SEWERMAX® & SEWERMAX+® TECHNICAL GUIDE

Polypropylene Structured Wall Systems for Gravity Sewer applications

May 2025

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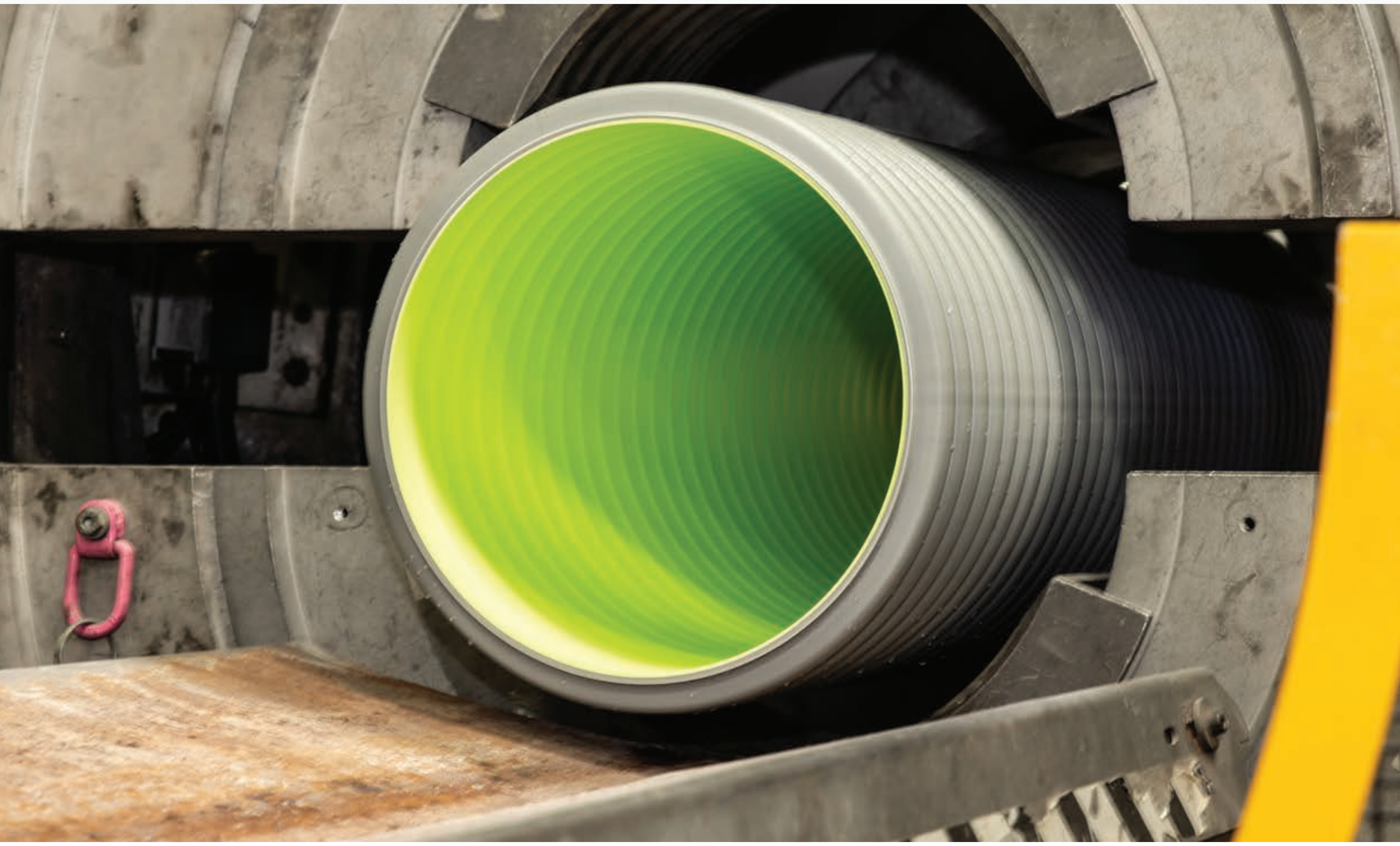


SewerMax+ pipe manufacturing process

1.0 INTRODUCTION

Iplex is a major Australian manufacturer and supplier of plastic pipes and fittings suitable for civil, plumbing, irrigation, industrial and mining applications. As a leader in plastic pipe technology, Iplex has continued to develop innovative products offering solutions for the demanding service and environmental needs of today. To meet these requirements, Iplex has introduced SewerMax and SewerMax+ for gravity sewer applications.

SewerMax and SewerMax+ are cost-effective alternatives to conventional pipe systems, with improved performance and exceptional durability. They are corrosion and abrasion resistant, which limit the life of more conventional materials.

The profile wall structure provides an efficient use of material, producing a pipe with high ring stiffness and low mass. As a result, pipes are only a fraction of the weight of conventional materials and can readily withstand both installation and service loads. Figure 1.1 and figure 1.2 illustrate the wall cross-section.

SewerMax pipes and fittings are manufactured in diameters DN225 up to DN1200* in 3m nominal lengths and are classified as SN10.

Heavy wall SewerMax+ pipes are manufactured in sizes DN225 up to DN525 in 3m nominal lengths and are classified as SN20.

*Larger diameters coming soon – for more information contact Iplex.

1.1 MANUFACTURE

SewerMax and SewerMax+ pipes are manufactured using a combined continuous extrusion and vacuum moulding process. The polypropylene pipe wall structure is comprised of a solid smooth inner wall and profiled outer wall. The inner and outer walls are extruded simultaneously and fused together circumferentially at the trough of each corrugation. This wall construction results in a high-stiffness pipe with a smooth inner bore which can be cut and re-joined anywhere along its length.

SewerMax and SewerMax+ pipes and fittings are manufactured to Australian and New Zealand Standard, AS/NZS 5065 'Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications' and carry StandardsMark and WaterMark third party product certifications under this standard.

A range of fittings is available for use with SewerMax and SewerMax+ pipes providing a complete system. Fittings are moulded and/or fabricated from PP or PVC-U pipe sections.

SewerMax+ pipe during manufacturing process ready for cutting

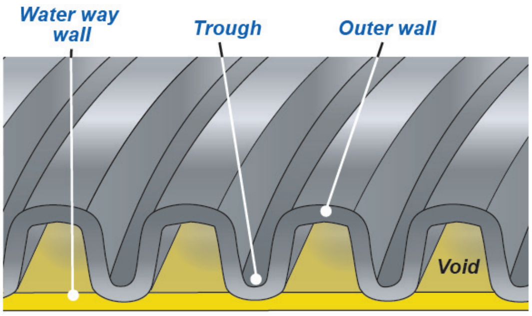


Figure 1.1 Cross section of Iplex SewerMax PP structured wall pipe

- SewerMax pipes with a grey outer wall and yellow internal liner
- Pipe classification SN10
- Standard lengths 3m nominal

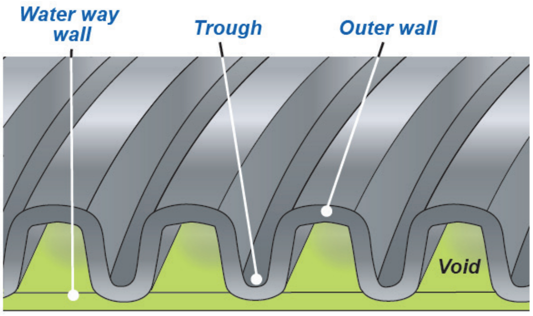


Figure 1.2 Cross section of Iplex SewerMax+ PP structured wall pipe

- SewerMax+ pipes with a grey outer wall and light green internal liner
- Pipe classification SN20
- Standard lengths 3m nominal

All images are indicative only and not to scale.

1.2 PRODUCT FEATURES

Throughout Australia, SewerMax and SewerMax+ have been chosen for their unique characteristics, material properties and benefits.

1. CHEMICAL AND ABRASION RESISTANT

The inherent properties of polypropylene make it resistant to chemical attack in naturally occurring soils, such as acid sulphate soils. Polypropylene is also resistant to sulphuric erosion common in gravity sewers.

2. LONGEVITY AND INTEGRITY

SewerMax may provide a service life of over 100 years when installed, operated and maintained in accordance with the relevant product standards and manufacturer's guidelines. Made from polypropylene, SewerMax harnesses the material's durability and high stiffness. This makes SewerMax structurally robust, whilst maintaining lightweight properties.

3. LIGHTWEIGHT

SewerMax and SewerMax+ pipes are lightweight making them easier to transport and lift. Most sizes can be easily manoeuvred in confined areas by hand or with light lifting equipment enabling increased site efficiency and savings during installation.

4. SHORT LENGTHS FOR DEEP TRENCHING

SewerMax and SewerMax+ pipes are manufactured in standard 3 metre nominal lengths for ease of handling in deep sewers with trench shields.

5. IN-GROUND PERFORMANCE

SewerMax and SewerMax+ pipes have a high tolerance to deformation and can resist soil movement without structural damage or cracking.

6. TOUGHNESS

The tough, ductile nature of polypropylene enables SewerMax and SewerMax+ pipes to resist accidental impact damage during transportation and site handling.

7. WEATHERING RESISTANCE

SewerMax and SewerMax+ pipes contain a minimum 0.2% HALS UV light stabiliser. These additives allow temporary storage of pipes in sunlight without undue degradation.

8. RUBBER RING JOINT

Our structured and double-layered pipe joining technology provides a watertight seal, resisting infiltration, exfiltration, and root intrusions. The SewerMax and SewerMax+ rubber ring joint is designed for ease of assembly and jointing and allows pipes to be cut anywhere along the pipe length and joined with the same rubber ring seal.

1.3 APPLICATIONS

SewerMax and SewerMax+ pipes and fittings are versatile solutions that cater to various applications within sewer infrastructure. These include:

- SewerMax and SewerMax+ pipes and fittings are designed to efficiently manage wastewater flow in gravity-fed sewer systems, whether it's for branch lines or main trunk lines.
- Industrial areas often have specific requirements for sewer systems due to the nature of the waste they handle. SewerMax and SewerMax+ offer robust solutions suitable for industrial applications, ensuring durability and reliability.
- Trenchless methods are becoming increasingly popular due to their minimal disruption and cost-effectiveness. SewerMax and SewerMax+ pipes can be used in boring applications, providing a durable and efficient solution for underground sewer installations without the need for extensive excavation.
- In aging sewer systems, rehabilitation is often necessary to extend the life of the infrastructure. SewerMax and SewerMax+ pipes can serve as liner pipes, reinforcing existing sewer lines and enhancing their structural integrity without the need for complete replacement.

By offering suitability across these diverse applications, SewerMax and SewerMax+ provide a comprehensive solution for various sewer infrastructure needs, addressing both traditional and modern challenges in the field.

SewerMax being installed

2.0 PRODUCT DATA

POLYPROPYLENE MATERIALS – GENERAL

Polypropylene is a high-quality material which has been used since the 1950's. Polypropylene was first used for sewer pipe production in the 1970's. Polypropylene's intrinsic properties of high stiffness, tensile strength and inertness towards acids, alkalis and solvents has secured its position in a wide range of industrial applications.

High impact resistance and stiffness combined with chemical resistance and temperature performance make polypropylene suitable for sewerage applications. Throughout the Middle East, Europe and Oceania, Water Authorities are turning to plastics for their sewer systems. The major concern is sulphuric erosion and acid development inside sewers. Plastics such as polypropylene are resistant in these environments and are often used by engineers to line concrete sewers.

Polypropylene pipes such as SewerMax and SewerMax+ are also highly resistant to abrasion making them suitable for gravity sewer. The rate of abrasive wear of the pipe wall will be dependent upon the velocity and quantity of flow and the size and shape of the particles in the sewer. Darmstadt abrasion tests* demonstrated polyolefin pipes had low abrasion compared with other materials due to their low surface roughness.

The smooth inner bore of SewerMax and SewerMax+ pipes allows excellent hydraulic capacity even at low gradients and helps prevent slime build up and pipe blockages.

*Borouge, Tech Note Abrasion resistant (TN218 R)

SewerMax+ pipes packed and ready for despatch

2.1 MATERIAL PROPERTIES

SewerMax and SewerMax+ pipes are manufactured from block (heterophasic) copolymer polypropylene, which is a thermoplastic of the polyolefin group. Polypropylene is noted for its excellent chemical resistance, high modulus, and elevated temperature performance.

TABLE 2.1 Physical properties of SewerMax and SewerMax+ polypropylene pipes

Property	Value	Standard/Reference
Density of Pipe Compound	900 kg/m³	ISO 1183
Ring Bending Modulus (3min)	1300 MPa	ISO 178
Creep ratio (2 years)	3	ISO 9967
Apparent Ring Bending Modulus (2 years)	433 MPa	ISO 9967
Apparent Ring Bending Modulus (50 years)	342 MPa	ISO 9967
Pipe Ring Bending Stiffness - SewerMax	≥ 10000 N/m/m	AS/NZS 1462.22
Pipe Ring Bending Stiffness – SewerMax+	≥ 20000 N/m/m	AS/NZS 1462.22
Tensile Yield Stress (50mm/min)	31MPa	ISO 527-2
Tensile Yield Strain (50mm/min)	8%	ISO 527-2
Poisson's Ratio	0.45	ISO 527-2
Thermal Co-efficient of Linear Expansion	15×10^{-5} / °C	DIN 53752
Shore D Hardness	60	ISO 868
Pipe - Allowable Long-Term Deflection	7.5%	AS/NZS 2566.1
Pipe - Allowable Long-Term Ring Bending Strain	4%	AS/NZS2566.1

SewerMax+ PP pipes under Creep test in accordance with ISO 9967

2.2 STANDARDS

The following standards relate to the manufacture, testing, design, and installation of SewerMax and SewerMax+ pipes and fittings.

