
	Backfill requirements amended	C221.22.1	M		
	PCA Concurrence added	C221-A	A		

	Haunch zone requirements amended	Fig C221.1	M		
	"s" dimension amended	Table C221.5	M		
VERSION 2	Reference Documents updated	C221.02	M	AG	01/06/2023
	FRC pipe removed	C221.03.9	M		
	FRC pipe replaced with twin wall polypropylene	C221.04.02	M		
	Trench stops and bulkheads requirements amended	C221.07.4	M		
	Trench stops and bulkheads requirements for HP	C221.07.5	M		
	Joints for FRC pipe removed	C221.07(b)	O		
	Steel Pipes and Pipe Arches removed	C221.09 – C221.18	O		
	Backfill under existing and proposed roads amended	C221-08, C221-17 & C221-22	M		
	Digital Records requirements – Hold Point added	C221.23	A		

QPRC

ENGINEERING SPECIFICATION IS APPROVED FOR USE

COORDINATOR, DEVELOPMENT ENGINEERING:
Andrew Palmer

SIGNATURE:

DATE: 21 June 2023

SPECIFICATION C221 – PIPE DRAINAGE – VERSION 2

SPECIFICATION C221 – PIPE DRAINAGE – VERSION 2

GENERAL

C221.01 SCOPE

1. This Specification covers the supply and installation of pipe culverts and pipe arches for stormwater drainage. ***Scope***

2. This Specification should be read in conjunction with the specification for STORMWATER DRAINAGE – GENERAL - VERSION 2. ***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***

4. Requirements for quality control and testing, including maximum lot sizes and minimum test frequencies, are cited in the Specification Part for Quality Requirements. ***Quality***

5.. The Contractor shall give notice so that inspection may be made of all **HOLD POINTS** and **WITNESS POINTS** documented in this specification and tabulated in Annexure C221-A. Release of **HOLD POINTS** and **WITNESS POINTS** shall be made by the Superintendent, with the concurrence of the Principal Certifying Authority, where stipulated in Annexure C221-A. ***Notice***

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. All current versions of the references are applicable. ***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/NZS 1141.7	-	Methods for sampling and testing aggregate – Apparent particle density of filler
AS 1141.11.1	-	Particle size distribution - Sieving method
AS/NZS 1254	-	PVC-U pipes and fittings for stormwater and surface water applications.
AS 1289.0		Methods of testing soils for engineering purposes
AS 1289.3.3.1	-	Soil classification tests - Calculation of the plasticity index of a soil
AS 1289.5.4.1	-	Soil compaction and density tests - Compaction control test - Dry density ratio, moisture variation and moisture ratio
AS 1289.4.3.1	-	Soil chemical tests - Determination of the pH value of a soil - Electrometric method.
AS 1289.4.4.1	-	Soil chemical tests - Determination of the electrical resistivity of a soil – Method for fine granular materials.
AS 1289.5.6.1	-	Soil compaction and density tests - Compaction control test - Density index method for a cohesionless material.
AS 1289.5.7.1	-	Soil compaction and density tests – Compaction control test – Hilf density ration and Hilf moisture variation

AS 5101.4	-	Unconfined compressive strength of compacted materials
AS 1646	-	Elastomeric seals for waterworks purposes
AS/NZS 2032	-	Installation of PVC pipe systems
AS/NZS 2033	-	Installation of polyethylene pipe systems
AS/NZS 2566.1		Buried flexible pipelines – Structural design
AS/NZS 2566.2		Buried flexible pipelines - Installation
AS 3600		Concrete structures
AS/NZS 3725		Design for installation of buried concrete pipes
AS/NZS 4058		Precast concrete pipes (pressure and non-pressure)
AS/NZS 5065		Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications
AS/NZS ISO 9001		Quality management systems - Requirements.

(c) AASHTO Standard

M190	Bituminous coated corrugated metal culvert pipe and pipe arches.

(d) WSAA Standard

WSA 01	Polyethylene pipeline code of Australia
WSA 05	Conduit inspection reporting code of Australia

COMMON REQUIREMENTS

C221.03 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 manufacture of the products to be used in the works has complied with the Manufacturer's Quality Plan in accordance with AS/NZS ISO 9001. This is a **HOLD POINT**. ***Compliance with Quality Plan (HP)***

2. Documentation shall comprise a conformance certificate to AS/NZS 4058 or as appropriate for each batch of pipes or pipe arches to be included in the works. Conformance certificates are to be supplied at least 24 hours in advance of dispatch to site. ***Certification***

3. Each unit shall be marked at time of manufacture with: ***Marking***
   a) Class and size.
   b) Manufacturer's name.
   c) Date of casting.

