

Australian/New Zealand Standard™

Buried flexible pipelines

Part 2: Installation



AS/NZS 2566.2:2002

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee WS-028, Design and installation of buried flexible pipes. It was approved on behalf of the Council of Standards Australia on 25 June 2002 and on behalf of the Council of Standards New Zealand on 27 June 2002. This Standard was published on 12 August 2002.

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Australian/New Zealand Standard™

Buried flexible pipelines

Part 2: Installation

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee WS-028—Design and Installation of Buried Flexible Pipes.

This Standard incorporates Amendment No. 1 (June 2013), Amendment No. 2 (May 2018) and Amendment No. 3 (November 2018). The changes required by the Amendments are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

This Standard is Part 2 of AS/NZS 2566 *Buried flexible pipelines*. The Parts are as follows:

Part 1: *Structural design*.

Part 1: *Structural design—Commentary*

Part 2: *Installation* (this Standard).

A2 | The purpose of Amendment 2 to AS/NZS 2566.2 is to update the text to reflect changes in AS/NZS 2566.1 Amendment 1, and to make editorial corrections.

Additionally, errors in Table 6.1 have been corrected.

The objective of this Standard is to provide designers and installers with uniform procedures for the installation of buried flexible pipelines.

The terms ‘normative’ and ‘informative’ have been used to define the application of the Appendix to which they apply. A ‘normative’ appendix is an integral part of the Standard, whereas an ‘informative’ appendix is for information and guidance only.

Statements expressed in mandatory terms in notes to figures and tables are deemed to be requirements of the Standard. All other notes are for information and guidance only.

Informative appendices and notes, except as mentioned above, use the word ‘should’ (implying for information and guidance only), whereas normative appendices, clauses, figures and tables use the word ‘shall’ (implying a mandatory requirement).

Where the term ‘specified’ has been used, but no reference given to where the requirement is to be found, the requirement is expected to be stated or referred to in other project documentation.

CONTENTS

	<i>Page</i>
SECTION 1 SCOPE AND GENERAL	
1.1 SCOPE.....	5
1.2 REFERENCED DOCUMENTS.....	5
1.3 APPLICATION	5
1.4 DEFINITIONS	6
1.5 NOTATION.....	10
1.6 WORK METHOD STATEMENT	11
1.7 ASSET PROTECTION.....	11
SECTION 2 TRANSPORTATION, HANDLING AND STORAGE	
2.1 SCOPE.....	12
2.2 TRANSPORTATION	12
2.3 HANDLING	12
2.4 ON-SITE STORAGE.....	13
SECTION 3 PIPELINE COMPONENTS ACCEPTANCE CRITERIA	
3.1 SCOPE.....	14
3.2 ACCEPTANCE CRITERIA	14
3.3 ACCEPTANCE AFTER RECTIFICATION.....	14
SECTION 4 EXCAVATION	
4.1 SCOPE.....	15
4.2 PRIOR TO COMENCEMENT	15
4.3 EXCAVATION METHOD.....	15
4.4 EMBEDMENT ZONE GEOMETRY	17
SECTION 5 INSTALLATION	
5.1 SCOPE.....	20
5.2 LAYING.....	20
5.3 FOUNDATION	23
5.4 EMBEDMENT ZONE.....	23
5.5 FILL ZONE	28
5.6 COMPACTION	29
5.7 DEFLECTION CRITERIA	31
5.8 ALTERNATIVE EMBEDMENT MATERIAL FOR PIPE RESTRAINT	31
SECTION 6 FIELD TESTING	
6.1 SCOPE.....	36
6.2 PURPOSE.....	36
6.3 PRESSURE PIPELINES—HYDROSTATIC PRESSURE TESTING	36
6.4 NON-PRESSURE PIPELINES—LEAKAGE TESTING.....	40
6.5 DEFLECTION TESTING.....	42
SECTION 7 COMMISSIONING	
7.1 GENERAL.....	43
7.2 CLEANING WATER SUPPLY PIPELINES.....	43
7.3 DISINFECTION OF DRINKING WATER SUPPLY PIPELINES.....	43

APPENDICES

A	LIST OF REFERENCED DOCUMENTS.....	44
B	INSTALLATION AND RELATED MANUFACTURING STANDARDS	47
C	GUIDE TO THE INSTALLATION PROCESS	48
D	WORK METHOD STATEMENT	50
E	ASSET PROTECTION.....	51
F	METHODS OF JOINTING	52
G	EMBEDMENT MATERIALS—PARTICLE SIZE AND GRADING LIMITS	56
H	EMBEDMENT AND FILL MATERIALS—COMPACTION	59
I	PREVENTION OF EMBEDMENT ZONE SOIL PARTICLE MIGRATION	62
J	SPECIFICATION FOR GEOTEXTILE FILTER FABRIC	63
K	CONTROLLED LOW STRENGTH MATERIALS—CLSM	64
L	STABILIZED SOILS AND AGGREGATES	68
M	FIELD HYDROSTATIC TESTING FOR PRESSURE PIPELINES.....	72
N	LEAKAGE TESTING FOR NON-PRESSURE PIPELINES	83
O	DIAMETRAL DEFLECTION MEASUREMENT.....	86

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Australian/New Zealand Standard **Buried flexible pipelines**

Part 2: Installation

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard specifies requirements for the installation, field testing and commissioning of buried flexible pipelines with structural design in accordance with AS/NZS 2566.1. These pipelines rely primarily upon side support to resist vertical loads without excessive deformation by adopting an elliptical shape.

NOTE: Australian and New Zealand Standards generally do not—

- (a) restate the duties of employers, employees, designers and installers;
- (b) determine the applicability of regulatory limitations; or
- (c) determine appropriate health and safety practices.

1.2 REFERENCED DOCUMENTS

The documents referred to in this Standard are listed in Appendix A.

1.3 APPLICATION

1.3.1 Applicable installations

This Standard applies to flexible pipes conveying water, wastewater, stormwater or slurry, for both pressure and non-pressure applications, or for flexible pipes serving as conduits for the later installation of cables or pipes.

This Standard is applicable to flexible pipes that are manufactured from the materials listed in Table 1.1, and that are—

- (a) homogeneous or composite;
- (b) creep affected (plastics) or unaffected (metallic); or
- (c) plain or structured wall.

Provided suitable data can be obtained, this Standard may be used for pipelines whose pipe materials are not given in Table 1.1 and where open cut excavation techniques are used.

NOTES:

- 1 Australian and New Zealand installation standards specific to different flexible pipe materials and their related manufacturing Standards are given in Appendix B.
- 2 Guidance, in the form of flow charts, to the installation process is given in Appendix C.