Standard
AS/NZS 5065 'Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications'
EN13476 Plastics piping systems for non-pressure underground drainage and sewerage - Structured-wall piping systems of unplasticized poly(vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE) - Part 3: Specifications for pipes and fittings with smooth internal and profiled external surface and the system, Type B
AS/NZS 1260 'PVC-U pipes and fittings for drain, waste, and vent applications' Section 3.4 Tests on elastomeric joints
AS/NZS 1462.8 'Methods of test for plastics pipes and fittings Method 8: Method of testing the leak tightness of assemblies'
AS/NZS 1462.10 'Methods of test for plastics pipes and fittings Method of hydrostatic pressure testing of fittings and elastomeric seal joints for non-pressure applications'
AS/NZS 1462.13 'Methods of test for plastics pipes and fittings Method for the determination of elastomeric seal joint contact width and pressure'
AS/NZS 1462.22 'Methods of test for plastics pipes and fittings Method for the determination of pipe stiffness'
AS/NZS 1462.23 'Methods of test for plastics pipes and fittings Method for determination of ring flexibility'
AS 1646 'Elastomeric seals for waterworks purposes'
AS 2200 'Design charts for water supply and sewerage'
AS/NZS 2566.1 'Buried flexible pipelines - Part 1: Structural design'
AS/NZS 2566.2 'Buried flexible pipelines – Part 2: Installation'
AS/NZS2033 'Design and installation of Polyolefin pipe systems'
AS 4181 'Repair and off-take clamps for water industry purposes'
ISO 9967 'Thermoplastics pipes – Determination of creep ratio'
AS/NZS ISO 9001 'Quality management systems – requirements'
ISO 14025 'Environmental labels and declarations – Type III environmental declarations – Principles and procedures'
EN 15804 'Sustainability of construction works. Environmental product declarations. Core rules for the product category of construction products'

Certified Product™ AS/NZS 5065

Certified System™ Quality ISO 9001 SAI GLOBAL

WaterMark™ AS/NZS 5065

AS/NZS 4801 OHSAS 18001 BUREAU VERITAS Certification

2.3 SERVICE EXPECTANCY

In determining the life expectancy of a buried pipe, it is necessary to consider all the potential modes of failure and assess whether there is a real risk of the pipe failing by a mechanism under consideration. Polypropylene as a pipe material has been in existence for many years. Polypropylene is an inert material, will not readily abrade in service and is not affected by high or low pH soils or saltwater environments.

SewerMax and SewerMax+ pipes are manufactured from block copolymer polypropylene (PP-B). These components are designed to have a service life of more than 100 years. The 'greater-than-100-year' anticipated service life is based on the following:

- The convention applied by Iplex to the design of the SewerMax and SewerMax+ is the same as used for many years in International (ISO), Australian and European (CEN) Standards for the design of plastics pipes. The design philosophy considers the visco-elastic behaviour of plastics together with the mechanical and chemical properties of the material.
- If installed, operated and maintained in accordance with the relevant product and installation standards and manufacturer's guides. The life expectancy is a guide only and may increase or decrease because of the system operating conditions, operating environment, and other geographical and site-specific factors.

2.3.1 ENVIRONMENTAL PRODUCT DECLARATION

An Environmental Product Declaration (EPD) is a standardised and verified way of quantifying the environmental impacts of a product based on a consistent set of rules known as PCR (Product Category Rules).

The Environmental Product Declaration (EPD)* for SewerMax and SewerMax+ polypropylene pipes:

- Conforms with International Standards ISO14025 and EN15804.
- Has been verified by an independent third party.
- Has at least a cradle to gate scope.
- Has product specific results.

The SewerMax and SewerMax+ polypropylene pipes EPD results can be used in Whole of life Cycle assessments under Green Star rating tools. Refer to the Tables in the SewerMax and SewerMax+ Environmental Product Declaration (EPD) to convert the product results from kilogram of installed pipe to length of pipe for individual pipe products.

2.3.2 WATER SERVICES ASSOCIATION OF AUSTRALIA (WSAA) PRODUCT APPRAISAL

The Water Services Association of Australia (WSAA) is the peak body of the Australian urban water industry and represents the major water agencies and authorities through-out Australia.

SewerMax and SewerMax+ have been appraised by WSAA to Australia standard AS/NZS65065 'Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications'.

2.3.3 CHEMICAL RESISTANCE

SewerMax and SewerMax+ pipes are made from a copolymer of polypropylene (PP-B). The elastomeric seals used to join the pipes are made from styrene butadiene rubber (SBR).

Polypropylene is inherently resistant to a wide range of chemicals such as acids, alkalis, salts, wetting agents, and alcohols.

SBR seals are also resistant to a wide range of chemicals such as salt solutions, alkalis, glycols, and some alcohols.

Further reference and details about chemical resistance are available at iplex.com.au.

2.3.4 RESISTANCE TO MICROBIOLOGICAL ATTACK

There is no evidence microbiological attack is a potential failure mechanism for polypropylene pipes.^ Polypropylene (PP-B) pipes are used widely for sewerage applications in most European countries.

*EPD currently applies to SewerMax and SewerMax+ polypropylene pipes manufactured in Brisbane.
^BlackMax Structured Wall Polypropylene pipes" 29.11.2004, Dr Alan Whittle PhD Senior scientist, Iplex Pipelines Australia Pty Ltd.

2.3.5 RESISTANCE TO SUNLIGHT

SewerMax and SewerMax+ pipes have a minimum of 0.2% HALS light stabilisers for protection against UV radiation. These additives allow temporary storage of pipes in sunlight without degradation. Once buried, SewerMax and SewerMax+ pipes are not exposed to UV radiation and therefore will not degrade by this mechanism.

2.3.6 ABRASION RESISTANCE

Polypropylene is highly resistant to abrasion and is used for industrial and mining applications such as handling slurries with high solids content. It is also selected for several mechanical and automotive applications such as linings for truck trays, spoilers, and bumpers for cars. As polypropylene is generally accepted as having a higher resistance to abrasion than PVC, abrasion loss is an unlikely failure mode for SewerMax and SewerMax+ pipes.

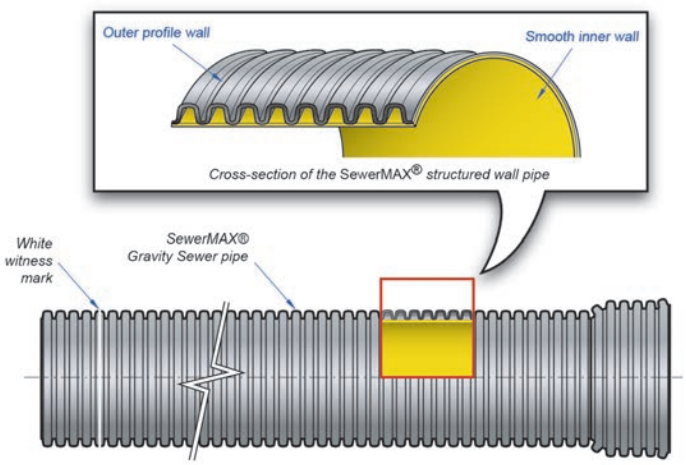
2.3.7 OXIDATION

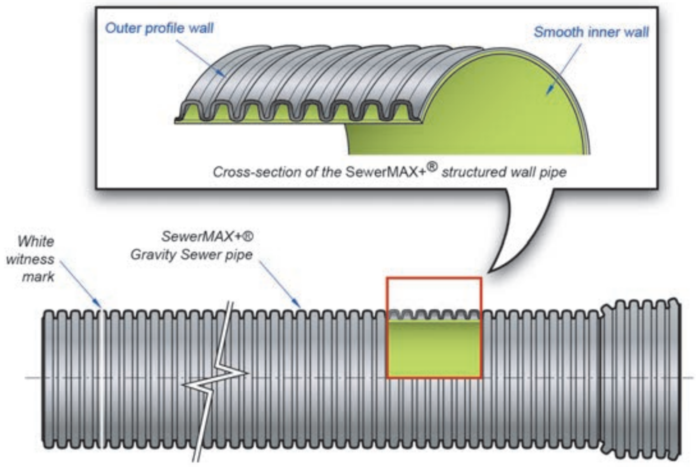
The polypropylene compound used for SewerMax and SewerMax+ pipes contains an antioxidant to protect against oxidation. Under normal ambient temperatures the level of protection is enough to provide more than 100 years service life when installed, operated and maintained in accordance with the relevant product and installation standards, and manufacturer's guides

2.3.8 ELECTROCHEMICAL CORROSION

Polypropylene, as with other plastics, is resistant to electrochemical corrosion.

2.4 SEWERMAX AND SEWERMAX+ PIPE RANGE





Application	Product Code	DN	Description (SN)	Nominal Length (m)	Colour Outer Wall	Colour Inner Wall
Reticulation, Branch and Trunk Sewers (Non-pressure)	GR10225C	225	SewerMax 10	3	Grey	SewerMax has a Yellow Liner
	GR10300C	300				
	GR10375C	375				
	GR10450C	450				
	GR10525C	525				
	GR10600C	600				
	GR10750C*	750				
	GR10900C*	900				
	GR101000C*	1000				
	GR101200C*	1200				
	GR20225C	225	SewerMax+ 20			SewerMax+ has a Light Green Liner
	GR20300C	300				
	GR20375C	375				
	GR20450C	450				
	GR20525C*	525				

*Larger diameter coming soon - for more information contact Iplex

All images are indicative only and not to scale.

Figure 2.1 SewerMax and SewerMax+ Pipe cross section longitudinal

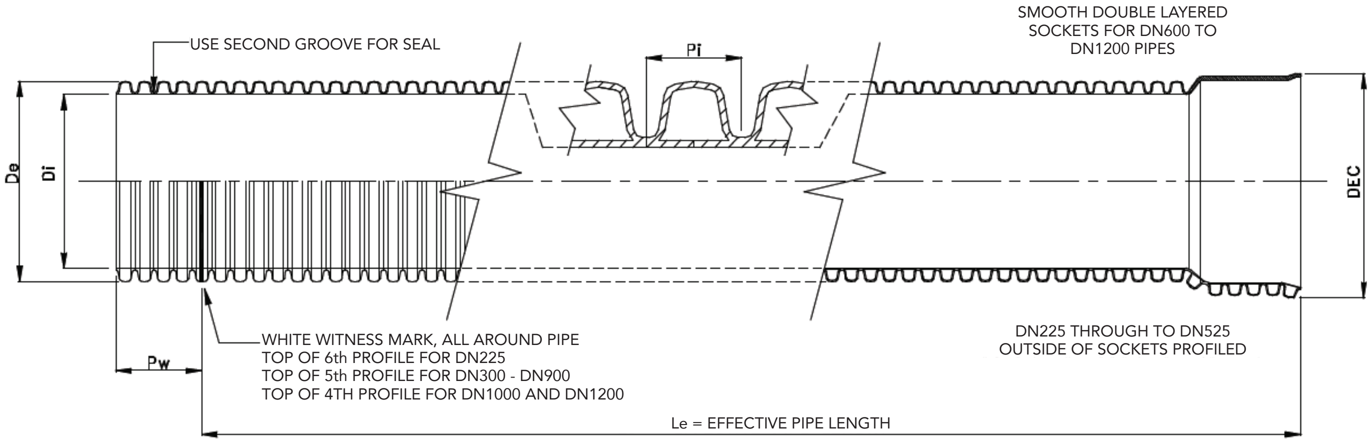


TABLE 2.2 SewerMax Pipe dimensions – SN10

DN	Mean Pipe OD D_e (mm)	Mean Pipe ID (mm)	Socket OD DEC (mm) REF	Mean Length Witness Mark P_w (mm)	Profile Pitch P_i (mm)	Approx. Pipe Mass (Kg/m)	Effective Length Le Min (mm)
225	259	225	305	135	25	4	3000
300	344	300	403	147	33	8	3000
375	428	373	502	176	40	11	3000
450	514	447	603	222	50	14	3000
525	600	522	704	254	57	18	3000
600	682	596	750	296	66	23	2765
750	843	736	896	319	80	35	TBC
900	1010	877	1072	398	100	47	TBC
1000	1103	987	1187	TBC	TBC	TBC	TBC
1200	1342	1170	1432	476	133	90	TBC

TABLE 2.3 SewerMax+ Pipe dimensions – SN20

DN	Mean Pipe OD D_e (mm)	Min Pipe ID D_i (mm)	Socket OD DEC (mm) REF	Mean Length Witness Mark P_w (mm)	Profile Pitch P_i (mm)	Approx. Pipe Mass (kg/m)	Effective length Le min (mm)
225	259	224	305	135	25	6	3005
300	344	297	403	147	33	10	3005
375	428	370	502	176	40	17	3030
450	514	443	603	222	50	20	3015
525	600	516	704	254	57	27	3005

All images are indicative only and not to scale.

2.4.1 SEWERMAX FITTINGS

A standard range of fittings for use with SewerMax and SewerMax+ pipes is available for a complete sewer pipe system. bends, junctions, couplings, plugs, reducers and adaptors are fabricated from polypropylene SewerMax and PVC pipe sections.

SewerMax fittings comply with Australian Standard, AS/NZS 5065 'Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications'.

FITTINGS RANGE DN225 UP TO DN375 (SECTION 2.4.2)

SewerMax fittings in sizes DN225, DN300 and DN375 are fabricated with PVC pipe sections with moulded socket ends for rubber ring joint connection with SewerMax pipe spigots. Bends are fabricated as segmented bends with a radius of 2.5 x DN.

All fittings are fibreglass reinforced and coloured light grey for identification.

FITTINGS RANGE DN450 UP TO DN1200 (SECTION 2.4.2)

SewerMax fittings in sizes DN450 up to DN1200 are fabricated with SewerMax (PP) pipe sections. Bends are fabricated as segmented bends with a radius of 2.5 x DN.

Fittings are generally supplied with socketed ends suitable for rubber ring connection with SewerMax pipe spigots. Other end configurations are also available, such as spigot ends with separate pipe couplings for jointing.

SewerMax fittings fabricated with DN100, DN150 or DN225 components are supplied with either PVC RRJ or SWJ socket ends or standard solid wall polypropylene plain-ended pipe spigots (110mm OD) and (160mm OD). These components allow connections with PVC DWV gravity sewer property connections.

Prefabricated DN450 SewerMax Bend ready for despatch

FITTINGS FOR REPAIRS (SECTION 2.4.2)

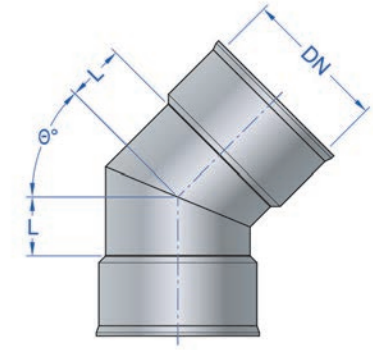
A range of stainless-steel clamps is available for pipe repairs and jointing. The clamps have been designed for use with SewerMax and SewerMax+ pipes and comply with the requirements of Australian Standard AS 4181 'Repair and off-take clamps for water industry purposes'.