4. 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***

5. Culverts shall be installed within 10mm of the grade line and within 10mm of the horizontal alignment specified on the Drawings. This is a **WITNESS POINT**. The Contractor shall relay any culvert which is not within these tolerances. ***Tolerances (WP)***

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 100mm above the invert level of the culvert and discharging through the wall of the pit or headwall at 100mm above the invert level of the culvert or headwall. The subsurface drainage pipe shall be sealed at the upstream end and ***Subsurface Drain***

shall be enclosed in a seamless tubular filter fabric in accordance with the Specification for SUBSURFACE DRAINAGE – GENERAL. This is a **WITNESS POINT**. ***(WP)***

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

8. 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 is a **WITNESS POINT**. ***Construction Plant Movement (WP)***

9. All trunk stormwater drainage lines shall be constructed using Class 4 reinforced concrete pipes or twin wall polyethylene or PVC pipe. Interallotment drainage lines shall be constructed using uPVC Class SN8 or twin wall polyethylene. The use of other materials is prohibited. ***Materials***

PRECAST REINFORCED CONCRETE PIPES

C221.04 PIPES

1. Precast reinforced concrete pipes shall comply with AS/NZS 4058 and shall be minimum Class 4 and minimum size of 375mm when used within road reserve, or of higher class and size as shown on the Drawings. ***Precast Reinforced Concrete Pipes***

2. 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***

C221.05 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. This is a **WITNESS POINT**. ***Formation to Subgrade Level (WP)***

2. For normal trench conditions, the pipe shall be laid in an excavated trench with bedding as specified in Clause C221.06. 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 without a design check for compliance of the pipe strength in accordance with AS/NZS 3725 This is a **WITNESS POINT**. ***Wide Trench Conditions*** ***Design Check (WP)***

C221.06 BEDDING

1. Bedding shall be in accordance with this Specification, AS/NZS 3725 and AS/NZS 3725 (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 within road reserves and H2 elsewhere. ***Pipe Support Type***

2. Figure C221.1 and Table C221.1 indicate the dimensions of bedding and backfilling for pipes laid in trench conditions and embankment conditions for all AS/NZS 3725 pipe support types. ***Bedding Dimensions***

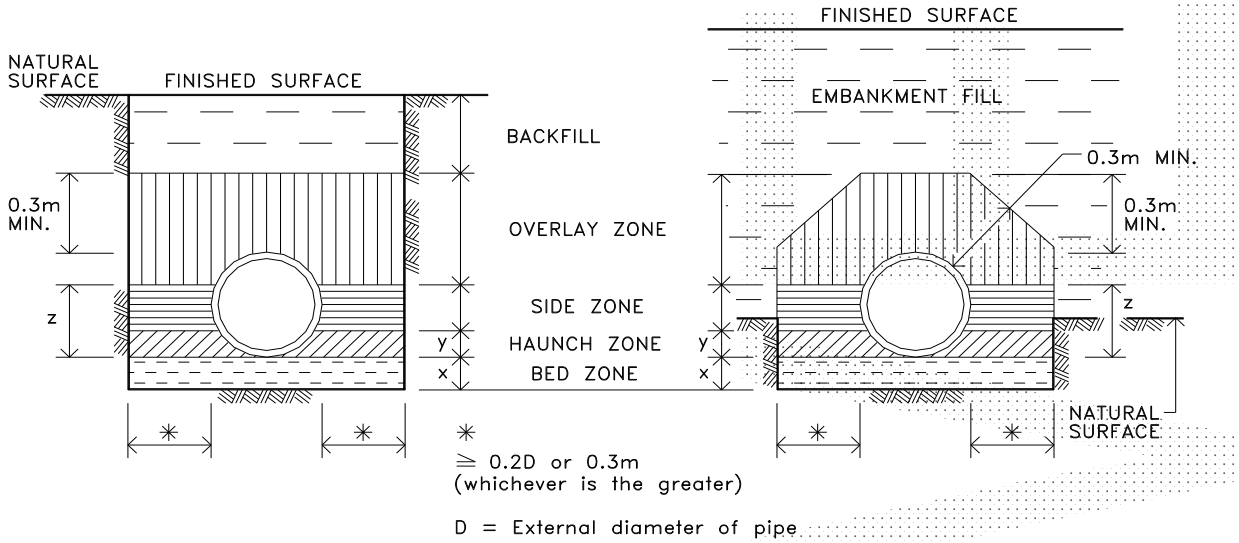

Figure C221.1 – Pipe Installation Conditions

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

D = External diameter of pipe

Table C221.1 - Pipe Installation Dimensions

3. Bedding material for the bed, haunch zones, side zones and overlay shall consist of a granular material having a grading, determined by AS 1141.11.1 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	Weight passing %
	Bed and Haunch Zones
9.5	100
2.36	50 -100
0.60	20 - 90
0.30	10 - 60
0.15	0 - 25
0.075	0 - 10