TABLE 1.1
TYPICAL FLEXIBLE PIPE MATERIALS

Plastics	Metallic
Acrylonitrile butadiene styrene (ABS)	Ductile iron (DI)
Glass filament reinforced plastics (GRP)	Steel
Modified PVC (PVC-M)	
Oriented PVC (PVC-O)	
Polyethylene (PE)	
Polypropylene (PP)	
Polyvinyl chloride (PVC-U)	

NOTE: Where the term 'PVC' only is used, it refers equally to PVC-M, PVC-O and PVC-U.

1.3.2 Other installations

This Standard, generally, does not apply in whole or part to—

- (a) aboveground pipe systems;
- (b) rigid pipes, e.g., fibre-reinforced concrete and steel-reinforced concrete, vitrified clay;
- (c) access chambers;
- (d) corrugated metal pipes, arches and non-circular shapes (see AS 1762, AS/NZS 2041 and AS 3703.2);
- (e) bored, jacked or mole-ploughed pipelines;
- (f) relining pipes;
- (g) submarine pipelines; and
- (h) pipe branches and fittings (e.g., service connections).

1.4 DEFINITIONS

For the purpose of this Standard, the definitions below apply.

1.4.1 Bedding zone

Subzone of the embedment zone between the foundation and the bottom of the pipe (see Figure 1.1).

1.4.2 Bulkheads and trenchstops

1.4.2.1 Partitions across a trench

Bulkheads and trenchstops are partitions built across a trench on sloping ground to prevent, or impede, the potentially rapid flow of surface and ground water through the embedment material and the subsequent erosion of embedment material and fill materials from the trench. Bulkheads have the additional function of retaining the pipe, to prevent longitudinal and lateral movement of the pipe on steeper gradients.

1.4.2.2 Bulkheads

Normally, a wall of concrete poured around the pipe, which is keyed into the trench walls and floor to form a pipe anchor, and which extends to within 300 mm of the finished surface level. Drainage holes, through the wall, are located in the lower part of the embedment zone to eliminate long-term retention of water behind the bulkhead.

1.4.2.3 Trenchstops

Normally, a wall of bags of sand, or cement-stabilized sand, which is packed around the pipe and across the trench and extends to within 300 mm of the finished surface level.

1.4.3 Clegg impact tester

A free falling mass, with a flat base, and accelerometer attached. Used to produce the Clegg impact value (CIV), expressed in units of tens of gravities, derived from the peak deceleration (see AS 1289.6.9.1).

1.4.4 Cohesionless soils

Non-plastic soils that do not exhibit a well-defined moisture-density relationship when tested in accordance with AS 1289.5.1.1 or AS 1289.5.2.1.

1.4.5 Cohesive soils

Plastic soils that exhibit well-defined moisture-density relationships when tested in accordance with AS 1289.5.1.1 or AS 1289.5.2.1.

1.4.6 Composite pipe

Pipe having more than one material in the wall.

1.4.7 Controlled low strength materials (CLSM)

High water content, high slump, low strength cementitious materials of suitable stiffness and stability used as an alternative to mechanically compacted granular material in the embedment or fill zones (see Appendix K).

1.4.8 Design pressure

The maximum system pressure at a point in the pipeline, considering future developments, static pressure, dynamic pressure and an allowance for surge.

1.4.9 Dynamic cone penetrometer

A steel cone on a shaft, which is struck by a hammer free falling onto its anvil. Used for determining the resistance of a soil to penetration. Penetration resistance (N_p) is in units of blows per 300 mm (see AS 1289.6.3.2).

1.4.10 Embankment fill zone

Zone of the embankment over the embedment zone (see Figure 1.1).

1.4.11 Embedment zone

Zone around the pipe including, bedding, haunch support, side support and overlay zones (see Figure 1.1).

1.4.12 Embedment materials

Material surrounding a pipe within the embedment zone.

NOTE: Bedding, haunch support, side support, overlay, trench fill and embankment fill materials are similarly defined.

1.4.13 Existing surface

Undisturbed ground level immediately prior to commencement of the works.

1.4.14 Flowable fill

A controlled low strength material.

1.4.15 Finished surface level

Design surface level after pipeline installation.

1.4.16 Flexible pipe

Pipe that relies primarily on the side support of the surrounding soil to resist vertical loads without excessive deformation.

1.4.17 Foundation

Naturally occurring or replaced material beneath the bedding zone.

1.4.18 Haunch support zone

That part of the side support zone located below the spring-line of the pipe and under the pipe (see Figures 1.1).

1.4.19 Homogeneous pipe

Pipe having one material in the wall with the same characteristics over the pipe wall section.

1.4.20 Nominal diameter or nominal size (DN)

An alphanumeric designation of diameter or size for components of a pipeline system, which is used for reference purposes. It comprises the letters *DN* followed by a dimensionless whole number.

NOTE: The number following the letters DN may not represent a measurable value and should not be used for calculation purposes except where specified in the relevant Standard.

1.4.21 Ordinary fill

Material obtained from the excavation or imported and containing not more than 20% by mass of rock with size between 75 mm and 150 mm and none larger than 150 mm.

NOTE: Assessment may be by visual inspection.

1.4.22 Overlay zone

Subzone of the embedment zone that is directly over the top of the pipe.

NOTE: Overlay material protects the pipe from damage and provides a means of distributing superimposed loads.

1.4.23 Perth sand penetrometer

A steel shaft that is struck by a hammer free falling onto its anvil. Used for determining the resistance of a soil to penetration. Penetration resistance (N_p) is in units of blows per 300 mm (see AS 1289.6.3.3).

1.4.24 Plain wall pipe

Homogeneous pipe with plain inside and outside wall.

1.4.25 Profiled wall pipe

Pipe with a non-uniform outside wall or designed hollow sections in the wall, or both (see also structured wall pipe Clause 1.4.34).

1.4.26 Rated (or class) pressure and PN

A long-term (i.e., design life) internal pressure capacity for a pipe, fitting or valve. For installation purposes, it is usually determined from the markings on the product, or obtained from the relevant product Standard or the manufacturer. The PN 'number' is used as a pressure rating for pipeline components. The number is 10 times the rated pressure in MPa, e.g., PN 12 rating means the allowable long-term internal pressure is 1.2 MPa.

1.4.27 Relative compaction

For cohesionless soils, the density index determined in accordance with AS 1289.5.6.1; and for cohesive soils, the standard dry density ratio determined in accordance with AS 1289.5.4.1, or the Hilf density ratio determined in accordance with AS 1289.5.7.1.