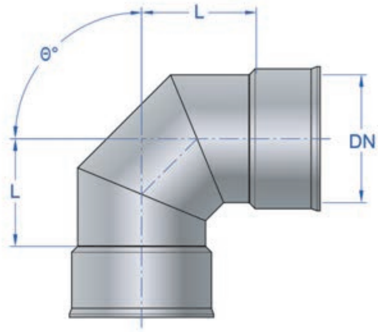
The stainless-steel clamps provide a quick and reliable solution for repairing damaged pipes. Clamps are manufactured from 316 stainless steel, with EPDM flat rubber matting (Joiner clamps) and moulded polyurethane rubber matting (Repair clamps). All welding is fully passivated to maintain the original state of the stainless steel for corrosion resistance.

2.4.2 SEWERMAX FITTINGS RANGE

SewerMax Bends FF RRJ – DN225 to DN375 (Fabricated with PVC-U DWV Pipe sections)

Product Code	Description	L (mm)
GSR0222511	DN225 x 11.25° SMax Bend RRJ F&F	TBC
GSR0230011	DN300 x 11.25° SMax Bend RRJ F&F	TBC
GSR0237511	DN375 x 11.25° SMax Bend RRJ F&F	TBC
GSR0222515	DN225 x 15° SMax Bend RRJ F&F	111
GSR0230015	DN300 x 15° SMax Bend RRJ F&F	153
GSR0237515	DN375 x 15° SMax Bend RRJ F&F	161
GSR0222522	DN225 x 22.5° SMax Bend RRJ F&F	TBC
GSR0230022	DN300 x 22.5° SMax Bend RRJ F&F	TBC
GSR0237522	DN375 x 22.5° SMax Bend RRJ F&F	TBC
GSR0222530	DN225 x 30° SMax Bend RRJ F&F	192
GSR0230030	DN300 x 30° SMax Bend RRJ F&F	254
GSR0237530	DN375 x 30° SMax Bend RRJ F&F	290
GSR0222545	DN225 x 45° SMax Bend RRJ F&F	280
GSR0230045	DN300 x 45° SMax Bend RRJ F&F	363
GSR0237545	DN375 x 45° SMax Bend RRJ F&F	428
GSR0222560	DN225x 60° SMax Bend RRJ F&F	TBC
GSR0230060	DN300x 60° SMax Bend RRJ F&F	TBC
GSR0237560	DN375 x 60° SMax Bend RRJ F&F	TBC
GSR0222590	DN225 x 90° SMax Bend RRJ F&F	549
GSR0230090	DN300 x 90° SMax Bend RRJ F&F	645
GSR0237590	DN375 x 90° SMax Bend RRJ F&F	TBC

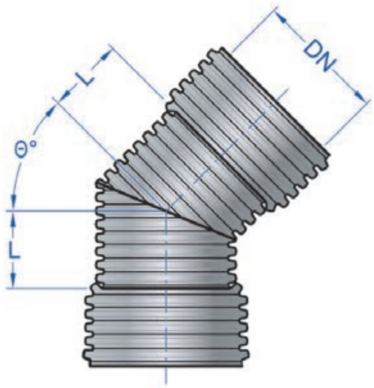


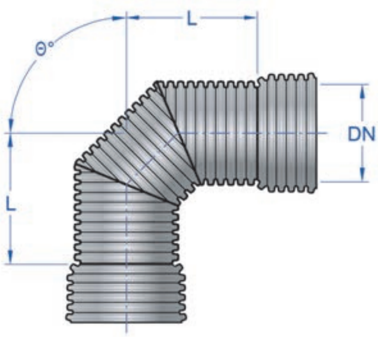


Note:
- Standard DN225 to DN375 SewerMax bends are fabricated with a minimum pipe radius of 2.5 x DN
- DN375 x 90° SMax Bend in development
- SewerMax Bends are subject to availability at time of orderingOther angles are available upon request
- Dimensions are approximate only
- All images are indicative only and not to scale

SewerMax Bends FF RRJ – DN450 to DN600 (Fabricated with SewerMax PP Pipe Sections)*

Product Code	Description	L (mm)
GSR0245011	DN450 x 11.25° SMax Bend RRJ F&F	TBC
GSR0252511	DN525 x 11.25° SMax Bend RRJ F&F	TBC
GSR0260011	DN600 x 11.25° SMax Bend RRJ F&F	TBC
GSR0245015	DN450 x 15° SMax Bend RRJ F&F	148
GSR0252515	DN525 x 15° SMax Bend RRJ F&F	173
GSR0260015	DN600 x 15° SMax Bend RRJ F&F	197
GSR0245022	DN450 x 22.5° SMax Bend RRJ F&F	TBC
GSR0252522	DN525 x 22.5° SMax Bend RRJ F&F	TBC
GSR0260022	DN600 x 22.5° SMax Bend RRJ F&F	TBC
GSR245030	DN450 x 30° SMax Bend RRJ F&F	299
GSR0252530	DN525 x 30° SMax Bend RRJ F&F	349
GSR0260030	DN600 x 30° SMax Bend RRJ F&F	414
GSR0245045	DN450 x 45° SMax Bend RRJ F&F	457
GSR0252545	DN525 x 45° SMax Bend RRJ F&F	533
GSR0260045	DN600 x 45° SMax Bend RRJ F&F	609
GSR0245060	DN450 x 60° SMax Bend RRJ F&F	TBC
GSR0252560	DN525 x 60° SMax Bend RRJ F&F	TBC
GSR0260060	DN600 x 60° SMax Bend RRJ F&F	TBC
GSR0245090	DN450 x 90° SMax Bend RRJ F&F	1039
GSR0252590	DN525 x 90° SMax Bend RRJ F&F	1213
GSR0260090	DN600 x 90° SMax Bend RRJ F&F	1386





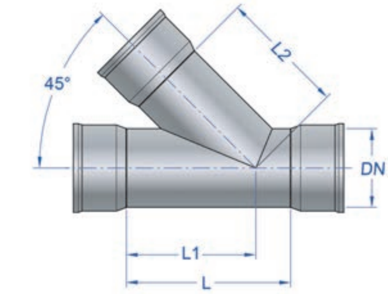
*Larger sizes are available on request

Note:
- Standard DN450 TO DN600 SewerMax bends are fabricated with a minimum pipe radius of 2.5 x DN
- SewerMax Bends are subject to availability at time of ordering
- Other angles are available upon request
- Dimensions are approximate only
- All images are indicative only and not to scale

.

SewerMax Equal Junctions x 45° FFF RRJ – DN225 to DN375 (Fabricated with PVC-U DWV Pipe sections)

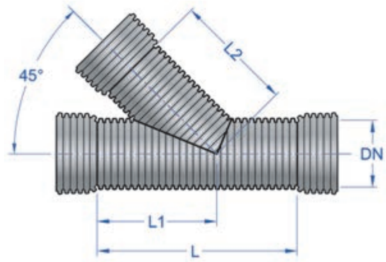
Product Code	Description	L (mm)	L1 (mm)	L2 (mm)
GSR2422545	DN225 x 45° SMax Equal Junction RRJ F&F	521	386	386
GSR2430045	DN300 x 45° SMax Equal Junction RRJ F&F	714	514	514
GSR2437545	DN375 x 45° SMax Equal Junction RRJ F&F	816	600	600



SewerMax Equal Junctions x 45° FFF RRJ – DN450 to DN600 (Fabricated with SewerMax PP Pipe Sections)*

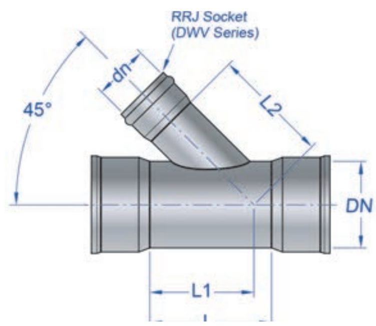
Product Code	Description	L (mm)	L1 (mm)	L2 (mm)
GSR2445045	DN450 x 45° SMax Equal Junction RRJ F&F	1042	748	748
GSR2452545	DN525 x 45° SMax Equal Junction RRJ F&F	1158	838	838
GSR2460045	DN600 x 45° SMax Equal Junction RRJ F&F	1356	956	956

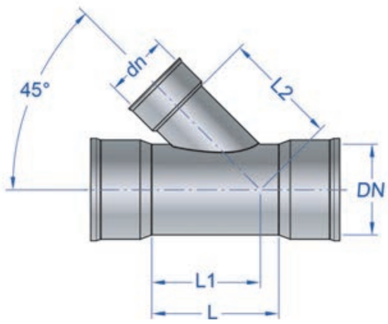
*Larger sizes are available on request



SewerMax Reducing Junctions x 45° FFF RRJ – DN225 to DN375 (Fabricated with PVC-U DWV Pipe sections)

Product Code	Description	L (mm)	L1 (mm)	L2 (mm)
GSR25221045	DN225 x dn100 (DWV RRJ) x 45° SMax Reducing Junction F&F	349	279	303
GSR25221545	DN225 x dn150 (DWV RRJ) x 45° SMax Reducing Junction F&F	380	330	332
GSR25301045	DN300 x dn100 (DWV RRJ) x 45° SMax Reducing Junction F&F	456	346	373
GSR25301545	DN300 x dn150 (DWV RRJ) x 45° SMax Reducing Junction F&F	459	389	398
GSR25371045	DN375 x dn100 (DWV RRJ) x 45° SMax Reducing Junction F&F	486	351	399
GSR25371545	DN375 x dn150 (DWV RRJ) x 45° SMax Reducing Junction F&F	TBC	TBC	TBC
GSR25302245	DN300 x dn225 x 45° SMax Reducing Junction F&F	634	546	440
GSR25372245	DN375 x dn225 x 45° SMax Reducing Junction F&F	TBC	TBC	TBC
GSR25373045	DN375 x dn300 x 45° SMax Reducing Junction F&F	TBC	TBC	TBC

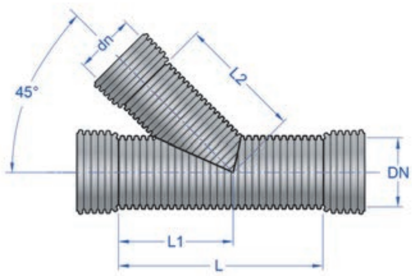




Note:
- For junctions with dn225 and dn300 SWJ branches add ‘S’ at the end of the product code
- For junctions with dn225 and dn300 DWV RRJ branches add ‘R’ at the end of the product code
- SewerMax junctions are subject to availability at time of ordering
- Dimensions are approximate only
- All images are indicative only and not to scale

SewerMax Reducing Junctions x 45° FFF RRJ – DN450 to DN600 (Fabricated with SewerMax PP Pipe Sections)*

Product Code	Description	L (mm)	L1 (mm)	L2 (mm)
GSR25452245	DN450 x dn225 x 45° SMax Reducing Junction F&F	725	590	604
GSR25453045	DN450 x dn300 x 45° SMax Reducing Junction F&F	831	643	678
GSR25453745	DN450 x dn375 x 45° SMax Reducing Junction F&F	925	684	700
GSR25522245	DN525 x dn225 x 45° SMax Reducing Junction F&F	732	635	658
GSR25523045	DN525 x dn300 x 45° SMax Reducing Junction F&F	838	688	732
GSR25523745	DN525 x dn375 x 45° SMax Reducing Junction F&F	941	741	753
GSR25524545	DN525 x dn450 x 45° SMax Reducing Junction F&F	1048	793	820
GSR25602245	DN600 x dn225 x 45° SMax Reducing Junction F&F	735	686	725
GSR25603045	DN600 x dn300 x 45° SMax Reducing Junction F&F	841	739	800
GSR25603745	DN600 x dn375 x 45° SMax Reducing Junction F&F	953	791	820
GSR25604545	DN600 x dn450 x 45° SMax Reducing Junction F&F	1048	834	887
GSR25605245	DN600 x dn525 x 45° SMax Reducing Junction F&F	1422	1090	906

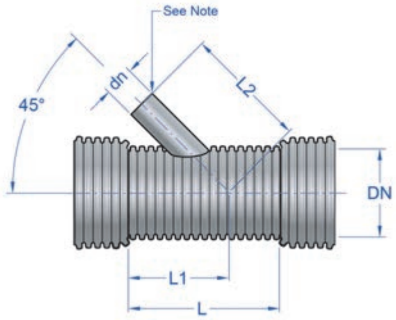


*Larger sizes are available on request

Note:
- SewerMax junctions are subject to availability at time of ordering
- Dimensions are approximate only
- All images are indicative only and not to scale

SewerMax Reducing Junctions x 45° FFF RRJ – DN450 to DN600 (Fabricated with SewerMax PP Pipe Sections) Solid wall branch suitable for property connections

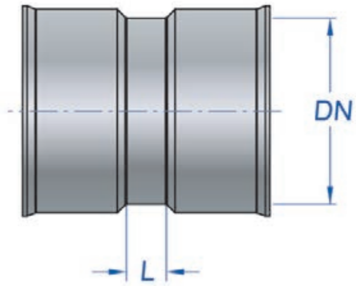
Product Code	Description	L (mm)	L1 (mm)	L2 (mm)
GSR25451045	DN450 x dn100[1] (DWV RRJ) x 45° SMax Reducing Junction F&F	555	505	575
GSR25451545	DN450 x dn150[1] (DWV RRJ) x 45° SMax Reducing Junction F&F	626	540	600
GSR25521045	DN525 x dn100[1] (DWV RRJ) x 45° SMax Reducing Junction F&F	555	543	630
GSR25521545	DN525 x dn150[1] (DWV RRJ) x 45° SMax Reducing Junction F&F	626	580	655
GSR25601045	DN600 x dn100[1] (DWV RRJ) x 45° SMax Reducing Junction F&F	615	600	700
GSR25601545	DN600 x dn150[1] (DWV RRJ) x 45° SMax Reducing Junction F&F	686	636	725



