

**CONSTRUCTION
SPECIFICATION**

C221

PIPE DRAINAGE

SPECIFICATION C221 - PIPE DRAINAGE

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CITATION

This document is named “Kempsey Shire Council, Construction Specification C221 – Pipe Drainage”.

ORIGIN OF DOCUMENT, COPYRIGHT

This document was originally based on PMHC AUS-SPEC. Parts of the AUS-SPEC document that remain are still subject to the original copyright.

VERSIONS, C221 Pipe Drainage

VERSION	AMENDMENT DETAILS	CLAUSES AMENDED	DATE ISSUED (The new version takes effect from this date)	Authorised by the Director of Infrastructure
1.0	Version 1 – First Draft Version		March 2025	

SPECIFICATION C221: PIPE DRAINAGE

GENERAL

C221.01 SCOPE

- | | | |
|----|---|----------------------------------|
| 1. | This Specification covers the supply and installation of pipe culverts for stormwater drainage. | Scope |
| 2. | This Specification should be read in conjunction with specification C220 STORMWATER DRAINAGE - GENERAL. | Associated Specifications |
| 3. | The work to be executed under this Specification consists of supply of pipes, 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 Development Construction Specification - Quality Control Requirements (CQC). | Quality |

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 | | |
| C211 | - | Control of Erosion and Sedimentation |
| C213 | - | Earthworks |
| C220 | - | Stormwater Drainage - General |
| C223 | - | Drainage Structures |
| C230 | - | Subsurface Drainage – General |
| C242 | - | Flexible Pavements |
| C271 | - | Minor Concrete Works |
| (b) Australian Standards | | |
| AS 1141.11.1 | - | Methods for sampling and testing aggregates - Particle size distribution - Sieving method. |
| 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 | - | Methods of testing soils for engineering purposes - Soil classification tests - Calculation of the plasticity index of a soil. |
| AS 1289.4.3.1 | - | Methods of testing soils for engineering purposes - Soil chemical tests - Determination of the pH value of a soil - Electrometric method. |

AS 1289.4.4.1 -	Methods of testing soils for engineering purposes - Soil chemical tests - Determination of the electrical resistivity of a soil - Method for fine granular materials.
AS 1289.5.4.1 -	Methods of testing soils for engineering purposes - Soil compaction and density tests - Compaction Control Test - Dry density ratio, moisture variation and moisture ratio.
AS 1289.5.6.1 -	Methods of testing soils for engineering purposes - Soil compaction and density tests - Compaction control test - Density index method for a cohesionless material.
AS 1289.5.7.1 -	Methods of testing soils for engineering purposes - Soil compaction and density tests - Compaction control test - Hilf density ratio and Hilf moisture variation (rapid method)
AS 1646	- Elastomeric seals for waterworks purposes.
AS 2032	- Installation of PVC pipe systems.
AS/NZS 2566.1-	Buried flexible pipelines – structural design
AS 3600	- Concrete structures
AS 3725	- Design for installation of buried concrete pipes
AS/NZS 3750.9-	Paints for steel structures - Organic zinc-rich primer.
AS/NZS 3750.15-	Paints for steel structures - Inorganic zinc silicate paint.
AS 4058	- Precast concrete pipes (pressure and non-pressure).
AS 4680	- Hot-dip galvanized (zinc) coatings on fabricated ferrous articles.
AS 4139	- Fibre reinforced concrete pipes and fittings
AS/NZS 5065 -	Polyethylene (PE) and polypropylene (PP) pipes and fittings for drainage and sewerage applications.
AS/NZS ISO 9001	Quality Management Systems

(c) Standard Drawings

Kempsey Shire Council Standard Drawings ASD 300 to ASD328 – Drainage Series.

C212.03 DEFINITIONS

GENERAL REQUIREMENTS

C221.04 GENERAL

1. Pipes shall not be placed in position until the Principal Contractor has produced documentary evidence to the Principal Certifier 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.

***Compliance
with Quality
Plan***

2. Prior to incorporating into the Works any supplied manufactured drainage products, provide a signed conformance certificate stating that the materials used and finished product conforms to the requirements of this specification. The conformance certificate described above must describe the item and identify the inspection and test records that verify conformity of the item, and must be available for inspection as part of the Quality Records. Conformance certificates are to be

***Certification

HOLD POINT***

supplied at least 24 hours in advance of dispatch of products to site. This is a **HOLD POINT**.