1.4.28 Rigid pipe

Pipe that supports vertical loads (full prism load of the soil) for its service life without significant ring deflection, and therefore without inducing significant horizontal pressure on the soil in the side support zone.

1.4.29 Selected fill

Material free from organic or other deleterious material obtained from the excavation or imported with a particle size for rock not greater than 20 mm or for other than rock not greater than 75 mm.

1.4.30 Side support zone

Subzone of the embedment zone to the side of the pipe between the bottom and top of the pipe (see Figure 1.1).

1.4.31 Soil (deformation) modulus

Measure of resistance of soil to compression.

NOTE: Estimated from Table 3.2 of AS/NZS 2566.1 using the soil classification system of AS 1726 and relative compaction. Alternatively, soil modulus may be estimated using established correlations with the standard penetration test, Clegg impact value, dynamic cone penetrometer, Perth sand penetrometer or nuclear density gauge measurements.

1.4.32 Springline

Projection of the horizontal centre-line to the walls of a pipe.

1.4.33 Static head

Vertical distance, usually expressed in metres, between the level of a point in a pipe under internal hydrostatic pressure and the level of the free water surface in a notional standpipe connected to it when the flow rate is zero.

1.4.34 Structured wall pipe

Either—

- (a) profiled wall pipe (see Clause 1.4.25); or
- (b) sandwich construction—a pipe with smooth inside and outside pipe walls separated by non-homogenous intermediate layer, e.g., PVC foamed or solid core.

1.4.35 Surge pressure

Short-term or transient pressure increase (or decrease) over steady state conditions due to changes in the flow in a pipeline (often referred to as water hammer). The magnitude of any surge pressures may differ significantly between pipe materials for the same operating conditions.

1.4.36 Test pressure

Hydrostatic, air or vacuum pressure applied to a pipeline being assessed for strength and water tightness. Hydrostatic pressure, at any point in the pipeline, is not less than the design pressure, and not more than 25% above the rated pressure of any pipeline component.

1.4.37 Trench fill zone

Zone between the overlay zone and any road pavement or surface reinstatement materials (e.g., topsoil).

1.4.38 Zone of influence for side support

Zone comprised of the surrounding soil beyond the embedment zone, to the side of the pipe between the bottom and top of the pipe (see Figure 1.2).

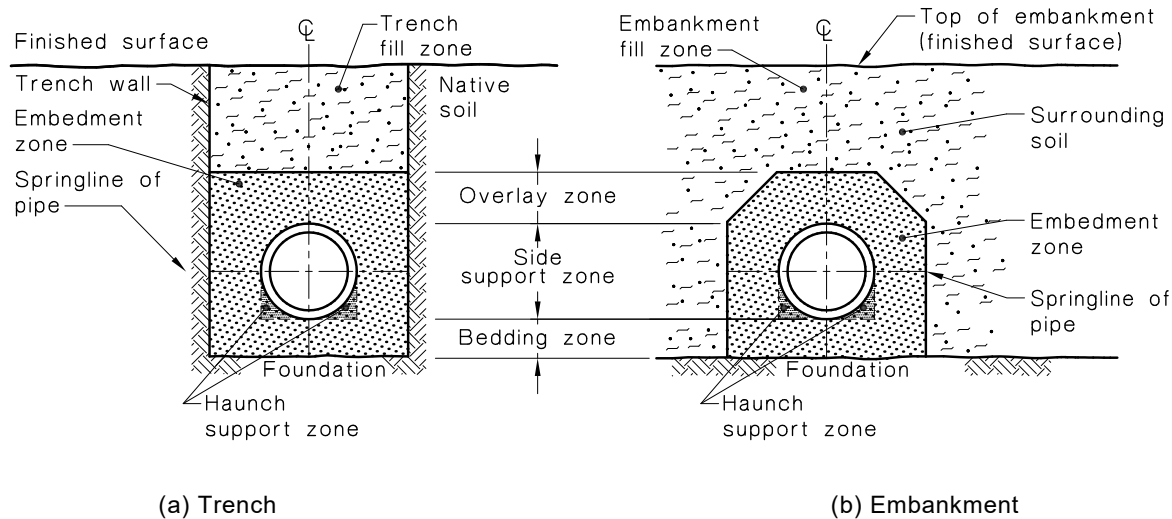


FIGURE 1.1 BURIED FLEXIBLE PIPE INSTALLATION—TERMINOLOGY

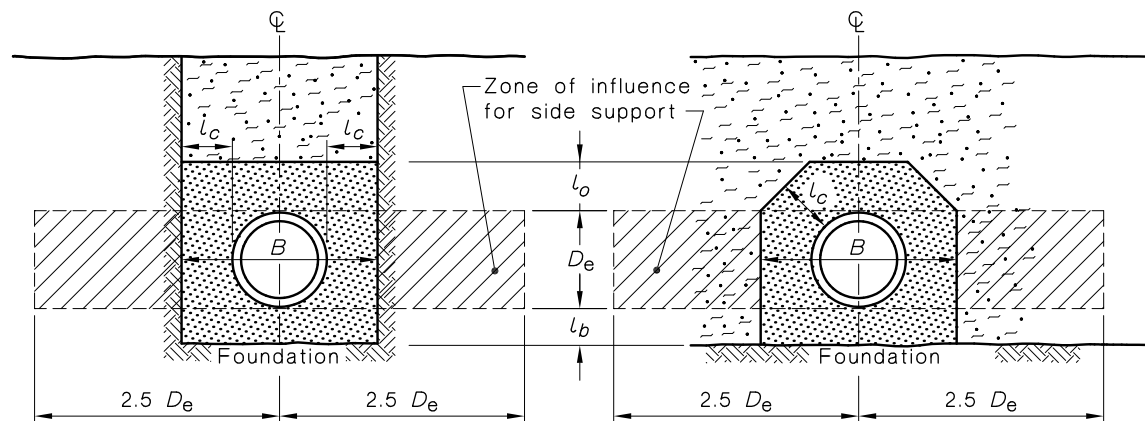


FIGURE 1.2 SIDE SUPPORT AND EMBEDMENT ZONE SYMBOLS

1.5 NOTATION

Notation not elsewhere defined in this Standard is given below and where appropriate is shown in Figure 1.2.