Table C221.2 - Bedding Material Grading Limits

4. The Contractor shall advise the Superintendent of the source of bedding material. This is a **WITNESS POINT**. ***Source (WP)***

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

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 C221.3 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 AS 3600. Pipe shall be suitably reinforced in accordance with AS/NZS 3725 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. This is a **WITNESS POINT**. ***Compaction Requirements*** ***Design Check (WP)***

		Pipe Support Type						
		U	H1	H2	H3	HS1	HS2	HS3
Minimum Relative Compaction %	Bed and Haunch Zones	—	50	60	Conc-rete	50	60	70
AS 1289.5.4.1 (Standard Compaction)	Side Zones: Cohesionless	—	—	—	—	50	60	70
	Cohesive	—	—	—	—	85	90	95

Table C221.3 - 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.

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***

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 1,200mm 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. ***Stiffening of Culverts*** ***Removal of Struts***

3. 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***

4. Trench stops and Bulkheads shall be constructed in accordance with AS/NZS 2566.2, section 5.8 on all lines where the pipe gradient exceeds 5 per cent. ***Trench stops and Bulkheads***

5. The Contractor shall present the laid and jointed pipes for inspection by the Superintendent prior to commencement of trench backfilling. This includes trench stops and bulkheads where applicable. This is a **HOLD POINT**. ***Inspection by Superintendent (HP)***

(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. ***Jointing***

2. The joints shall be sealed with proprietary rubber sleeves, supplied and installed in accordance with the manufacturer's recommendations. ***Sealing***

C221.08 BACKFILL

1. Following completion of the overlay zone, the Contractor shall backfill the remainder of the excavation and compact the backfill in layers of not more than 150mm thick as follows:

a) Where the trench is within an existing or proposed roadway, between the overlay zone and the top of subgrade, the trench shall be backfilled with 14 to 1 moist sand/cement mix using washed river sand or non-cohesive backfill material approved by the Superintendent in layers as directed. Any pavement layers shall be constructed in accordance with the Specification for FLEXIBLE PAVEMENTS – VERSION 1. ***Backfill under existing and proposed roads***

Elsewhere, unless stated otherwise, the remainder of the trench shall be backfilled with ordinary excavated backfill material. Where suitable material is not available, granular material may be used for the full depth of backfilling. The material shall be compacted to a density Index of 70 when determined in accordance with AS 1289.5.4.1 for cohesionless materials or 95 per cent of the standard maximum dry density of the material when determined in accordance with AS 1289.5.7.1 for cohesive materials. ***Backfill elsewhere***

2. 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. 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***

FLEXIBLE PIPES

C221.19 MATERIALS

1. Flexible pipes shall be those covered by Australian Standard AS/NZS 2566.1 "*Buried flexible pipelines Part 1: Structural design*". This Standard is applicable to buried flexible pipes manufactured from homogeneous or composite material; of plain or structured wall construction; and plastic (UPVC, OPVC, ABS, GRP, polyethylene) or metallic materials of manufacture. ***Specification***

2. Twin wall polyethylene drainage pipes shall comply with AS/NZS 5065 and shall be minimum Class SN8 and minimum size of 375mm when used within road reserve, or of higher class and size up to 600mm as shown on the Drawings. ***Twin wall polyethylene pipes***

3. The size/type/class of the flexible pipeline shall be as shown on the Drawings.

4. Embedment material in the bedding, side support and overlay zones shall be in accordance with this Specification, AS/NZS 2566.1 and AS/NZS 2566.2. ***Embedment material***

Unless otherwise specified, embedment material in the bedding, side support and overlay

zones, as shown in Figure 1, shall be a cohesionless granular material having a grading, determined by AS 1141.11.1, no finer than Table 221.4, and a Plasticity Index, determined by AS 1289.3.3.1, of less than 6.

Sieve Size (mm)	Weight Passing (%)
19.0	100
2.36	50 – 100
0.6	20 – 90
0.3	10 – 60
0.15	0 – 25
0.075	0 - 10

Table 221.4 – Embedment Material Grading

(Table taken from AS/NZS 2566.2, Table 5.5)

5. Other aggregates, gravels and sands suitable for embedment material are those complying with Tables G2 and G3 of AS/NZS 2566.2.