- | | | |
|----|---|--------------------------------|
| 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 Principal 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 20mm of the grade line and within 200mm of the horizontal alignment specified on the Drawings. The Principal Contractor shall relay any culvert which is not within these tolerances. | Tolerances |
| | | |
| 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 drain must be straight and discharge through the same wall as the drainage pipe. 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 - GENERAL. | Subsurface
Drain |
| | | |
| 7. | Excavation and backfilling for culverts shall be undertaken in a safe manner and in <i>accordance with all statutory requirements</i> . | Safety |

8. Where the Principal Contractor proposes to travel construction plant in excess of 5 tonnes gross mass over culverts, the Principal Contractor shall design and provide adequate protective measures for the crossings and shall submit these details to the Principal Certifier for prior approval. This is a **HOLD POINT**.

*Construction
Plant
Movement*

HOLD POINT

9. Backfilling of pipes shall be undertaken with equipment that does not cause cracking to the in-situ pipe. Self compacting backfill should be used if there is any risk of compaction equipment damaging the pipe.

*Compaction of
pipe backfill*

10. Trench stops shall be constructed in accordance with section C221.24 of this Specification on all lines where the pipe gradient exceeds 10 per cent. Concrete bulkheads shall be constructed in accordance with section C221.25 of this Specification on all lines where the pipe gradient exceeds 15 per cent.

*Trench Stops
and Bulkheads*

PRECAST REINFORCED CONCRETE PIPES AND FIBRE REINFORCED CONCRETE PIPES

C221.04 PRECAST REINFORCED CONCRETE PIPES

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

*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 Approved Plans.

*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

C221.05 EXCAVATION - CONCRETE PIPES

1. Unless otherwise indicated on the Approved Plans or approved by the Principal Certifier, 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 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

*Wide Trench
Conditions*

Design Check

C221.06 BEDDING - CONCRETE PIPES

- ### Bedding Dimensions



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

Table C221.1 Pipe Installation Dimension

3. Bedding material for the bed and haunch zones 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. Select fill material in the side zones, for pipe support type HS, shall also comply with Table C221.2, and shall have a Plasticity Index less than 12.

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 C221.2 Bedding Material Grading Limits

4. The Principal Contractor shall advise the Principal Certifier, in writing, of the source of bedding material at least 7 days prior to delivery of material to site.

Source

5. All material shall be compacted in layers not exceeding 150mm compacted thickness except where explicitly approved by the Principal Certifier, 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 Principal Certifier, is neither less than 60 per cent nor more than 95 per cent of the apparent optimum moisture content, as determined by AS 1289.5.4.1 (standard compaction).

Moisture Content

7. Compaction of backfill 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 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.

Compaction Requirements
Design Check

Pipe Support Type	Minimum relative compaction % (AS1289.5.4.1 Standard Compaction)		
	Bed and haunch zones	Side zones	
		Cohesionless	Cohesive
U	—	—	—
H1	50	NA	NA
H2	60	NA	NA
H3	*	NA	NA
HS1	50	50	85
HS2	60	60	90
HS3	70	70	95

* Concrete, Grade N20 to AS 3600

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 Principal Certifier to be a likely problem, the Principal Certifier may specify cementitious stabilisation of the bedding material used in the bedding and haunch zones.

**Cementitious
Stabilisation**

C221.07 INSTALLATION – CONCRETE PIPES

(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 1200mm 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 Principal 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 Principal Certifier before the commencement of backfilling. | <i>Seal Lifting Holes</i> |
| 4. | The Principal Contractor shall present the laid and jointed pipes for inspection by the Principal Certifier prior to commencement of trench backfilling. This is a WITNESS POINT . | <i>Inspection by Principal Certifier</i> |
| | | WITNESS POINT |
|
(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 except for any lubricants recommended by the manufacturer. | <i>Clean and Dry Material</i> |
| 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 Principal Certifier. | <i>Procedure for Rolling Rubber Rings</i> |
| 3. | The joint shall be tested to ensure that the rubber ring has rolled evenly into place. | <i>Joint Test</i> |
| 4. | Where wedge shaped “skid” rubber rings are prescribed the Manufacturer’s instructions, which include the use of lubricants, shall be followed. | <i>“Skid” Rings</i> |
| 5. | Rubber ring joints shall be used on all curves, and anywhere within the road reserve or within the CBD areas. | <i>Locations</i> |
| (ii) Flush or Butt Joints | | |
| 1. | A flush or butt joint shall only be used where required to extend an existing culvert and only with the express written consent of the Principal Consultant. If a flush or butt joint is approved for use, it shall only be adopted at the interface between the existing culvert and the new Works. Socket and spigot joints shall be used thereafter. | <i>Jointing</i> |
| 2. | The Principal Contractor shall present the completed flush or butt joint for inspection by the Principal Certifier prior to commencement of backfilling. The Principal Contractor shall provide at least 24 hours notification prior to the intended joint inspection time. This is a HOLD POINT . | HOLD POINT |
| 2. | The joints shall be sealed with proprietary rubber sleeves, supplied and installed in accordance with the manufacturer's recommendations. | <i>Sealing</i> |
|
(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 not be permitted.