Symbol	Definition	Unit of measurement
B	= width of trench or embedment zone measured at the springline of the pipe	mm
D_e	= diameter of the most extreme external surface along the pipe barrel, averaged in two directions	mm
D_i	= (minimum) mean internal diameter, which is the average of the maximum and minimum internal diameters	mm
	NOTE: For plain wall pipes this may be derived from the mean outside diameter and maximum wall thickness, determined from AS/NZS 1462.1, Sections 2 and 3.	
H	= cover, vertical distance between the top of the pipe and the finished surface	mm

I_D	=	density index (see AS 1289.5.6.1)	%
l_b	=	depth of bedding below the bottom of the pipe	mm
l_c	=	horizontal distance between the spring line and the trench wall or permanent trench support (not distance to temporary trench supports)	mm
l_o	=	depth of overlay	mm
O_d	=	outside diameter of prover (tolerance ± 0.5 mm)	mm
R_D	=	dry density ratio (see AS 1289.5.4.1)	%
R_{HD}	=	Hilf density ratio (see AS 1289.5.7.1)	%
Δ_y	=	vertical pipe deflection	%
$\Delta_{y\text{ sall}}$	=	maximum allowable short-term vertical pipe deflection	%
$\Delta_{y\text{ sact}}$	=	actual short-term vertical pipe deflection	%

1.6 WORK METHOD STATEMENT

NOTE: Activities that should be addressed by a work method statement (WMS) are given in Appendix D.

1.7 ASSET PROTECTION

The installation of pipelines shall comply with Appendix E.

NOTE: Regulatory authorities may have additional requirements.

SECTION 2 TRANSPORTATION, HANDLING AND STORAGE

2.1 SCOPE

This Section specifies requirements for the transportation, handling and storage of flexible pipes and fittings.

NOTE: The requirements may vary depending on pipe and fittings material type.

2.2 TRANSPORTATION

Pipes shall be supported and secured in a manner to prevent excessive distortion of the pipe cross-section or bowing or twisting of the pipe length.

All supports, restraints and packing bearing on pipe and fitting surfaces shall be suitable, to prevent point loading, chafing, scoring, shock and other damage during transit. Wrapping or padding may be required. Chains shall not come into direct contact with pipes and fittings.

The height of pipe stacks shall be limited, to minimize deformation during transport. Nesting and stacking of pipes may be permitted, provided appropriate protection measures are taken.

Where necessary, the spigots, sockets, flanges and any special end treatments shall be protected from damage.

NOTES:

- 1 Pipes of low stiffness may require internal supports to maintain roundness.
- 2 Cement-lined pipes may require internal stays or supports in order to minimize the risk of transport and handling damage to the cement lining.

2.3 HANDLING

2.3.1 General

Pipes, fittings and accessories shall be handled in a manner that avoids damage. Pipes shall not be rolled, dragged or pushed. Pipes and fittings shall not be dropped, knocked together or knocked against other objects.

2.3.2 Unloading

All operations shall be carried out in a manner that—

- (a) ensures stability of the pipe stack, crane and vehicle;
- (b) ensures the transport vehicle is level prior to releasing restraint mechanisms; and
- (c) prevents damage to pipeline components.

Pipe crates shall be removed without disassembling the crates where possible. Pipes and fittings shall not be dragged across the truck bed or edges or other hard sharp surfaces. Pipes and fittings shall not be pushed off the delivery vehicle, or be allowed to drop to the ground.

2.4 ON-SITE STORAGE

Suitable storage sites of sufficient area shall be chosen. Where necessary, the storage area shall be cleared of hazardous combustible vegetation or appropriate measures shall be taken to minimize the risk of fire damage. Pipe and fittings storage areas shall not obstruct property access or pedestrian routes. Pipe and fittings storage areas shall be in locations that allow easy access to handling machinery. Pipe shall be stored at least 2 m away from the side of a trench.

Pipe stacks shall be on level firm ground or the base of the pipe stack shall be made level using suitable packing. Singly stored pipes and pipe in pipe stacks shall be securely chocked to prevent rolling or pipe displacement from a pipe stack.

Plastic pipes, or plastic-coated pipes, shall not be stored within a distance of heat-emitting equipment, such as unprotected engine exhausts, such that the heat from the equipment will affect the material properties of the pipes, or cause the pipes to bend due to differential heating.

Where necessary, pipes shall be supported clear of the ground on sandbags, soil mounds, timber bolsters or similar, at sufficient support spacing to prevent excessive longitudinal bending of pipe lengths.

Pipes with end treatments, such as flanges or pre-assembled fittings or couplings, shall be stacked so that the ends are free from loading. Where necessary, they shall be protected from damage.

When pipes are stored in stacks, bottom layers may become distorted. The height of pipe stacks shall be limited, to minimize ovalization and distortion while stored. Pipe crates shall be stacked with timbers touching (either side by side or top to bottom) and with light duty crates on top and heavy duty at the bottom, as appropriate. Where necessary, pipes shall be removed from stacks for re-rounding prior to installation.

For nested pipes (that is, pipes stored inside pipes of a larger diameter), the number of supports between layers shall be increased accordingly.

Heat entrapment within stored pipe and fitting packs shall be avoided by appropriate means including ventilation and storage locations remote from high heat appliances.

Where the total exposed storage is likely to exceed 12 months, or where material properties are likely to be affected by ultraviolet radiation, or high temperature, additional protection from such exposure shall be provided.

NOTE: This additional protection may be provided by under-cover storage of pipes and fittings, or by covering stored pipes and fittings with an appropriate material such as hessian.

Coated pipes shall be positioned during transportation, storage and handling to facilitate inspection of coatings all round, and to minimize the potential for damage to coatings.

Elastomeric seals shall be stored in accordance with AS 1646.

NOTE: Manufacturers and transport agencies may be able to provide advice on the above requirements.

SECTION 3 PIPELINE COMPONENTS ACCEPTANCE CRITERIA

3.1 SCOPE

This Section specifies acceptance criteria for pipeline components, and methods for repair of defects and damaged components.

3.2 ACCEPTANCE CRITERIA

Pipeline components (pipes, fittings and accessories) shall be thoroughly inspected, internally and externally, on delivery and immediately prior to installation, for compliance with product specifications and to ensure no damage has occurred. However, components in sealed packaging shall not be removed for inspection until immediately prior to installation.