6. Trench backfill material shall satisfy the requirements for embankment material as defined in the Specification for EARTHWORKS - VERSION 2. ***Backfill material***

C221.20 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 C221.3 and Table C221.5 indicate the dimensions of bedding and backfilling for pipes laid in trench conditions and embankment conditions, unless otherwise indicated on the Drawings. ***Bedding Dimensions***

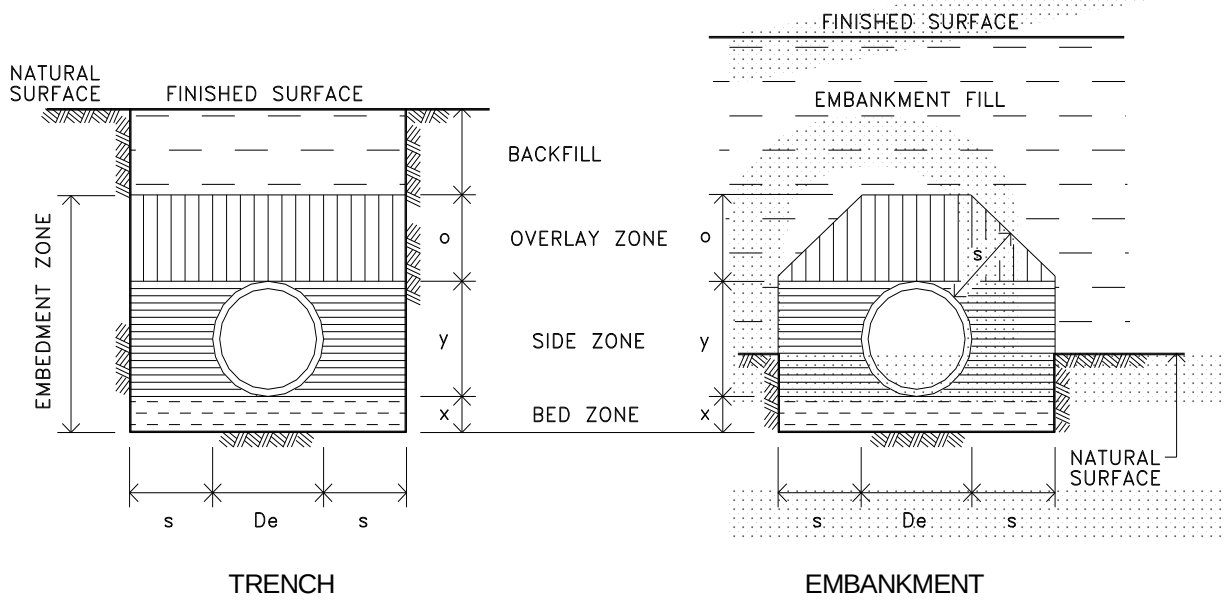

Figure C221.3 - Pipe Installation Conditions

(Figure taken from AS/NZS 2566.2)

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.
>450 ≤900	150	300	150	Pipe dia.
>900 ≤1500	150	450	200	Pipe dia.
>1500 ≤4000	150	450	300	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 C221.5 - 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). ***Compaction***

Embedment material	Test method	Compaction	
		Traffic Loading	No Traffic Loading
Cohesionless	Density Index (AS 1289)	70%	60%

Table 221.6 – Minimum Relative Compaction (Table taken from AS/NZS 2566.2)

C221.21 INSTALLATION

1. Embedment of the flexible pipes shall be in accordance with the requirements of the Drawings, Section 5 of AS/NZS 2566.2 and to the dimensions shown in Figure 221.3.

2. Pipes shall be laid and joined in accordance with the manufacturer's Specifications, and to any Australian Standards relevant to installation of the type of pipe. Pipes with markings indicating the crown or invert of the pipe, or the required direction of flow in the pipe shall be laid strictly in accordance with the markings. All pipes shall be lowered into the trench without being dropped. ***Laying and Jointing***

3. Bulkheads or trenchstops shall be constructed, where required, in accordance with Table 5.7 of AS/NZS 2566.2. Bulkheads shall be constructed in accordance with the Specification for DRAINAGE STRUCTURES - VERSION 2. ***Bulkheads***

4. Bedding zone material compaction and pipeline placement prior to backfill constitutes a **HOLD POINT**. Approval of the bedding, including positioned and jointed pipeline, is required by the Superintendent prior to release of the hold point. ***Approval (HP)***