C221.08 BACKFILL – CONCRETE PIPES

1. Select Fill material (meeting the requirements of Table C221.2) placed in the side zones for pipe support type HS shall be compacted to the requirements shown in Table C221.3 when tested in accordance with AS 1289.5.4.1 for standard compactive effort.

Type HS Pipe Support

2. "Ordinary fill" placed in 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 Specification C213 EARTHWORKS. It shall be placed around the pipe to the dimensions shown in Figure C221.1.

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. Testing shall be carried out in accordance with this specification and the Development Control Specification – Quality Control Requirements (CQC).

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 Principal Certifier, is neither less than 60 per cent nor more than 95 per cent of the apparent optimum moisture content, as determined by AS 1289.5.4.1 (standard compaction).

Moisture Content

5. 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

6. When compacted adjacent to culverts or drainage structures, the Principal Contractor shall adopt compaction methods which will not cause damage or misalignment to any culvert or drainage structure. Any damage caused shall be rectified by the Principal Contractor. Backfilling and compaction shall commence at the pipe or wall so as to confine remaining uncompacted material at commencement.

Precautions

Principal Contractor's Cost

7. Material meeting the requirements of Table C221.2 Bedding and Haunch Zones or Table C221.2 Side Zones, may be used for Side zones, Overlay zones and Backfill for all pipe support conditions

STEEL PIPES AND PIPE ARCHES

C221.09 DELETED

TWIN WALL CORRUGATED POLYETHYLENE AND POLYPROPYLENE PIPES

C221.10 TWIN WALL CORRUGATED POLYETHYLENE AND POLYPROPYLENE PIPES

1. Twin wall corrugated Polyethylene and Polypropylene pipes shall conform to AS/NZS5065: Polyethylene (PE) and polypropylene (PP) pipes and fittings for drainage and sewerage applications.

*PE and PP
Pipes*

C221.11 EXCAVATION – PE AND PP PIPES

1. Excavation for twin wall corrugated polyethylene and polypropylene pipes shall be carried out in accordance with clause C221.05 and the pipe manufacturer's recommendations.

Excavation

C221.12 BEDDING – PE AND PP PIPES

1. Bedding for twin wall corrugated polyethylene and polypropylene pipes shall be carried out in accordance with clause C221.06 and the pipe manufacturer's recommendations.

Bedding

C221.13 INSTALLATION – PE AND PP PIPES

1. Installation of twin wall corrugated polyethylene and polypropylene pipes shall be carried out in accordance with clause C221.07 and the pipe manufacturer's recommendations.

Installation

C221.14 BACKFILL – PE AND PP PIPES

1. Backfilling of twin wall corrugated polyethylene and polypropylene pipes shall be carried out in accordance with clause C221.08 and the pipe manufacturer's recommendations.
2. The Principal Contractor shall take particular care when compacting overlay and back fill material above polyethylene and polypropylene pipes to ensure the pipes are not damaged or deformed. The Principal Contractor will submit a work procedure to the Principal Certifier prior to pipe installation confirming the proposed backfilling procedure.

Backfill

*Work
Procedure*

C221.15 RESERVED

C221.16 RESERVED

C221.17 RESERVED

UPVC PIPES

C221.18 UPVC 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 Plans.

2. Embedment material in the bedding, side support and overlay zones shall be in accordance with the material specified as 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.