Acceptance criteria for pipes, fittings and pipeline accessories (e.g., elastomeric seals, solvent cements and lubricants) on delivery and immediately prior to installation shall be as follows:

- (a) All product materials, diameters, lengths, pressure and stiffness ratings, joint types, fitting types and accessories shall comply with project specifications.
- (b) No product (e.g., solvent cements and priming fluids) use-by date shall have elapsed.
- (c) Seals and gaskets shall have no cuts, weathering damage, deleterious materials or dislodgment that could impair performance in service.
- (d) Pipeline component jointing surfaces, coatings and wall structures shall have no defects or damage that could impair component performance in service.
- (e) The following material-specific criteria shall also apply.
 - (i) *GRP*—AS 3571 Appendix B.
 - (ii) *ABS/PE/PP/PVC*—Cuts or scratches on pipes or fittings shall be within the limits specified in the relevant product Standard or relevant material-specific installation Standard; and
 - (iii) *Metallic (DI and steel)*—Damaged or defective linings and coatings shall comply with acceptability criteria as follows:
 - (A) Cement mortar lining crack width shall be within the limits specified in AS/NZS 2280 for DI, or AS 1281 for steel; and
 - (B) In Australia, steel pipe fusion bonded PE coatings and linings shall comply with the relevant requirements of AS 4321. In New Zealand, an approved alternative may be used.
 - (C) Other coatings and linings shall comply with the relevant Standard.

Pipeline components that do not comply with acceptance criteria shall not be installed in the pipeline.

3.3 ACCEPTANCE AFTER RECTIFICATION

For acceptance, rectification of damage or defects to pipeline components shall be in accordance with methods, approved by the specifier, that ensure a service performance at least equivalent to that of undamaged components.

SECTION 4 EXCAVATION

4.1 SCOPE

This Section specifies the requirements for pipeline excavations.

NOTE: In meeting these requirements it may be necessary to seek professional geotechnical advice.

4.2 PRIOR TO COMENCEMENT

The following requirements apply, prior to commencing any excavation:

- (a) The soil and ground water conditions shall be determined along the route of the pipeline to a depth at least to the design foundation level. The requirement of Clause 4.3.2 shall be applied. Soil and ground water conditions at, and below, the embedment zone depth shall be compared to the conditions adopted for design, and any adjustments to design and installation requirements shall be made.
- (b) The location of existing services in close proximity to the pipeline route shall be identified and marked.
- (c) Trench support systems shall be selected to prevent disturbance to adjacent structures and services.

NOTES:

- 1 In Australia, for the location of buried services, the 'dial before you dig' number is 1100 and internet address is www.dialbeforeyoudig.com.au. In New Zealand, there is no central agency with information on buried services. In Australia and New Zealand, installers are advised to make their own due diligence inquiries regarding the location of buried services.
- 2 The results of all relevant sub-surface investigations carried out for the purpose of pipeline design should be made available to the installer for determination of an appropriate excavation methodology.

4.3 EXCAVATION METHOD

4.3.1 General

An effective and efficient excavation methodology, which minimizes environmental impact, shall be employed.

The condition of existing services exposed by excavation shall be checked upon exposure and routinely monitored. The service owner shall be notified where existing services are found to be damaged.

Where compaction of the embedment material in an embankment to the required density is not possible owing to the absence of side containment, the embankment shall be first constructed to top of the pipe and then a trench cut for installation of the pipeline.

From commencement of excavation, trenches shall be maintained in a stable condition to prevent movement or collapse. The length of trench open at any one time shall be minimized.

The trench centre-line shall align with the design centre-line for the pipeline within tolerances specified.

4.3.2 Suitability of natural trench wall and foundation material

Soil types and soil condition shall be routinely monitored. Each occurrence of significant differences from the predicted soil type or conditions exposed by excavations shall be notified to the pipeline specifier, who shall determine the need for and, where required, obtain specialist geotechnical advice. Pipeline installation at the affected length of pipeline shall cease and shall not recommence until the structural design has been re-evaluated and confirmed or modified.

NOTE: Significant differences in soil type or conditions include—

- (a) a native soil of lower stiffness than that used for structural design of a pipeline;
- (b) the foundation material is suspected of being fissured with the potential for allowing escape of embedment material, unstable, or of low bearing capacity; and
- (c) the proximity of other structures to the pipeline not envisaged in the design.

4.3.3 Minimum cover

Minimum pipeline cover shall be specified to—

- (a) ensure surcharge loadings, e.g., traffic and construction equipment, are not concentrated but instead are distributed over an adequate area;
- (b) give sufficient clearance to overlying layers that require heavy mechanical compaction, e.g., road sub-bases; and
- (c) ensure the pipe or side support is appropriate, having regard to the proposed land use and any foreseeable lowering of finished surface levels.

The cover (H) shall not be less than the values given in Table 4.1.

TABLE 4.1
MINIMUM COVER (H)

Loading condition	Minimum cover H^* m
Not subject to vehicle loading	0.30
Land zoned for agricultural use	0.60
Subject to vehicular loading—	
(a) no carriageway;	0.45
(b) sealed carriageways; and	0.60
(c) unsealed carriageways	0.75
Pipelines in embankments or subject to construction equipment loads	0.75

* Subject to variation by the relevant asset owner. Under cultivated agricultural land H should not be less than 0.6 m. Railway crossings shall comply with AS 4799.

4.3.4 Road surface cutting

The road pavement shall be cut wider than the trench excavation, to ensure that the re-instated pavement bridges onto undisturbed road material by a sufficient margin to provide adequate foundation for the road. Such margin shall be greater than or equal to 150 mm clear from any excavation cutting.

4.3.5 Dewatering

Excavations shall be kept free of water to maintain the stability of the surrounding soil and to provide suitable working conditions until the pipeline has been installed and embedment and fill materials placed and compacted to a sufficient height, to prevent flotation of the pipeline.

Groundwater shall be kept below the bottom of the cut to prevent wash-out or sloughing of exposed walls. Where sloughing occurs, the resulting loose material shall be removed so that it cannot interfere with the placement and compaction process.

NOTE: Sloughing in the void behind a shield may be prevented by filling it with cohesionless material (embedment material) promptly (see Clause 5.4.6 and Figures 5.4 and 5.5).

Water removed by the dewatering process shall be disposed of in accordance with the relevant environmental protection requirements.

NOTE: Dewatering is normally carried out with well points, or sump pumps and geotextile mattress.

4.3.6 Use of explosives

Where explosives are intended to be used, a blasting proposal outlining management of the process shall be submitted for approval by the relevant authority and asset owner.

4.4 EMBEDMENT ZONE GEOMETRY

4.4.1 Trench width at embedment zone level

The width of the trench shall be as specified.

The minimum width of trench, measured at the springline, shall comply with Table 4.2 and shall be sufficient for—

- (a) the placement and compaction of embedment materials, particularly below the pipeline springline in the haunch support area, to ensure complete filling with material to the specified relative compaction; and
- (b) the making and inspection of joints.