C221.22 BACKFILL

1. Following completion of the overlay zone, the Contractor shall backfill the remainder of the excavation and compact the backfill in layers of not more than 150mm thick as follows:

a) Where the trench is within an existing or proposed roadway, between the overlay zone and the top of subgrade, the trench shall be backfilled with 14 to 1 moist sand/cement mix using washed river sand or non-cohesive backfill material approved by the Superintendent in layers as directed. Any pavement layers shall be constructed in accordance with the Specification for FLEXIBLE PAVEMENTS – VERSION 2

Backfill under existing and proposed roads

Elsewhere, unless stated otherwise, the remainder of the trench shall be backfilled with ordinary excavated backfill material. Where suitable material is not available, granular material may be used for the full depth of backfilling. The material shall be compacted to a density Index of 70 when determined in accordance with AS 1289.5.4.1 for cohesionless materials or 95 per cent of the standard maximum dry density of the material when determined in accordance with AS 1289.5.7.1 for cohesive materials.

Backfill elsewhere

2. 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. 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

C221.23 DIGITAL RECORDS

1. The contractor shall provide a digital recording of the internal condition of all mains. The digital recording shall be undertaken at the completion of Civil works. The guide for internal inspection, reporting and criteria for acceptance are to be in accordance with WSA 05 – Conduit inspection reporting code of Australia. The records shall be submitted to the Council for acceptance. This action constitutes a **HOLD POINT.**

Digital Records

(HP)

SPECIAL REQUIREMENTS

C221.24 RESERVED

C221.25 RESERVED

LIMITS AND TOLERANCES

C221.26 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 C221.5 below.

Item	Activity	Limits/Tolerances	Spec Clause
1.	**Culvert Position**		
	(a) Grade Line	± 10mm	C221.03
	(b) Horizontal Alignment	± 10mm	C221.03
2.	**Bedding**		
	(a) Bed and Haunch Zone Compaction	Table C221.3	C221.06
3.	**Backfill - Concrete Pipes**		
	(a) Side and Overlay Zone Compaction	Table C221.3	C221.08
4.	**Sprayed Concrete**		
	(a) Over crest of corrugations over bottom third of pipe circumference	> 100mm	C221.18
5.	**Bedding Zone Compaction**	≥95%	C221.20
6.	**Backfill - Flexible Pipes**		
	(a) Side and Overlay Zone Compaction	≥95%	C221.21

Table C221.5 - Summary of Limits and Tolerances

MEASUREMENT AND PAYMENT

C221.27 PAY ITEMS (UNITS OF MEASURE)

1. Payment shall be made for all the activities associated with completing the work detailed in this specification on a schedule of rates in accordance with pay item C221(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 - VERSION 2.

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 C221(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
- Bituminous painting
- Sprayed concrete lining and other protective measures
- Selected material backfilling
- Embankment material trench backfilling

ANNEXURE C221- A

INSPECTIONS

Summary of HOLD POINTS

Clause title/Item	Requirement	Notice for inspection	Release by
COMMON REQUIREMENTS			
GENERAL			
C221.03.1 - Compliance with Quality Plan	Provide documentary evidence of manufacture of pipes	2 weeks prior to commencing site work	Superintendent
PRECAST REINFORCED CONCRETE AND FLEXIBLE PIPES			
Laying			
C221.07.5 - Inspection by Superintendent	Call for inspection	1 working day	Superintendent – PCA concurrence required
FLEXIBLE PIPES			
Installation			
C221.21.4 - Approval	Call for inspection	1 working day	Superintendent – PCA concurrence required
CONSTRUCTION COMPLIANCE			
C221.23.1 – Digital Records	Provide digital (video) records	At time of Civil Works completion	Superintendent – PCA concurrence required

Summary of WITNESS POINTS

Clause title/Item	Requirement	Notice for inspection
COMMON REQUIREMENTS		
GENERAL		
Tolerances	Culvert alignment	Progressive
Subsurface drainage	Enclose pipe in tubular filter fabric	Progressive
Construction plant movement	Design and provide protective measures for crossings	Progressive
PRECAST REINFORCED CONCRETE AND FLEXIBLE PIPES		
Excavation		
C221.05.1 - Formation to subgrade level	Lay pipe at subgrade level	Progressive
C221.05.3 - Wide trench conditions	Design check for compliance	Progressive
Bedding		
C221.06.4 -Source	Provide source of bedding material	2 weeks prior to delivery
C221.06.6 - Design check	Confirm pipe suitability	Progressive