Note:
- [1]dn100 (110mm OD) & dn150 (160mm OD) branches are PP spigots
- For dn100 or dn150 DWV RRJ branches use a PVC DWV RRJ coupling or Fernco Coupling for connection with DWV PVC pipes (Note: Couplings are not included with the junctions)
- SewerMax Reducing Junctions are subject to availability at time of ordering
- Dimensions are approximate only
- All images are indicative only and not to scale

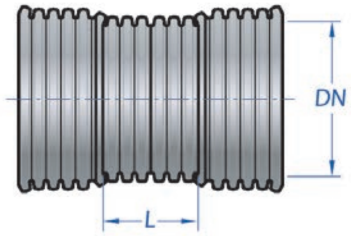
SewerMax Couplings FF RRJ – DN225 to DN375 (Fabricated with PVC-U DWV Pipe sections)

Product Code	Description	L (mm)
GSR57225	DN225 SMax Coupling F&F	116
GSR57300	DN300 SMax Coupling F&F	158
GSR57375	DN375 SMax Coupling F&F	149



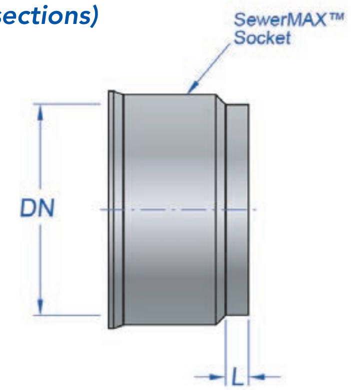
SewerMax Couplings FF RRJ – DN450 to DN600* (Fabricated with SewerMax PP Pipe Sections)

Product Code	Description	L (mm)
GSR57450	DN450 BMax Coupling F&F	300
GSR57525	DN525 BMax Coupling F&F	360
GSR57600	DN600 BMax Coupling F&F	400



Note: *Larger sizes are available on request

SewerMax End Caps RRJ – DN225 to DN375 (Fabricated with PVC-U DWV Pipe sections)



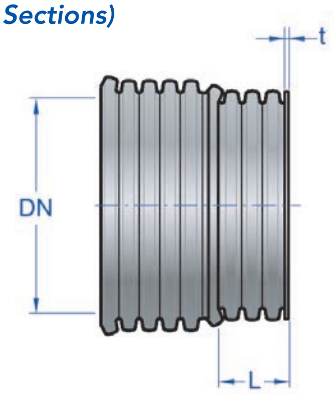
Product Code	Description	L (mm)
GSR105225	DN225 SMax CAP RRJ	105
GSR105300	DN300 SMax CAP RRJ	100
GSR105375	DN375 SMax CAP RRJ	135

Note:
- SewerMax Couplings and Caps are subject to availability at time of ordering
- Dimensions are approximate only
- All images are indicative only and not to scale

SewerMax End Caps RRJ – DN450 to DN600 (Fabricated with SewerMax PP Pipe Sections)*

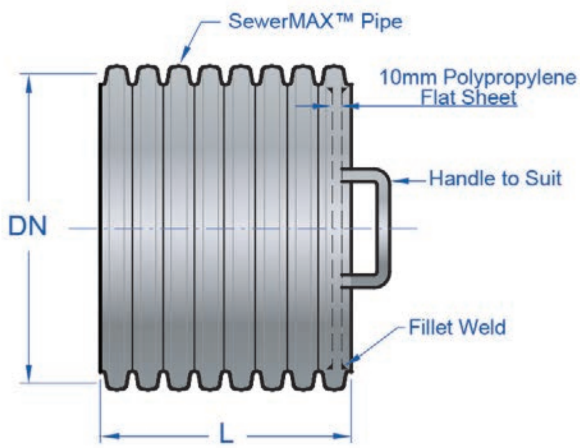
Product Code	Description	t (mm)	L (mm)
GSR105450	DN450 SMax CAP RRJ	15	200
GSR105525	DN525 SMax CAP RRJ	20	230
GSR105600	DN600 SMax CAP RRJ	20	270

*Larger sizes are available on request

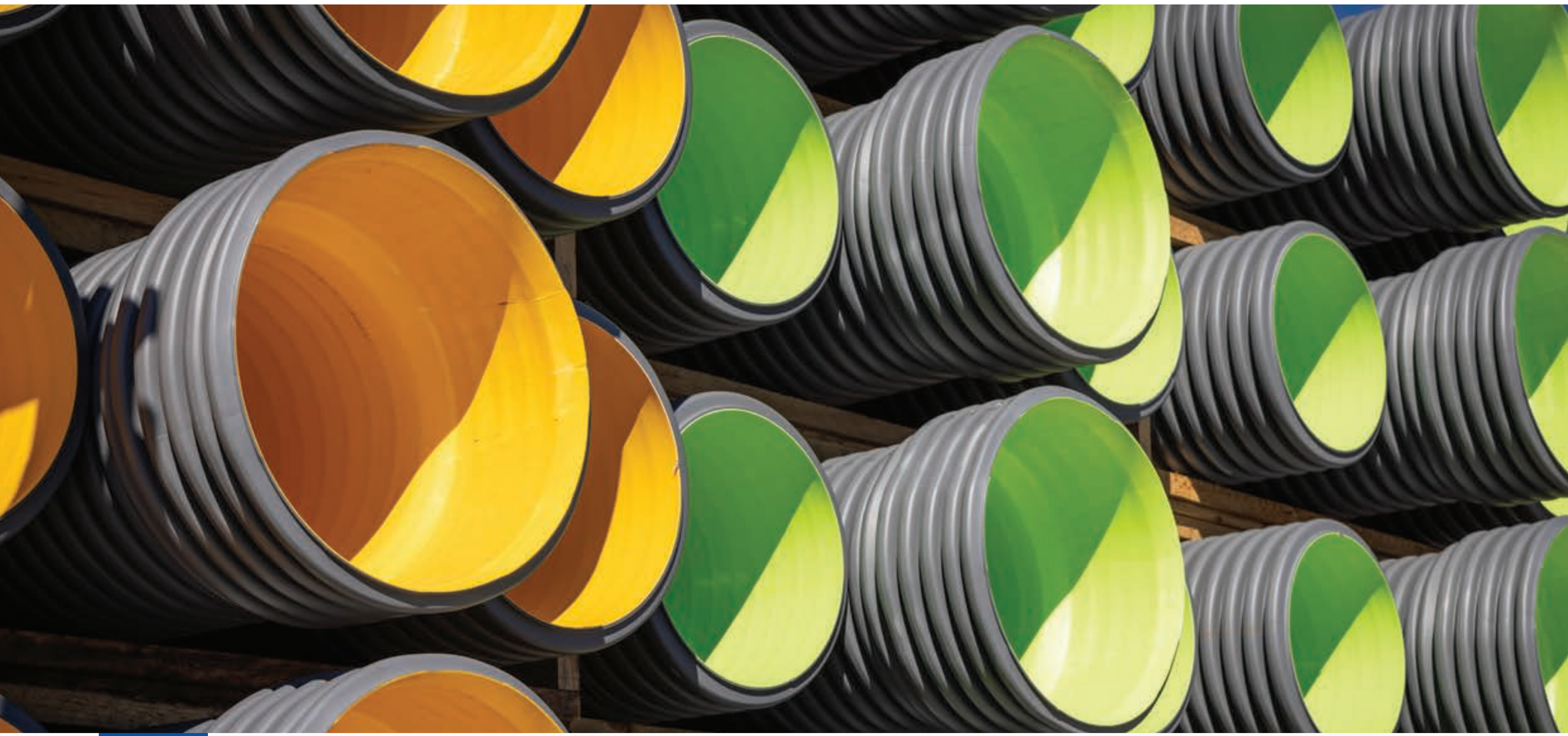


SewerMax Plugs RRJ – DN225 to DN600 (Fabricated with SewerMax PP Pipe Sections)*

Product Code	Description	L (mm)
GSR106225	DN225 SMax Plug	160
GSR106300	DN300 SMax Plug	180
GSR106375	DN375 SMax Plug	215
GSR106450	DN450 SMax Plug	270
GSR106525	DN525 SMax Plug	310
GSR106600	DN600 SMax Plug	360

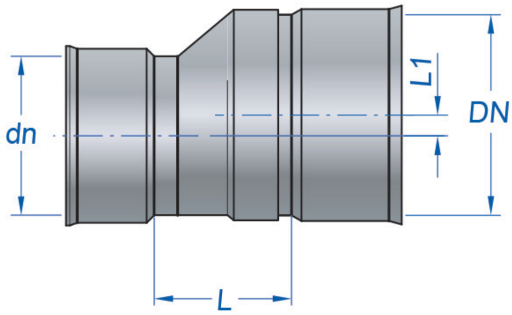


Note:
- *Larger sizes available on request
- SewerMax caps and plugs are subject to availability at time of ordering
- Dimensions are approximate only
- All images are indicative only and not to scale



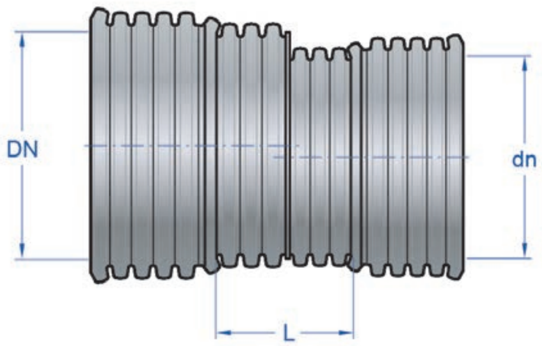
SewerMax Level Invert Tapers FF RRJ – DN225 to DN375 (Fabricated with PVC-U DWV Pipe sections)

Product Code	Description	L (mm)	L1 (mm)
GSR722215	DN225 x dn150 SMax Level Invert Taper Socket x DWV RRJ F&F	460	41
GSR723015	DN300 x dn150 SMax Level Invert Taper Socket x DWV RRJ F&F	108	69
GSR723022	DN300 x dn225 SMax Level Invert Taper F&F	234	33
GSR723715	DN375 x dn150 SMax Level Invert Taper Socket x DWV RRJ F&F	168	110
GSR723722	DN375 x dn225 SMax Level Invert Taper F&F	203	65
GSR723730	DN375 x dn300 SMax Level Invert Taper F&F	405	43



SewerMax Level Invert Tapers FF RRJ – DN450 to DN600 (Fabricated with SewerMax PP Pipe Sections)*

Product Code	Description	L (mm)
GSR724522	DN450 x dn225 SMax Taper F&F	400
GSR724530	DN450 x dn300 SMax Taper F&F	400
GSR724537	DN450 x dn375 SMax Taper F&F	400
GSR725222	DN525 x dn225 SMax Taper F&F	400
GSR725230	DN525 x dn300 SMax Taper F&F	400
GSR725237	DN525 x dn375 SMax Taper F&F	400
GSR725245	DN525 x dn450 SMax Taper F&F	400
GSR726022	DN600 x dn225 SMax Taper F&F	400
GSR726030	DN600 x dn300 SMax Taper F&F	400
GSR726037	DN600 x dn375 SMax Taper F&F	400
GSR726045	DN600 x dn450 SMax Taper F&F	400
GSR726052	DN600 x dn525 SMax Taper F&F	400

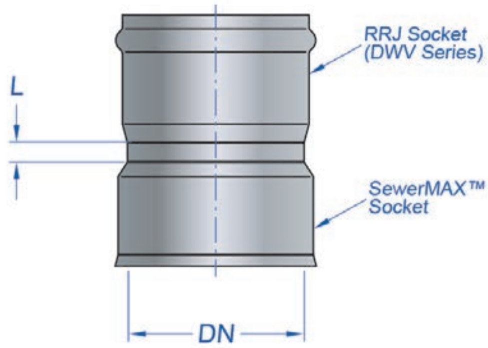


*Larger sizes are available on request

Note:
- For Tapers with dn150 DWV SWJ Socket add ‘S’ at the end of the product code
- For Tapers with dn150 DWV RRJ Socket add ‘R’ at the end of the product code
- For Tapers with dn225 or DN300 DWV SWJ Socket add ‘S’ at the end of the product code
- For Tapers with dn225 or DN300 DWV RRJ Socket add ‘R’ at the end of the product code
- SewerMax Reducers are subject to availability at time of ordering
- Dimensions are approximate only
- All images are indicative only and not to scale

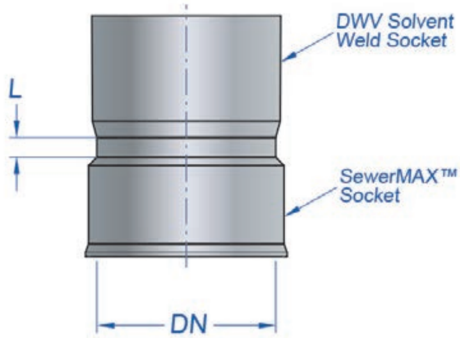
SewerMax Adaptor FF SMax x DWV RRJ – DN225 to DN375 (Fabricated with PVC-U DWV Pipe sections)

Product Code	Description	L (mm)
GSR612222	DN225 SMax Adaptor - SMax x DWV RRJ F&F	77
GSR613030	DN300 SMax Adaptor - SMax x DWV RRJ F&F	155
GSR613737	DN375 SMax Adaptor - SMax x DWV RRJ F&F	107



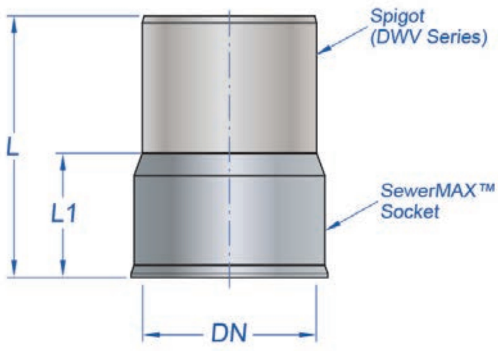
SewerMax Adaptor FF SMax RRJ x DWV SWJ – DN225 to DN375 (Fabricated with PVC-U DWV Pipe sections)

Product Code	Description	L (mm)
GSR622222	DN225 SMax Adaptor - SMax x DWV SWJ F&F	75
GSR623030	DN300 SMax Adaptor - SMax x DWV SWJ F&F	145
GSR623737	DN375 SMax Adaptor - SMax x DWV SWJ F&F	125



SewerMax Adaptor MF SMax RRJ x DWV SP – DN225 to DN375 (Fabricated with PVC-U DWV Pipe sections)