NOTES:

- 1 The use of CLSM may allow ' l_c ' to be reduced to 50% of that given in Table 4.2.
- 2 Localized widening and deepening may be necessary to allow for jointing, e.g., welding of pipes in the trench, and the installation of valves, fittings and associated thrust or anchor blocks.

TABLE 4.2
MINIMUM EMBEDMENT ZONE DIMENSIONS

D_e	Minimum dimension				millimetres
	l_b	l_c (see Note 2)	l_o	$B = D_e \ 2l_c$	
$\geq 75, \leq 150$	75	100	100	275 – 350	
$> 150, \leq 300$	100	150	150	450 – 600	
$> 300, \leq 450$	100	200	150	700 – 850	
$> 450, \leq 900$	150	300	150	1050 – 1500	
$> 900, \leq 1500$	150	350	200	1600 – 2200	
$> 1500, \leq 4000$	150	$0.25D_e$	300	2250 – 6000	

NOTES:

- 1 The objective is to achieve uniform compaction of the embedment material.
- 2 The tabulated values may provide insufficient clearances for installation purposes in certain circumstances.
- 3 The minimum spacing between adjacent parallel pipelines shall be determined from Clause 5.2.6.
- 4 Refer to Figure 1.2 for definitions of l_b , l_c , l_o .

4.4.2 Trench width above embedment zone

The trench width above the embedment zone shall be determined by taking into account the stability of the trench wall material and any trench support.

NOTE: The shape of this part of the trench, according to the design method specified in AS/NZS 2566.1, does not vary the magnitude of load on the pipeline.

4.4.3 Embedment zone dimensions for embankments

Where embankments are to be constructed from material that is unsuitable for contact with the pipeline, embedment material shall be placed and compacted to ensure the embedment zone complies with the minimum dimensions given in Table 4.2.

4.4.4 Gradient and depth

The finished excavation level of the foundation, or the level of compacted material placed to restore over-excavation of the foundation, shall have—

- (a) levels in accordance with the depths and gradients specified; and
- (b) an evenly modified gradient between specified gradient changes.

Where the pipeline is to be laid directly on the naturally occurring foundation (bottom of trench), the foundation shall be graded as for standard bedding and shall provide continuous support for the pipe barrels.

4.4.5 Over-excavation of foundation

Where the foundation is excavated below that required, to achieve the depths and gradients given in Clause 4.4.4, the over-excavation shall be filled with embedment material and compacted in accordance with Clause 5.6.

4.4.6 Variation from specified trench or embedment zone width

Where the embedment zone width will be other than as specified at springline, pipeline installation shall cease until the structural design has been reviewed to determine whether greater side support compaction and greater pipe stiffness is required.

4.4.7 Pockets for pipeline projections

Pockets for pipeline projections such as pipe sockets, flanges, and couplings shall be provided, as required, to ensure the embedment zone requirements are met and the pipeline is fully supported along the pipe barrels. The pockets shall be excavated in the bedding material, or in the bottom of the trench for pipelines without bedding (see Clause 4.4.4) or where the depth of the projection exceeds the depth of bedding material.

NOTE: Most pipe sockets offer minimal protrusion, and thus require minimal pocket or none. Over-excavation of pockets along the pipe barrel should be avoided as it reduces support for the pipe barrel.

4.4.8 Clearances for on-site works

Where personnel will require access for welding or application of corrosion protection, clear space shall be provided, measuring at least 0.5 m in all directions from the workface, in the bottom and the wall of the trench.

4.4.9 Excavation for structures for pipeline restraint and component support

Additional excavation shall be undertaken for—

- (a) thrust and anchor blocks, to longitudinally restrain pressure pipelines from internal pressure thrust;
- (b) bulkheads, to longitudinally restrain pipelines from slippage on steep slopes; and
- (c) concrete pads, to support heavier structures such as valves.

The size of the excavation shall be sufficient to ensure that the specified covers, gradients or invert levels for the pipeline are maintained and that the pipe barrels retain continuous bedding material support.

SECTION 5 INSTALLATION

5.1 SCOPE

This Section specifies requirements for the installation of pipeline components.

5.2 LAYING

5.2.1 Inspection immediately prior to laying

Pipeline components shall be inspected immediately prior to laying, in accordance with Section 3.

5.2.2 Handling and storage

Handling and storage of pipes and fittings shall comply with Clauses 2.3 and 2.4.

5.2.3 Positioning the pipeline

Pipes shall be positioned in the trench such that the embedment material can be placed and compacted as required. Any necessary adjustments to the alignment of a pipe shall be done by re-lifting the pipe without disturbing the integrity of the joint and placing it in the correct position. Correcting the alignment shall be performed such that the pipe, or fitting, and its protective coating are not damaged.

5.2.4 Joint deflections in a pipeline

Angular deflection of a pipe or fitting at a pipeline joint from a straight alignment shall be limited by a specified maximum angular deflection. Pipeline joints shall be made with the mating pipe or fitting in straight alignment with the preceding pipe or fitting before moving it off-line to achieve the desired angular deflection. The deflected pipe or fitting shall be sufficiently embedded to prevent movement prior to jointing of the next pipe.

NOTES:

- 1 For pipelines with jointing systems that are designed to permit angular deflection, incremental changes in alignment, gradient or level may be achieved by deflecting individual pipe lengths at a number of joint positions.
- 2 Some pipe types will allow cutting of the pipe length on site, so a tighter curvature may be possible using shorter pipe lengths.

5.2.5 Bending the pipeline

The bending of a pipeline is dependent on pipe material, pipe size, wall thickness and allowable joint deflection (see Clause 5.2.4). Bending shall not exceed specified limits. A pipeline joint shall be made in a straight line before bending to the required radius. The curvature of bending shall be uniformly distributed along the pipe length. Temporary pegs or stakes for restraining or holding the curved pipe shall be removed after completion of pipelaying and embedment material placement as these may cause unacceptable localised stresses in the pipe.

5.2.6 Adjacent parallel pipelines

Spacing between adjacent parallel pipelines, laid concurrently, shall be sufficient to ensure that the required compaction and support of the side support material is achieved. Minimum clear distances between pipes, for mechanically compacted embedment materials and flowable embedment materials, are given in Table 5.1. Where pipes are of different diameters the minimum spacing shall be the sum of the diameters divided by two, e.g., in common trenching.

NOTE: Excavations parallel to, and level with or deeper than, existing pipes can result in the failure of the existing pipes, due to the removal of their side support system.