Specification

C221.19 EXCAVATION AND BEDDING – UPVC PIPES

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

2. Figure 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 Approved Plans.

Formation to
Subgrade
Level

Bedding
Dimensions

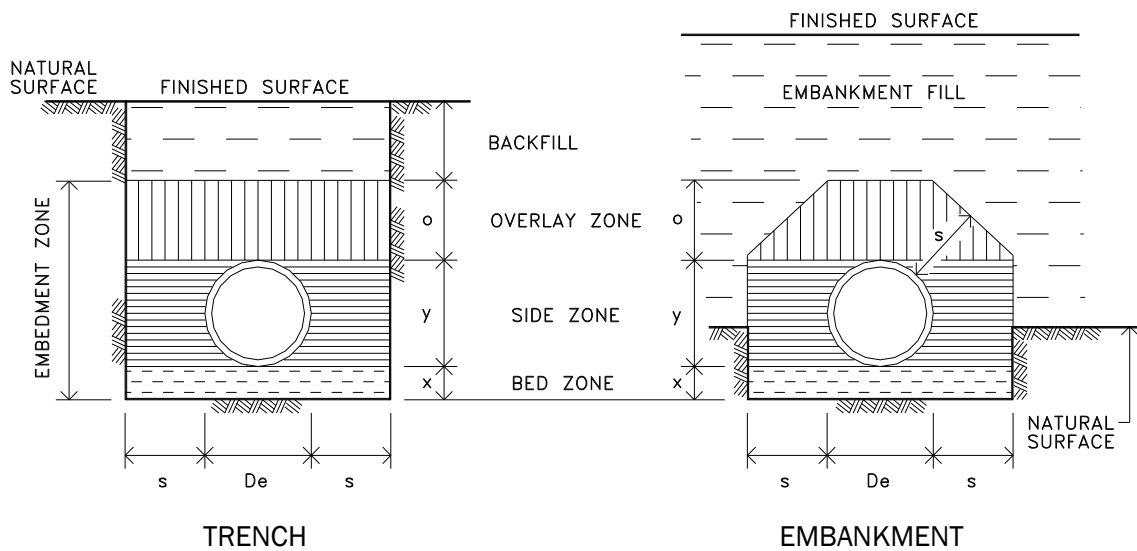


Figure C221.3 - Pipe Installation Conditions

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 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 it shall be compacted to a Density Index of 95 per cent (AS 1289.5.4.1 Standard compaction).

C221.20 INSTALLATION – UPVC PIPES

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 5 of AS 2032 and solvent-cement pipe jointing shall be in accordance with Part 4 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. The Principal Contractor shall present the laid and jointed pipes for inspection by the Principal Certifier prior to commencement of trench backfilling. This is a **WITNESS POINT**.

**Inspection by
Principal
Certifier**

**WITNESS
POINT**

C221.21 BACKFILL – UPVC PIPES

1. Compaction of the material in the side support and overlay zones shall comply with the requirements of clause C221.06 except that the side support and overlay zones shall be compacted to a Density Index of 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 Principal Certifier, is neither less than 60 per cent nor more than 95 per cent of the apparent optimum moisture content, as determined by AS 1289.5.4.1 (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

SPECIAL REQUIREMENTS

C221.22 EMBEDMENT MATERIAL UNDER ROADS AND KERBS

**Backfill under
roads**

1. For all pipe drainage located under roadways or kerbs, material in the bedding, haunch, side support, overlay zones and backfill shall be in accordance with the material specified as bed and haunch zone material in Clause C221.06.

Material

2. Compaction of the material in the bedding, haunch, side support, overlay zones and backfill shall comply with the requirements of clause C221.06 except that the required compaction of all material shall be of Density Index 70 (AS 1289.5.4.1 standard compaction).

Compaction

3. The final 200mm (minimum) of fill below the underside of Subbase shall be backfilled with material satisfying the requirements of Subbase material as per Specification C242 - FLEXIBLE PAVEMENTS, and shall have a minimum relative compaction of 98 per cent (AS 1289.5.4.1 standard compaction).

Capping

C221.23 TRENCH STOPS

Grade 10% or

1. Where a pipeline is laid on bedding at a grade of ten (10) percent or steeper, trench stops are to be provided in accordance with standard drawing ASD408. These will consist of polyethylene bags of minimum thickness 0.25mm filled with sand or other approved material and sealed in an approved manner. Hessian bags filled with cement-stabilised sand may be used as an alternative.

2. The distance between trench stops shall be determined by the following formula:

$$D = \frac{100}{G}, \text{ whereby}$$

D = Distance between stops in m,

G= Grade of pipe expressed in percent.

3. Note that trench stops may be required by the Principal Certifier or Council for grades less than 10% in some circumstances or soil types.

C221.24 CONCRETE BULKHEADS

1. Where a pipeline is installed at a grade of 15% or greater, concrete bulkheads are to be provided in accordance with standard drawing ASD 409 and constructed of Grade 25 concrete complying with Specification C271 MINOR CONCRETE WORKS.

Grade 15% or steeper

2. The distance between concrete bulkheads shall be determined in accordance with the table in standard drawing ASD431.

LIMITS AND TOLERANCES

C221.25 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
6.	Bedding Zone Compaction UPVC	≥95%	C221.20
7.	Backfill - UPVC Pipes		
	(a) Side and Overlay Zone Compaction	≥95%	C221.22
8	Under Roads and Kerbs		

Bedding Zone and Backfill	≥95%	C223.23
Capping (Subbase material)	≥95%	C223.23

Table C221.5 - Summary of Limits and Tolerances