Product Code	Description	L (mm)	L1 (mm)
GSR602222	DN225 SMax Adaptor - SMax x DWV SP F&M	375	145
GSR603030	DN300 SMax Adaptor - SMax x DWV SP F&M	470	150
GSR603737	DN375 SMax Adaptor - SMax x DWV SP F&M	450	185

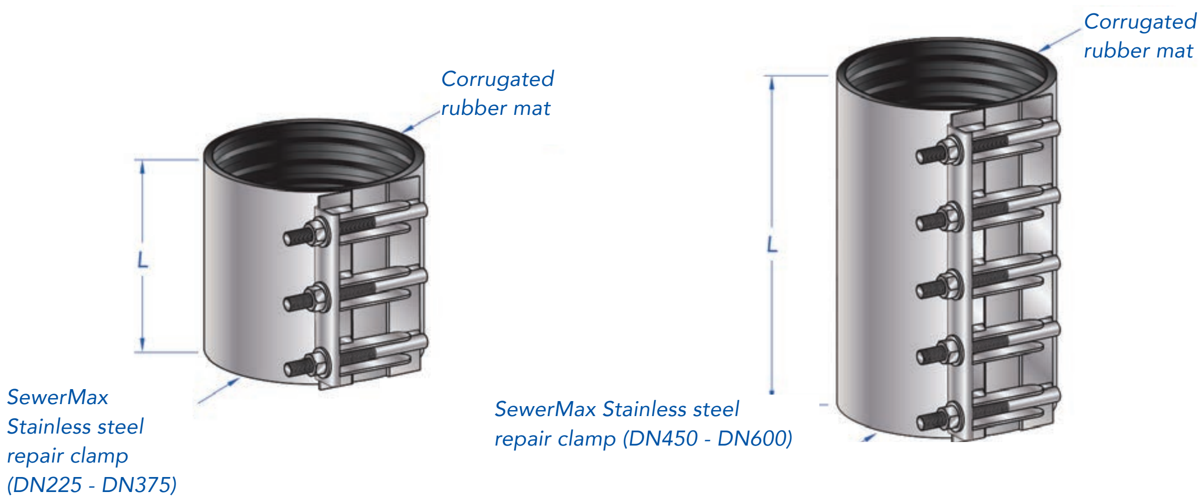


Note:
- SewerMax Adaptors are subject to availability at time of ordering.
- Dimensions are aproximate only
- All images are indicative only and not to scale

2.4.3 SEWERMAX STAINLESS STEEL CLAMPS

SewerMax Stainless Steel Repair Clamp – DN225 to DN600 (For minor repairs)

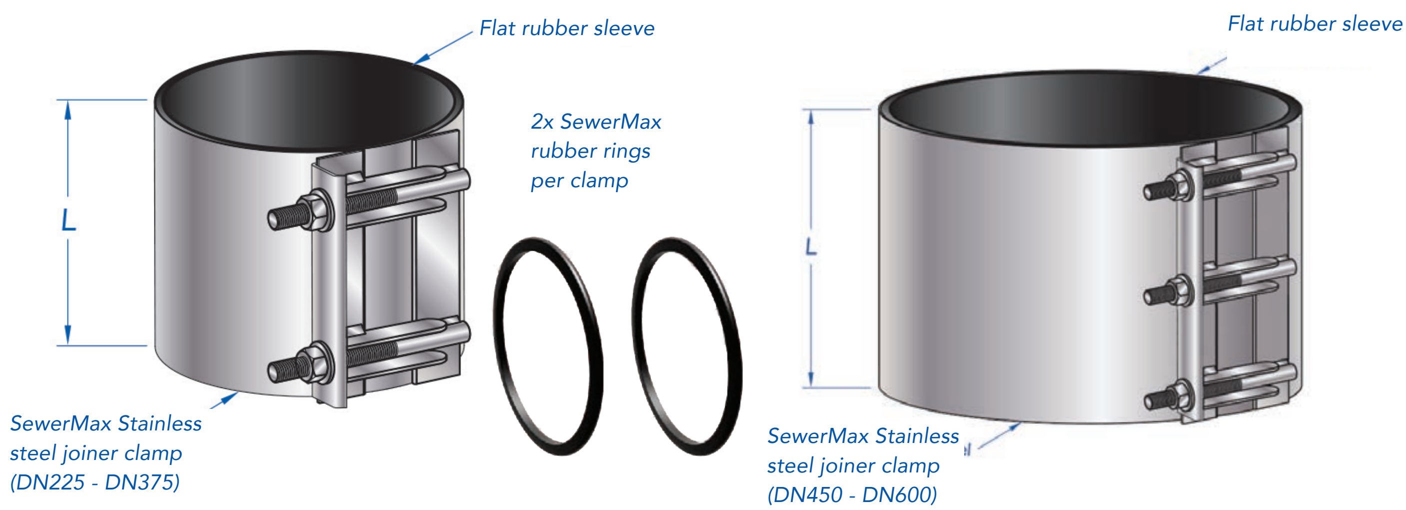
Product Code	Description	L (mm)
C37018.22530	DN225 SMax Repair Clamp (3 bolts)	300
C37018.30030	DN300 SMax Repair Clamp (3 bolts)	300
C37018.37530	DN375 SMax Repair Clamp (3 bolts)	300
C37018.45040	DN450 SMax Repair Clamp (5 bolts)	400
C37018.52540	DN525 SMax Repair Clamp (5 bolts)	400
C37018.60040	DN600 SMax Repair Clamp (5 bolts)	400



Note:
- SewerMax SS clamps are subject to availability at time of ordering
- Installation instructions must be strictly followed. Refer to the markings on the clamp, attached label and section 4.12.1 Minor Repairs of this guide for further details
- The clamps must not be changed, altered or modified
- Dimensions are approximate only
- All images are indicative only and not to scale

SewerMax Stainless Steel Joiner Clamp – DN225 to DN600 (For major repairs)

Product Code	Description	L (mm)
C37019.22520	DN225 SMax Joiner Clamp (2 bolts) incl. rubber sleeve and 2x SewerMax rings	200
C37019.30020	DN300 SMax Joiner Clamp (2 bolts) incl. rubber sleeve and 2x SewerMax rings	200
C37019.37520	DN375 SMax Joiner Clamp (2 bolts) incl. rubber sleeve and 2x SewerMax rings	200
C37019.45030	DN450 SMax Joiner Clamp (3 bolts) incl. rubber sleeve and 2x SewerMax rings	300
C37019.52530	DN525 SMax Joiner Clamp (3 bolts) incl. rubber sleeve and 2x SewerMax rings	300
C37019.60030	DN600 SMax Joiner Clamp (3 bolts) incl. rubber sleeve and 2x SewerMax rings	300

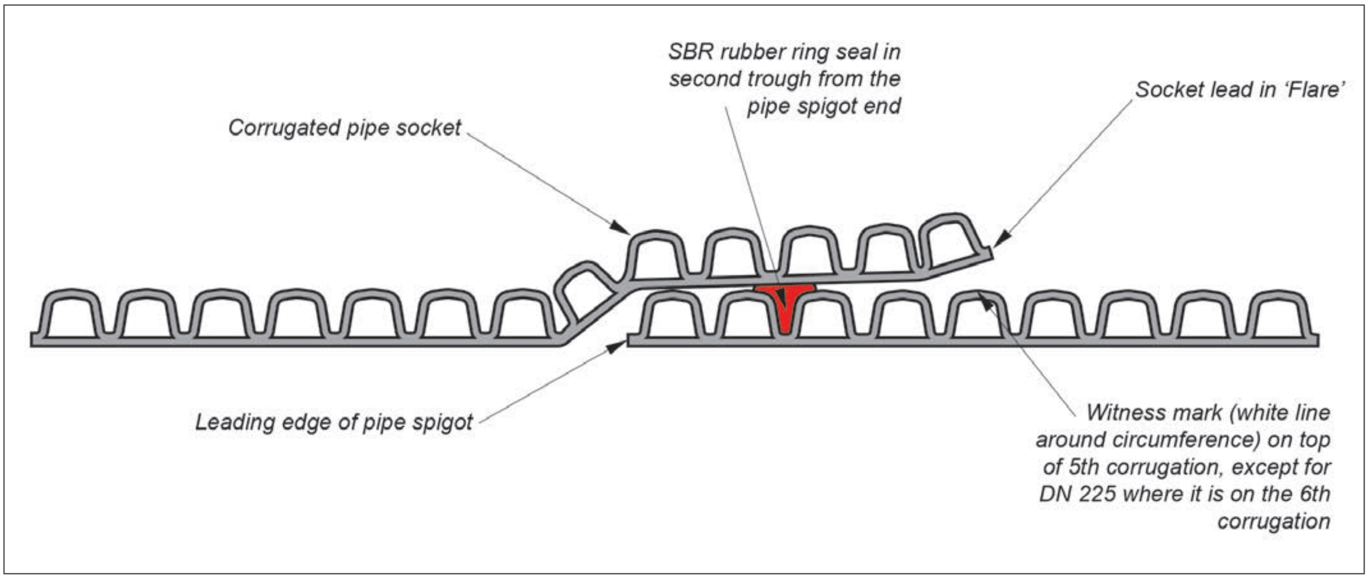


Note:
- SewerMax SS Clamps are subject to availability at time of ordering
- Each SewerMax SS joiner clamp is supplied with two SewerMax rubber rings
- Installation instructions must be strictly followed. Refer to the markings on the clamp, attached label and section 4.12.2 Major Repairs of this guide for further details
- The clamps must not be changed, altered or modified
- Dimensions are approximate only
- All images are indicative only and not to scale

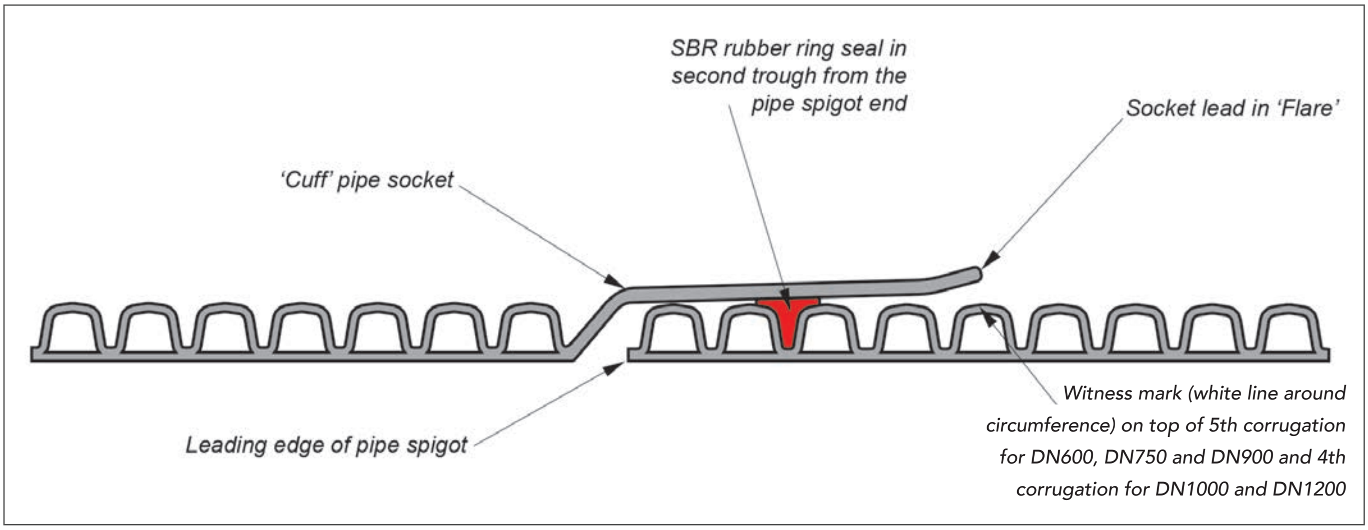
2.5 PIPE JOINTING

SewerMax and SewerMax+ pipes and fittings are manufactured with a spigot and socket rubber ring jointing system. A profiled rubber ring is assembled in the second trough from the spigot end and is compressed as the spigot enters the socket. This jointing system can be used after cutting the pipe in the field for short length adjustments. Joined pipes may be deflected up to 2° for sizes DN225 to DN750 and up to 1° for sizes DN900 to DN1200, from the socket off-line after assembly. See section 4.7.2 for details of the joining procedure.

2.5.1 JOINT CROSS SECTION DETAILS



DN225 to DN525 spigot and socket rubber ring cross section assembly



DN600 to DN1200 spigot and socket rubber ring cross section assembly

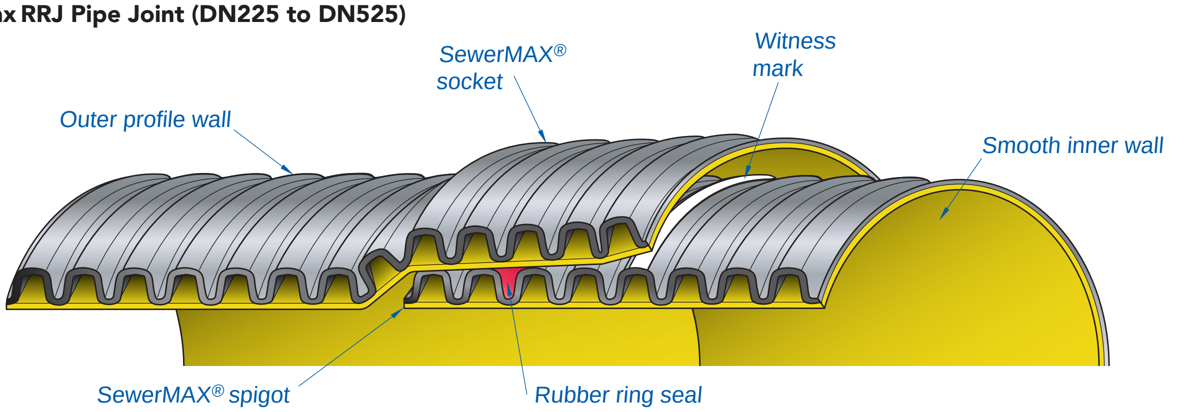
All images are indicative only and not to scale

2.5.2 RUBBER RING JOINT DESIGN AND PERFORMANCE

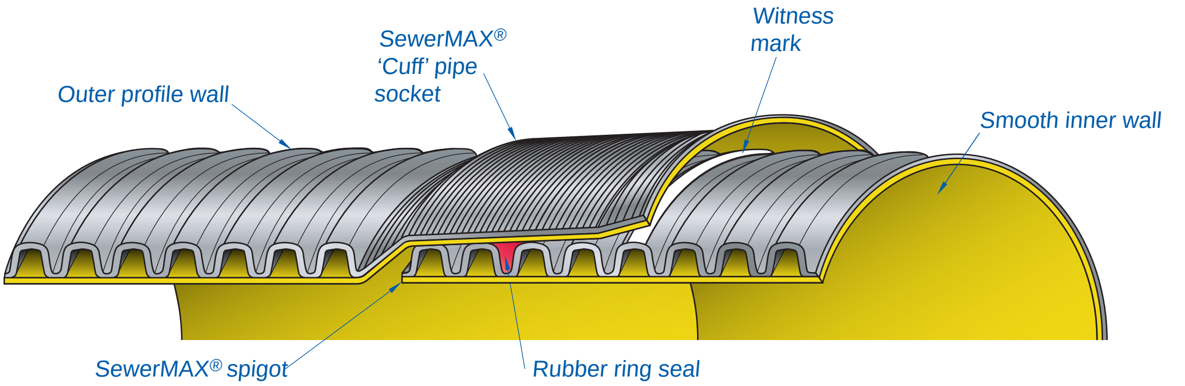
Poor joint performance can lead to leakage and tree root intrusion causing pipe blockages and ground water infiltration. Infiltration through the pipe joint can also cause silting of the pipeline and long-term maintenance issues. For this reason, the quality of the joint is critical to the performance of any pipe system.