TABLE 5.1
MINIMUM SPACINGS BETWEEN PARALLEL PIPELINES
(LAID CONCURRENTLY)

External diameter D_e	Minimum spacing l_p (see note)	
	Compactable embedment material	Controlled low strength embedment material (CLSM)
$\geq 75, \leq 150$	100	50
$> 150, \leq 300$	150	75
$> 300, \leq 450$	200	100
$> 450, \leq 900$	300	150
$> 900, \leq 1500$	350	175
> 1500	$D_e/4$	200

NOTE: The tabulated values may provide insufficient clearances for installation purposes in certain circumstances.

5.2.7 Horizontal or vertical separation of crossing pipelines

Where pipelines cross, the minimum vertical separation shall be the greater of the sum of the diameters divided by four, or 100 mm, between pipelines. This separation shall be filled with compacted embedment material.

Where 100 mm separation is not possible, or is impracticable, the separation may be reduced to a minimum of 50 mm with the agreement of the service owner(s) concerned. Compressible packing (e.g., expanded polystyrene) shall be used between the pipes to reduce the risk of point loading.

5.2.8 Storage in direct sunlight or hot weather

Measures shall be taken to minimize exposure of thermoplastics pipes to direct sunlight, such as storage under shelters or cover with hessian or light-coloured plastic sheeting in the period prior to laying.

NOTE: The purpose is to maintain even heat around the circumference of the pipe and thus to keep pipes straight prior to laying.

5.2.9 Provision for expansion and contraction

5.2.9.1 Thermal effects

Where an elastomeric seal joint is located at the end of a string of joint-restrained pipes (e.g., welded, flanged, elastomeric seal with locking segments), the joint shall be prevented from pulling apart, for example, by installing some form of anchorage (see also Clause 5.2.9.2).

NOTE: Where the air temperature is hotter or colder than the ground temperature, pipe lengths will contract or expand in length on adjustment to ground temperature. Typical values for thermal coefficients of expansion are given in Table 5.2. Tensile stresses may be minimized by restricting the making of final connections and backfilling to the cooler part of the day. Where elastomeric seal socket-spigot jointing is used such measures are not necessary.

5.2.9.2 Potential shortening of the pipeline due to pressurization (Poisson's ratio effect)

Pressurization of the pipeline may result in shortening of the pipeline if it is left unrestrained. Where elastomerically sealed joints are introduced into joint-restrained pipelines (e.g., welded, flanged, elastomeric seal with locking segments), those joints shall have sufficient capacity to accommodate the axial movement. Alternatively, pipeline restraints shall be constructed in accordance with the design.

TABLE 5.2
TYPICAL THERMAL LINEAR
EXPANSION COEFFICIENTS

Pipe material	Thermal linear expansion coefficient (typical values) $10^{-6} \text{ m/m.}^{\circ}\text{C}$
Plastics	
ABS	100
GRP	20
PE	200
PP	150
PVC	70
Metallic	
DI	11
Steel	12

5.2.10 Temporary internal struts

Temporary struts that are used to prevent ovalization during transport and storage shall be removed before pipes are laid, and, where necessary, the internal liner shall be reinstated.

5.2.11 Pipe laying tolerances

Pipelines shall be laid with all alignments, levels and gradients within the tolerances specified.

5.2.12 Jointing methods

Jointing shall comply with the relevant material specific installation Standard, where applicable.

NOTES:

- 1 For the pipes and fittings of the materials given in Table 1.1, the usual methods of jointing are given in Table 5.3.
- 2 Basic principles of the methods for jointing are given in Appendix F.

5.2.13 Removal of pegs and packing

All levelling pegs or temporary packing, such as wooden blocks and internal props, shall be removed during the laying process.

TABLE 5.3
TYPICAL METHODS OF JOINTING

Pipe material	Joint type				
	Elastomeric seal	Solvent cement	Thermal weld	Mechanical	
				Flanged	Couplings
Plastics					
ABS	Y	Y	NA	Y	Y
GRP	Y	NA*	NA	Y	Y
PE	Y	NA	Y	Y	Y
PP	Y	NA	Y	Y	Y
PVC-M	Y	Y	NA	Y	Y
PVC-O	Y	NA	NA	Y	Y
PVC-U	Y	Y	NA	Y	Y
Metallic					
DI	Y	NA	NA	Y	Y
Steel	Y	NA	Y	Y	Y

* GRP Laminated joint available.

Y = generally available.

NA = generally unavailable.

5.3 FOUNDATION

The foundation shall be as specified.

NOTES:

- 1 Native soils in the foundation material should be able to support the loads placed on it and should be graded or excavated to provide an even bed and maintain alignment of the pipes.
- 2 Very soft or expansive clays, irregular or fragmented rock, and saturated soils, are unsuitable foundations and should be avoided. Where avoidance is impracticable, most of these situations may usually be overcome by adequate drainage of ground water, removing the unsuitable material and replacing it with compacted embedment material (see also Clause 4.3.2).

5.4 EMBEDMENT ZONE

5.4.1 Migration of fines

Where there is a possibility of migration of fines between the native soil and the embedment zone, a geotextile filter fabric, complying with Appendix J and as illustrated in Figure 5.1, shall be provided to ensure that the integrity of the side support to the pipe is not compromised. Alternatively, the embedment material may be graded appropriately (see Appendix I).

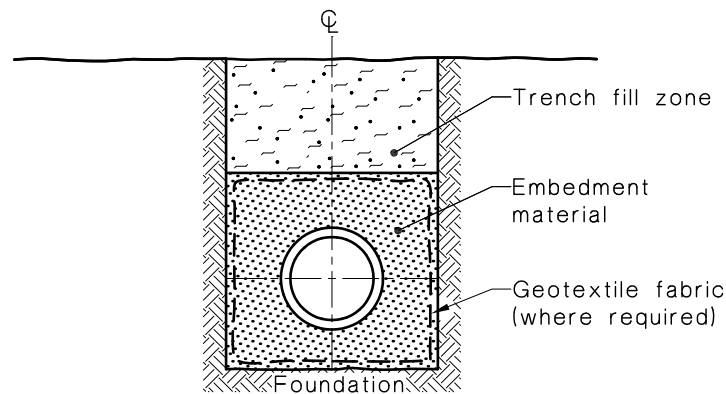


FIGURE 5.1 PREVENTION OF FINES MIGRATION
USING GEOTEXTILE FILTER FABRIC

5.4.2 Materials

5.4.2.1 Material types

The material in the embedment zone may consist of—

- (a) selected cohesionless soils (see Appendix G);
- (b) controlled low strength materials (CLSM) (see Appendix K); and
- (c) stabilized soils (see Appendix L).

NOTES:

- 1 Selected cohesive soils may be used when approved by the specifier. They are more difficult to place and compact and should only be considered for shallow pipelines not subject to imposed live loads (see Appendix H).
- 2 The higher the granular content of the embedment material, particularly a higher gravel content, the more supportive it becomes to the pipe, where an equivalent compactive effort is used.
- 3 The requirements of this Clause may not preclude non-conforming materials provided they have the consistency and moisture content suitable for placement (without segregation) and can be compacted to achieve the specified soil modulus/density (see Section 3 of AS/NZS 2566.1).
- 4 Sharp granular embedment material should not be used with some pressure pipe materials as it can either score the external surface of the pipe, or damage the protective coatings and sleeving.

5.4.2.2 Material composition

The embedment material shall—

- (a) comply with the maximum particle sizes of Table 5.4 and be of a particle size and grading that will allow the specified relative compaction to be achieved with the intended compaction methods;
- (b) contain no organic material that will affect embedment material performance;
- (c) be free of materials that would be physically or chemically harmful to any pipeline component, including any protective coating; and
- (d) for unprotected metallic pipes, be a granular fill with a resistivity greater than 50 $\Omega \cdot \text{m}$, when tested in accordance with AS 1289.4.4.1.

TABLE 5.4
MAXIMUM PARTICLE SIZE

Nominal pipe diameter <i>DN</i>	Maximum particle size mm
< 100	10
≥ 100 ≤ 150	14
> 150	20

5.4.2.3 Free-draining material

Where free-draining material is present as embedment material, soil migration into the voids shall be prevented by the use of appropriate particle size gradings (see Appendix G, Paragraph G2). Alternatively, the embedment material may be enveloped in geotextile filter fabric that overlaps by at least 300 mm and complies with Appendix J.

NOTE: For guidance on the use of graded embedment material to restrict soil particle migration into the embedment material, see Appendix I. Other solutions are given in Clause 5.4.3.

5.4.3 Trench drainage during construction

Where dewatering of the trench is required, the following options may be adopted:

- (a) A geotextile mattress, comprised of a layer of free-draining embedment material enveloped in a geotextile filter fabric, which overlaps by at least 300 mm and complies with Appendix J (see Figure 5.2).
- (b) Drainage pipes, of appropriate diameter, perforation size and stiffness, with geotextile filter socks, may be incorporated in the pipeline foundation or bedding zone, to minimize migration of fines and the creation of voids in the surrounding native materials.

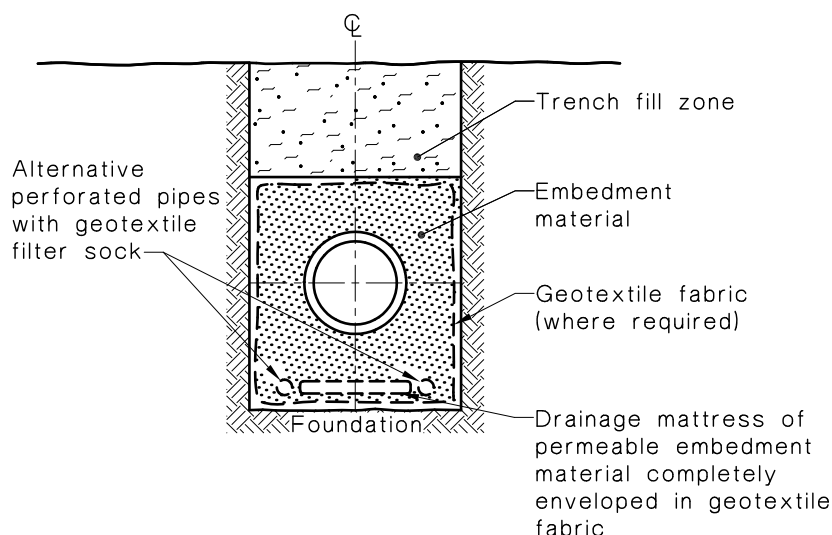


**FIGURE 5.2 DRAINAGE MATTRESS FOR DEWATERING
DURING CONSTRUCTION**

5.4.4 Placement and compaction

5.4.4.1 Bedding material

The bedding material shall be embedment material placed and compacted to the specified relative compaction, and thus to uniformly support the pipeline.

NOTE: In accordance with AS/NZS 2566.1, the relative compaction of the bedding material is that specified for embedment material. To achieve a specified relative compaction, the compactive effort will depend on the type of embedment material chosen (see Clause 5.6).

The bedding material surface shall be graded to the specified tolerances to ensure the bedding material surface is smooth and the pipeline is offered continuous support. Following grading, and where required compaction, pockets for sockets, couplings, flanges or other projections shall be excavated in the bedding material, so as to ensure the pipeline is fully supported along the pipe barrels. Such pockets shall be the minimum necessary to keep the projection clear of the bedding material, except where access for joint treatment may require additional excavation (see Clause 4.4.7).

5.4.4.2 Side support and overlay

The side support and overlay material shall be placed in a manner to ensure—

- (a) uniform distribution and compaction of embedment material, especially under the haunches of the pipeline;
- (b) the material relative compaction is consistent with design;
- (c) pipeline distortion is minimized;
- (d) the pipeline and any coatings are not damaged; and
- (e) the specified pipeline alignment, level and grade is maintained.

The side support and overlay material shall be placed in layers of appropriate thickness for the method of compaction, to achieve the relative compaction or soil modulus specified. The side support material shall be brought up evenly on each side of the pipe.

NOTE: The diametral deflection should be checked on completion of the backfilling operation and should not exceed the allowable short-term deflection criterion of Clause 5.7.

Compaction shall comply with Clause 5.6.

5.4.5 Interface with the native soil

The embedment material shall be compacted to achieve a specified relative compaction or stiffness between the pipe and the interface with the native soil.

NOTE: The design of a flexible pipe installation takes into account the effects of both the embedment material and the native soil to a distance of 2.5 times the pipe diameter on each side of the pipe centre-line (see Figure 1.2).

5.4.6 Trench Support Systems

Shield removal shall be done by lifting in stages, to enable all voids to be filled by adding embedment material and allowing for additional compaction to achieve the required relative compaction over the whole side support zone (see Figure 5.4).

Where shields have to be used in the side support zone, and where, as a result of over-excavation, there is space behind them, the space at pipe level behind the shields shall be filled with good quality embedment material to prevent the accumulation of loose uncompacted debris (see Figure 5.5).

NOTES:

- 1 It is preferable that embedment material be compacted with the shields raised (see Figure 5.3 and Figure 5.4).
- 2 Shields that are a 'tight fit' in the excavation are more effective in preventing subsidence in surrounding ground. However, when removed, these shields will leave voids in the critical pipe side support zone.