The SewerMax elastomeric seal provides a high degree of resistance to infiltration, exfiltration, and root ingress. The SBR rubber ring seal is compliant to 'AS1646 Elastomeric seals for water works purposes' and is resistant to chemical and microbiological attack.

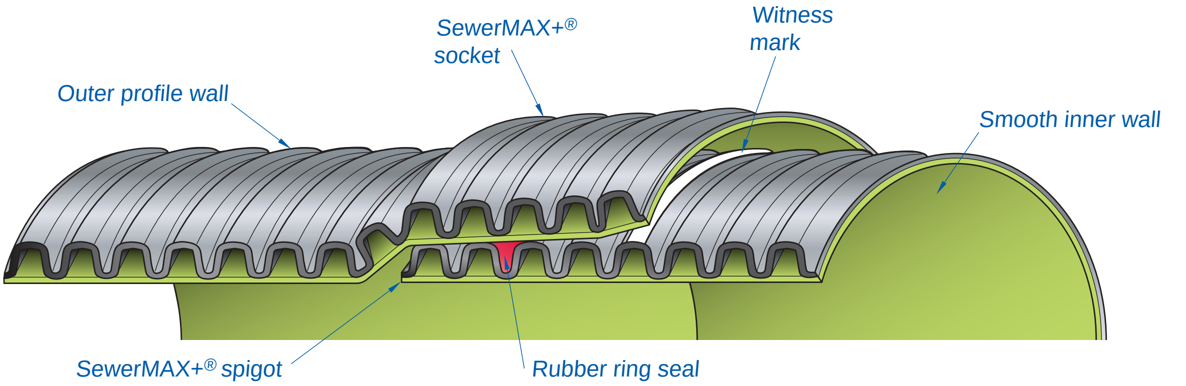
SewerMax RRJ Pipe Joint (DN225 to DN525)



SewerMax RRJ Pipe Joint (DN600 to DN1200)



SewerMax+ RRJ Pipe Joint (DN225 to DN525)



All images are indicative only and not to scale

2.5.3 JOINT TIGHTNESS TESTS

The SewerMax pipe joint has been tested in accordance with the performance requirements in 'AS/NZS 5065 Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications. Section 3.4.3 (AS/NZS 5065) 'Contact width and pressure' specifies a minimum contact pressure of 0.4MPa between the rubber ring seal and the pipe socket wall over a distance of at least 4mm. These conditions have been shown to provide high resistance to tree root intrusion for plastic pipes.

2.5.4 PRESSURE AND VACUUM

The SewerMax pipe joint has been tested in accordance with the performance requirements in 'AS/NZS 5065 Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications'. Sections 3.4.1 (AS/NZS 5065) 'Hydrostatic pressure test' and 3.4.2 'Liquid infiltration test' specifies a pressure test of 80 +5, -0 kPa for 60 +5, - 0 min and a vacuum test of - 80 +5, -0 kPa for 60 +5, - 0 min with a diametral distortion of 7.5%.

2.6 PIPE STIFFNESS

The ring stiffness of a flexible pipe indicates its ability to resist soil loads, external hydrostatic pressure, negative internal pressures, traffic, and construction loads. The nominal ring stiffness can be determined by laboratory testing and is expressed in N/m/m - Reference AS/NZS 2566.1 and AS/NZS 1462.22.

Pipe Description	Pipe Stiffness	Classification (AS/NZS 5065)
SewerMax	>10000 N/m/m	SN10
SewerMax+	>20000 N/m/m	SN20

The high ring stiffness of SewerMax and SewerMax+ provides a higher factor of safety for deep buried applications normally associated with gravity sewer mains.

The stiffness criterion has been adopted by Australian Standard AS/NZS 2566.1 'Buried flexible pipelines - Part 1 Structural design' as being the most appropriate means of classifying flexible pipes manufactured from all types of plastics and metallic materials. It is defined as the force required to achieve the nominated deflection (typically 3% to 5%) on a specific length of pipe and is expressed mathematically as follows:

Equation 2.1

$$SN = \frac{Ff}{L.dv} \quad N/m/m$$

Equation 2.2

$$SN = \frac{EI}{D_m^3.10^6} \quad N/m/m$$

SN = nominal stiffness (N/m/m)

E = apparent pipe material modulus (MPa)

F = force (N)

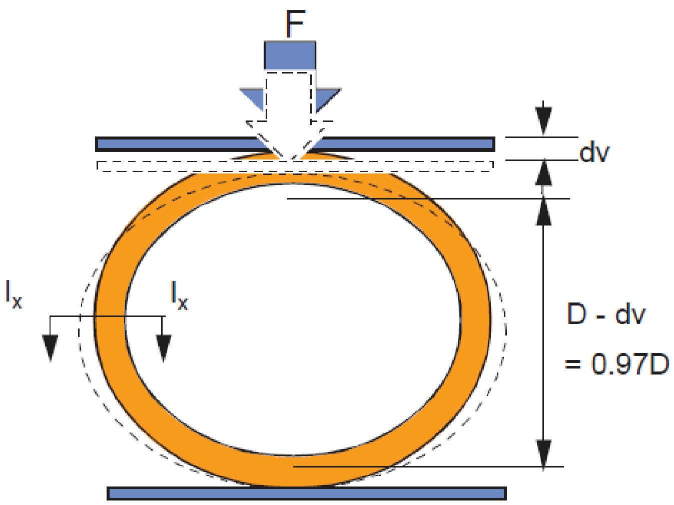
I = second moment of area (m^4/m)

L = Length of test specimen (m)

d_v = deflection (Diametral deformation) (m)

D_m = pipe diameter at neutral axis of the pipe wall (m)

f = the ovality correction factor, that is $f = 10^{-5}$ (1860 + 2500 *dv/D*)



2.7 RING FLEXIBILITY

Ring flexibility demonstrates that SewerMax and SewerMax+ are not strain limited i.e., AS/NZS 1462.23 Ring flexibility test requires that pipes must withstand 30% deflection without cracking, rupture or buckling. This effectively represents a factor of safety of at least 4 in the case of a vertical deflection limit of 7.5%

All images are indicative only and not to scale.

3.0 DESIGN

3.1 HYDRAULIC PERFORMANCE

SewerMax and SewerMax+ fall into the smooth polymer pipe category of AS2200 'Design charts for water supply and sewerage" and provide good hydraulic performance. Hydraulic performance may be affected by various adverse service factors including:

- Growth of slime (varies with the age of the pipeline and available nutrient in the water)
- Siltation or settlement of suspended particulate matter
- Solids deposition
- Roughening due to carrying of abrasive solids
- Joint imperfections or gaps
- Fitting types and configurations

The notations used for equations in this section are as follows:

Notation	Description	SI unit
d	Internal diameter	m
f	Darcy friction coefficient	
g	Acceleration due to gravity	m/s^2
k	Equivalent hydraulic roughness	m
L	Length of pipeline	m
n	Manning n	
Q	Flow or Discharge	L/s
Q_p	Most probable peak dry weather flow	L/s
Q_f	Flow or Discharge – pipe flowing full	L/s
R	Hydraulic mean radius. i.e. flow area perimeter	m
R_e	Reynolds number	
R_p	Hydraulic mean radius for part full pipe	m
R_f	Hydraulic mean radius for full pipe i.e. D/4	m
S	Hydraulic gradient or slope of gravity flow sewer	m/m
V	Mean velocity	m/s
V_p	Mean velocity in part full pipe	m/s
V_f	Mean velocity in pipe flowing full	m/s
H_L	Friction head loss	m
y	Depth of flow above pipe invert	m
ρ	Fluid density	kg/m^3
ν	Kinematic viscosity	m^2/s
2θ	Angle (radians) subtended at pipe centre by water surface in invert – (Figure 3.5)	
τ	Average boundary shear stress	Pa

To assist the designer in selecting the appropriate pipe diameter, flow resistance charts for SewerMax and SewerMax+ pipes have been provided. Figures 3.1, 3.2, 3.3 and 3.4.

These charts relate friction loss to discharge and velocity with pipes running full and have been calculated using the Colebrook-White transition equation (Equation 3.1). The two values of roughness are generally accepted for the given applications.

Equation 3.1

$$v = -2(2gdS)^{0.5} \log\left(\frac{k}{3.7d} + \frac{2.51v}{D(2gdS)^{0.5}}\right) \quad \frac{m}{s}$$

The Colebrook White equation considers the variation of viscosity with temperature and pipe roughness and is recognised as being one of the most accurate in general use. It requires iterative solutions and it is sometimes more convenient to use the Darcy head loss expression, with the Darcy friction co-efficient 'f' developed by P. Swamee and A. Jain based on the Colebrook-White approach. The Swamee-Jain equation approximates the Colebrook equation used to solve for the Darcy friction factor.

Equation 3.2

$$H_L = f.\frac{L}{d}.\frac{V^2}{2g} \quad m$$

Equation 3.3

$$f = \frac{0.25}{\left[\log\left(\frac{k}{3.7d} + \frac{5.74}{Re^{0.9}}\right)\right]^2}$$

The following flow resistance charts have been prepared based on the following assumptions:

- Temperature = 20°C
- Kinematic viscosity of water v = 1.01 x 10^{-6}m^2/s
- Equivalent hydraulic roughness values Colebrook White k = 0.06mm and Mannings n = 0.009

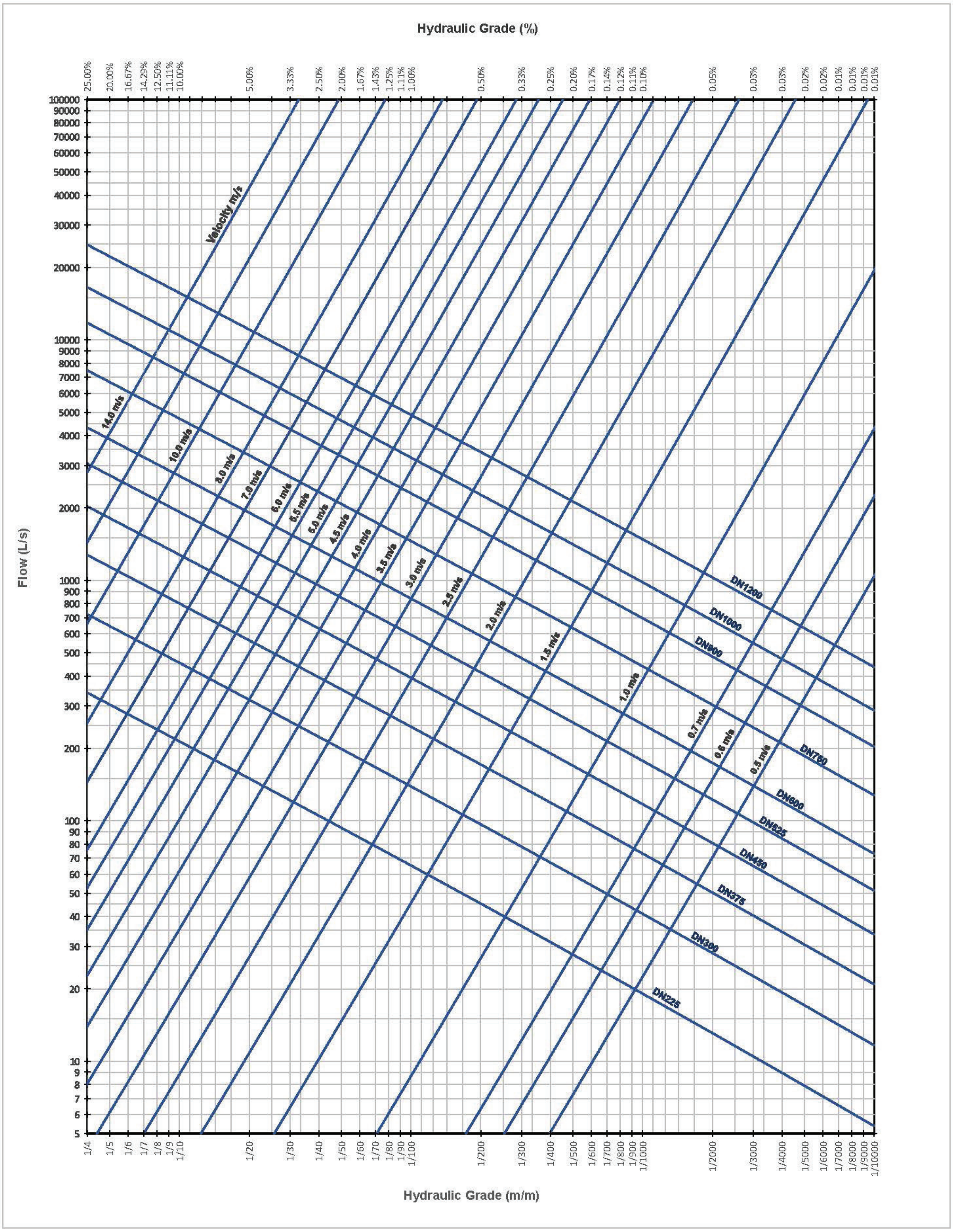
When comparing SewerMax and SewerMax+ with other pipe systems, designers should consider both the smooth surface characteristics of polypropylene and the anticipated pipeline service. Different applications may require a variation of the values of roughness coefficients chosen to conform to accepted practice. For example, for sewers, it may be necessary to consider possible slime development. Generally, smooth pipe materials have a lower value compared with rougher materials such as cement lined pipes, concrete and vitrified clay pipes used for the same purpose. Examples of comparative values are given in the following table.

TABLE 3.1 Comparative Roughness Values for Different Materials

Application	Polymer pipe roughness	Non polymer pipe roughness
Sewerage and drainage	Colebrook White k = 0.06 mm	Colebrook White k = 0.6 mm
	Mannings n = 0.009	Mannings n = 0.012

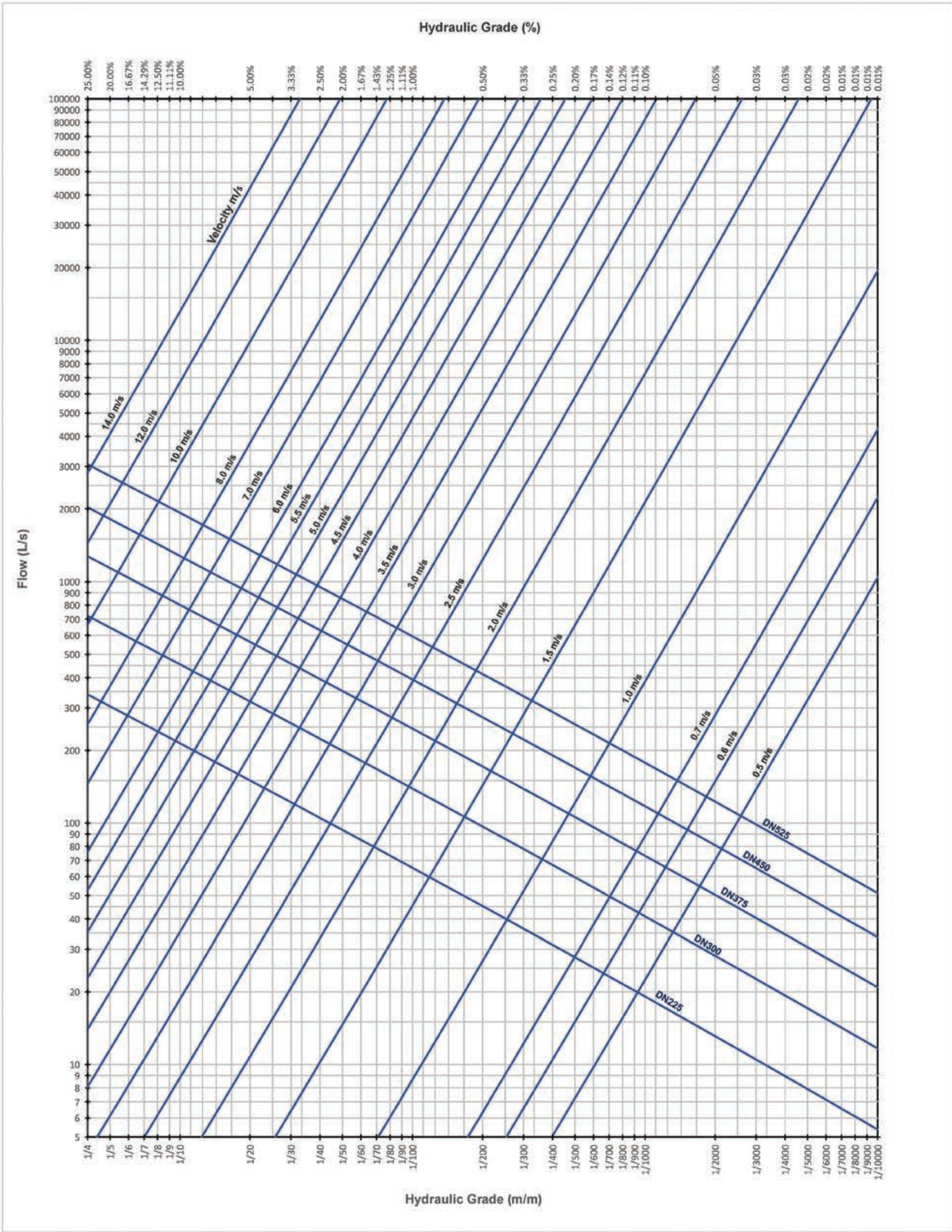
Note: These values are for clean water and assume the pipeline is straight, clean, and concentrically jointed. Australian Standard AS 2200 'Design charts for water supply and sewerage' gives a range of values for Designers to select. E.g., For thermoplastics, Colebrook White k is between 0.003mm to 0.015mm and Mannings n 0.008 to 0.009 and for Concrete, centrifugally spun pipes Colebrook White k is between 0.03mm to 0.15mm and Mannings n 0.009 to 0.012.

FIGURE 3.1 SewerMax flowchart based on the Colebrook White equation with a Roughness Coefficient of k=0.06



The graph shown is for guidance only.

FIGURE 3.2 SewerMax+ flowchart based on Colebrook White equation with a Roughness Coefficient of k=0.06mm



The graph shown is for guidance only.

Alternative empirical formulae, exponential in form, have been used over many years for flow calculations. Being relatively easy to use, they are still favoured by hydraulic engineers. The Manning Equations are the most common for non-pressure gravity flow. They can be written as:

Equation 3.4

$$Q = \frac{4000}{n} \pi \left(\frac{d}{4}\right)^{8/3} S^{1/2} \qquad \frac{L}{s}$$

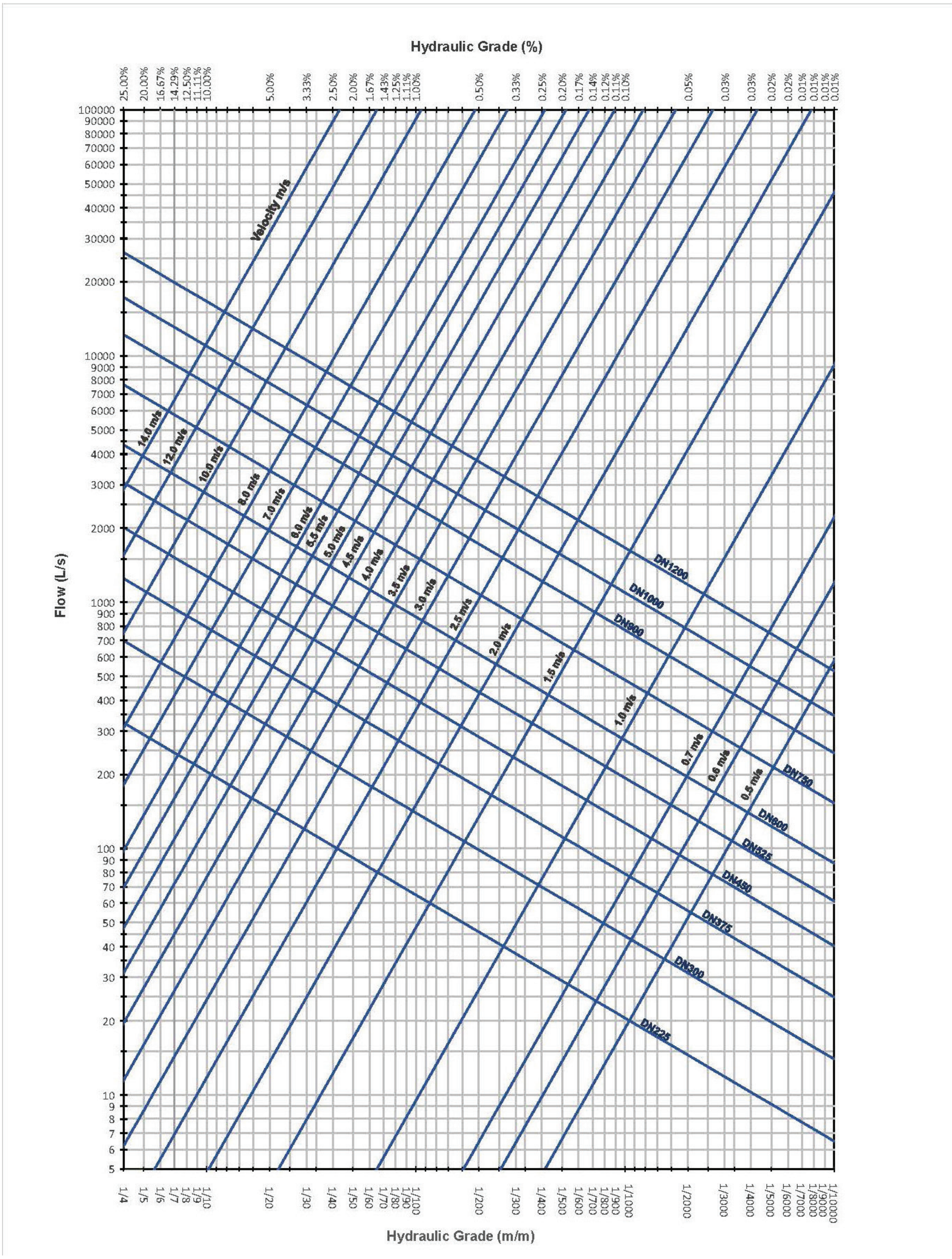
and

Equation 3.5

$$V = \frac{0.3950}{n} d^{0.67} S^{0.5} \qquad \frac{m}{s}$$

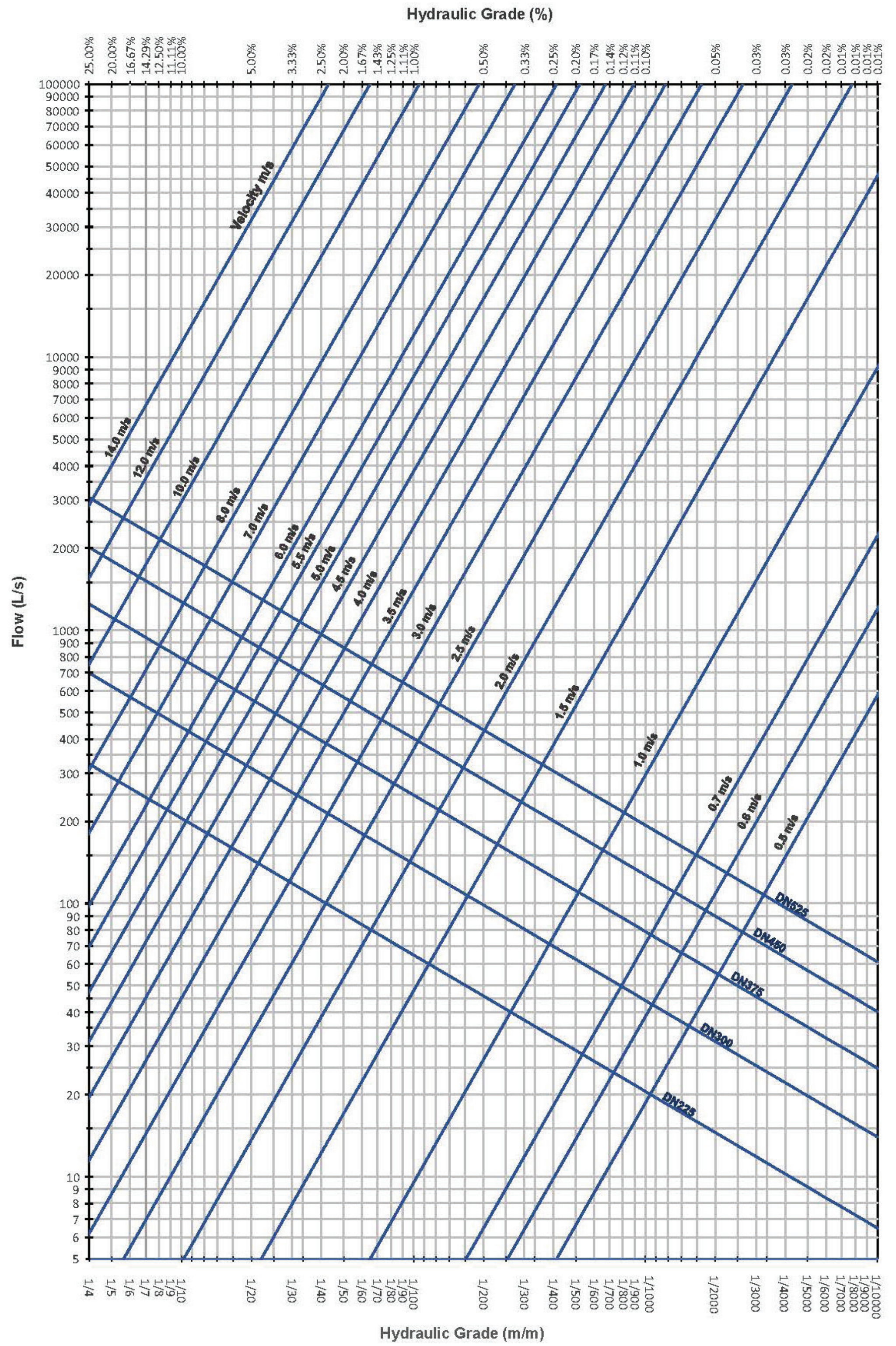
For clean polypropylene pipes such as SewerMax and SewerMax+, 'n' is usually taken as being equal to 0.009. In the Australian Standard AS 2200, 'n' for polymeric materials is in the range of 0.008 to 0.009 whereas for vitrified clay 'n' is in the range of 0.009 to 0.013.

FIGURE 3.3 SewerMax flowchart based on Mannings Equation using a Mannings n=0.009



The graph shown is for guidance only.

FIGURE 3.4 SewerMax+ flowchart based on Mannings equation using a Mannings n=0.009



The graph shown is for guidance only.

3.1.1 SEWER DESIGN

The design of gravity sewers can be complex due to the assumptions, which must be made to cover the wide variations between peak dry and wet weather flows. Although pipes must be sized to carry wet weather flows, the size and grade of the pipeline must also meet self-cleansing criteria under dry weather conditions.

Acceptable design methods will vary between authorities and whether the system is to be designed for sewage flows only or combined sewage and stormwater flows. In Australia, the separated sewage flow is the usual requirement. Even so, these systems often carry considerable stormwater flow in wet weather due to incidental inflow and infiltration of stormwater. For design purposes the normal average sewerage flow of say 0.003 L/s per head of population or equivalent population (EP) is increased by a series of empirical factors to allow for peak dry and wet weather flows. The resulting maximum design flow is therefore much higher than the estimated average flow. Sewer pipes are sized to carry the maximum design flow (Q_f) flowing full. In addition, a check is made to ensure that in dry weather there will be enough flow to ensure self-cleansing at least once daily.

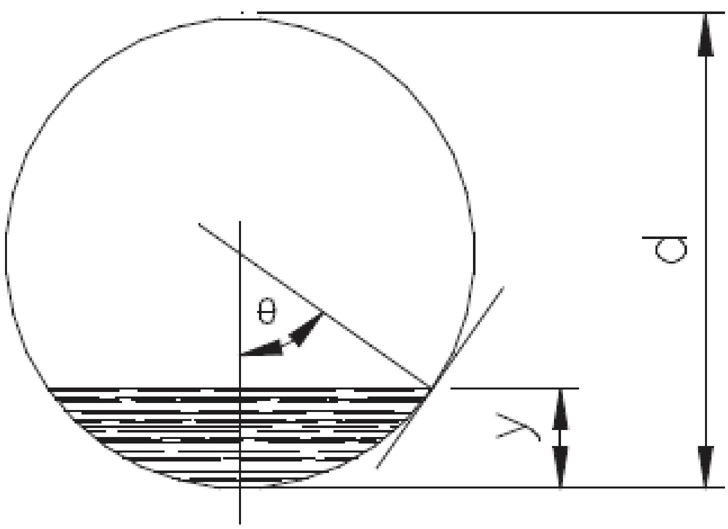


Figure 3.5 Angle of repose of sediment for a self-cleansing flow

All images are indicative only and not to scale.

Historically, the normal design criterion was that a partial flow with a self-cleansing velocity of 0.6 m/s had to be achieved once a day. Today most design methods are based on the Fluid Boundary Layer Shear Theory. Research on the movement of sand particles on submerged pipe perimeters at low flows show that deposition will occur on the flatter parts of the pipe invert when the slope of the pipe wall is less than θ = 35° Figure 3.5. The Boundary Layer design theory builds on this fact.

From open channel theory the following expression can be written in terms of average boundary shear stress 'τ'.

Equation 3.6

$$\tau = \rho.g.R.S \quad \textit{Pascals}$$

For a circular sewer flowing part full and since R_f= d/4, Equation 3.6 can be rewritten as:

Equation 3.7

$$\tau = \rho.g.\left(d/4\right).\left(Rp/Rf\right).S \quad \textit{Pascals}$$

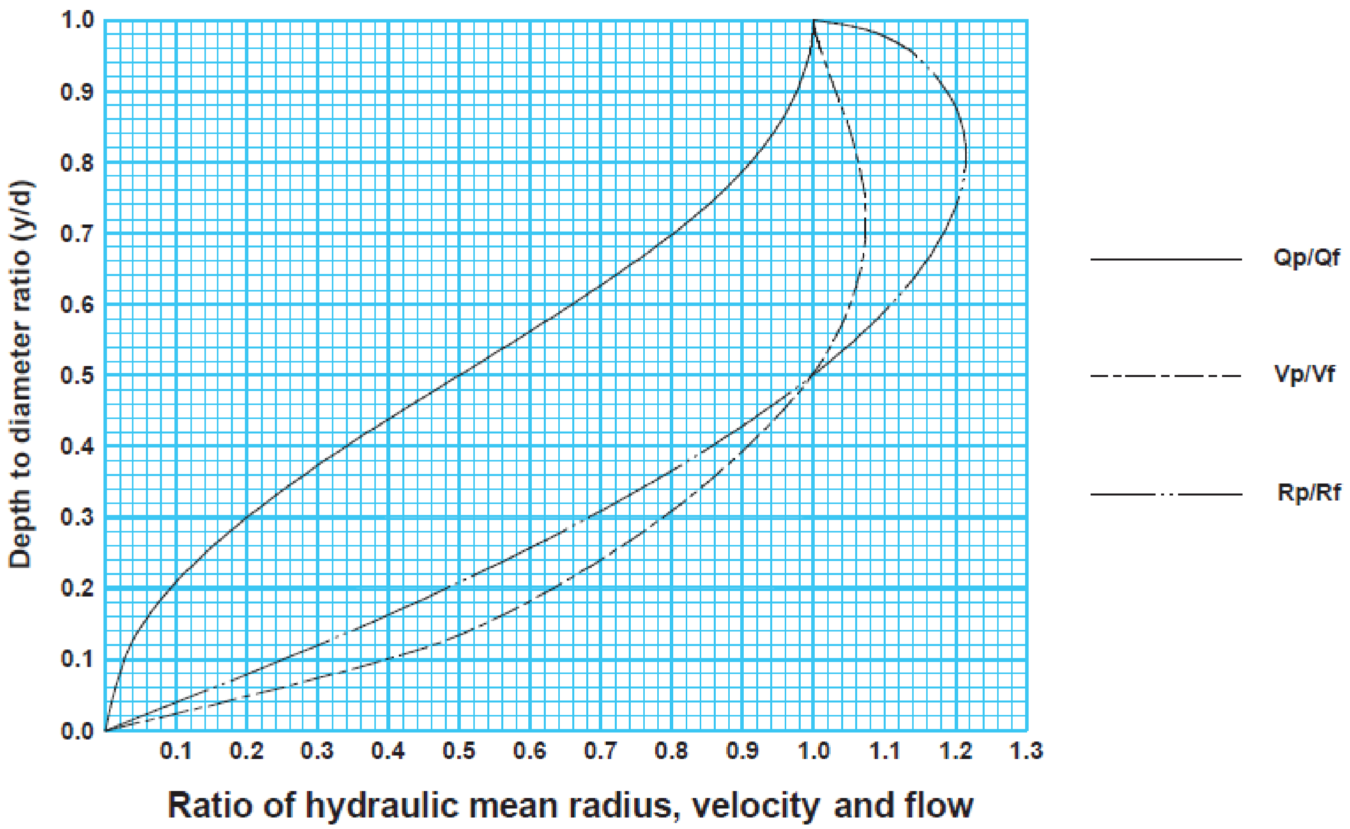
It can be assumed if 'τ' ≥ 1.5 Pa, the pipe invert will be self-cleansing. Therefore, taking this as the value for 'τ', the minimum self-cleansing slope can be determined by rearranging Equation 3.7.

Equation 3.8

$$S_{min} = \frac{4\tau}{\rho.g.d.\left(Rp/Rf\right)} \quad m/m$$

Using geometrical relationships and Mannings Equation 3.4, the hydraulic elements in Figure 3.6 have been developed to relate the flow, depth, and hydraulic mean radius ratios with each other. With the Q_p/Q_f ratio known, the depth to diameter ratio y/d can be found and then from this value the R_p/R_f ratio can be determined by substitution in Equation 3.8.

FIGURE 3.6 Proportional velocity and discharge in part-full pipes



The graph shown is for guidance only.

3.2 STRUCTURAL DESIGN

In engineering terminology, SewerMax and SewerMax+ pipes are flexible pipes. They are designed to deform or deflect diametrically within specified limits without structural damage after installation.

External soil and live loads on buried flexible pipes will cause a small decrease in vertical diameter and simultaneously an increase in the horizontal diameter. The horizontal movement of the pipe walls into the soil material at the sides develops a passive resistance within the soil to support the external load. The soil type and density and height of water table (if present), all influence structural performance. The greater the effective soil modulus, the less the pipe will deflect and structural stability against buckling is also enhanced.

Information on appropriate structural design methods for buried installations is given in AS/NZS 2033 Design and installation of polyolefin pipe systems. Applicable method for assessing the predicted long-term deflection are as follows:

i) Graphical design method which can be applied for installations meeting those parameters defined in clause 6.2.2.1 of AS/NZS 2033.

ii) Engineering structural design method as specified in AS/NZS 2566.1 'Buried flexible pipelines Part 1 - Structural design and Supplement.

SewerMax and SewerMax+ pipes are classified by their pipe stiffness (Table 3.2) and are suitable for a range of cover heights. (Figures 3.10 to 3.13).

All images are indicative only and not to scale.

TABLE 3.2 SewerMax and SewerMax+ pipe stiffnesses and classifications.

Pipe	Pipe Stiffness	Classification
SewerMax	>10000 N/m/m	SN10
SewerMax+	>20000 N/m/m	SN20

To properly assess the effects of site conditions on a proposed installation, specific information is needed for structural design.

This includes:

- Pipe diameter (m)
- Cover height (m)
- Properties of Native soil at pipe depth
- Width of Embedment (m)
- Properties of Embedment material
- Height of Water table (m)
- Traffic loading
- Special requirements, such as concrete encasement or grouting

Important Note:

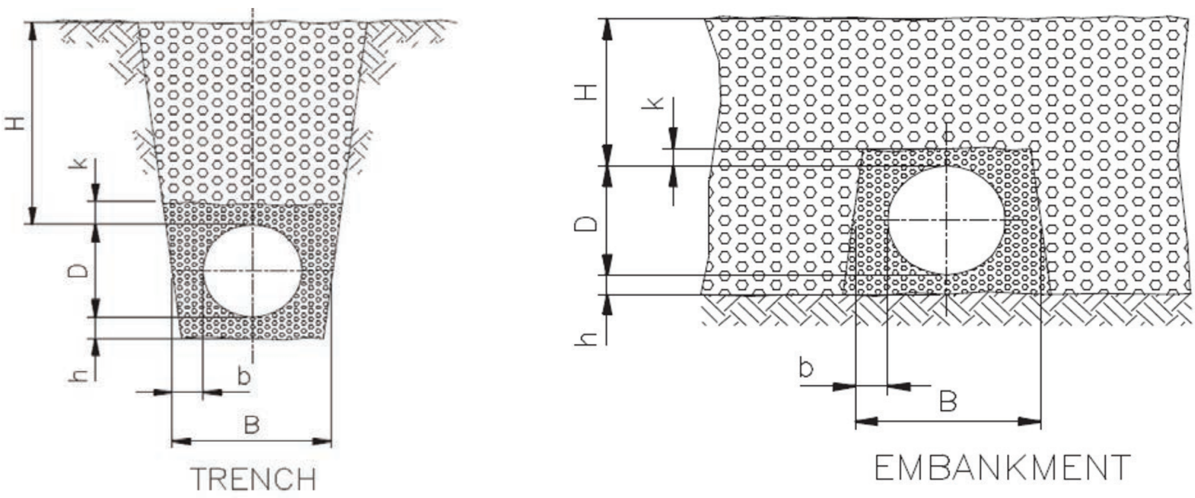
Professional advice should be obtained to determine the appropriate value of the effective soil deformation modulus for an installation. It will depend on the native soil type and condition, the pipe embedment material, its degree of compaction and its geometry (e.g. trench width and embedment width).

Geotechnical surveys giving soil types and properties, including soil-bearing capacities, SPT (Standard Penetration Test) values at pipe depth and embedment compaction will be relevant to the design.

The following notations are used in this Section:

Notation	Description	SI unit
a	The radius of applied circle of loading	m
b	Embedment width on each side of the pipe at spring line	m
B	Trench width at the pipe spring-line	m
D	Overall outside diameter of the pipe	m
E'_e	Embedment soil deformation modulus	MPa
E'_n	Native soil deformation modulus	MPa
E'	Combined soil deformation modulus	MPa
H	Cover height	m
h	Bedding thickness	m
k	Overlay thickness	m
p	Presumptive (allowable) bearing pressure	kPa
Δ	Displacement or settlement	m
ξ	Leonhardt factor	-

FIGURE 3.7 Critical dimensions for design and installation



B = trench width at spring line, D = external pipe diameter

All images are indicative only and not to scale.

3.2.1 GEOTECHNICAL INVESTIGATION

The conventional approach to a pipeline route investigation has been to assess the soil conditions at pipe depth by carrying out a drilling and soil sampling program along the alignment. While the intention in the past was often only to determine the presence of rock and to estimate trench stability for construction purposes, this investigation is now used for more detailed geotechnical reporting and includes additional information readily obtained from routine surveys. It includes design data such as the Standard Penetration Test (SPT), blow counts (at pipe depth), identification of native soil type and depth of water table. The designer will also require an assessment of the embedment material surrounding the pipe and the specified compaction procedure.

3.2.2 DERIVATION OF SOIL DEFORMATION MODULUS VALUES

The correct choice of soil moduli will have significant effects on design decisions. An approximate conversion of SPT blow counts to soil moduli is given in Table 3.2 of Australian Standard AS/NZS 2566.1. Often this is contained in records obtained over many years and frequently gives correlations between SPT and allowable soil bearing pressures.

The soil deformation moduli stated in AS/NZS 2566.1 were originally derived from European design practice using soil bearing plate tests. These moduli are generally about half the value of deformation moduli measured using standard laboratory tri-axial tests and should not be confused with these. Using allowable foundation bearing pressures, it is possible to derive the plate load or pipe design soil moduli from the Boussinesq's plate bearing theory for an elastic, homogenous, isotropic solid. That is for a rigid plate and a soil Poisson's ratio of 0.5.

For the purposes of obtaining a derivation, it can be assumed that the plate is a standard 750mm diameter and the allowable settlement is 15mm. Equation 3.9 provides a conversion relationship, $E'_n = 0.03p$. Table 3.3, which is based on data published by Sowers (1979), shows the result of applying this factor. Similarly Figures 3.8 and 3.9 give deformation moduli obtained by converting other published data (Hough 1959, Clegg 1996).

Values of the soil deformation moduli are needed for both the native and embedment soils within 2.5 x the pipe diameter on each side of the pipe centreline. The modulus for a given pipe embedment soil E'_e can be estimated from Table 3.4.

Equation 3.9

$$\Delta = \frac{1.18.p.a}{E'_n}.10^{-3} \qquad m$$

FIGURE 3.8

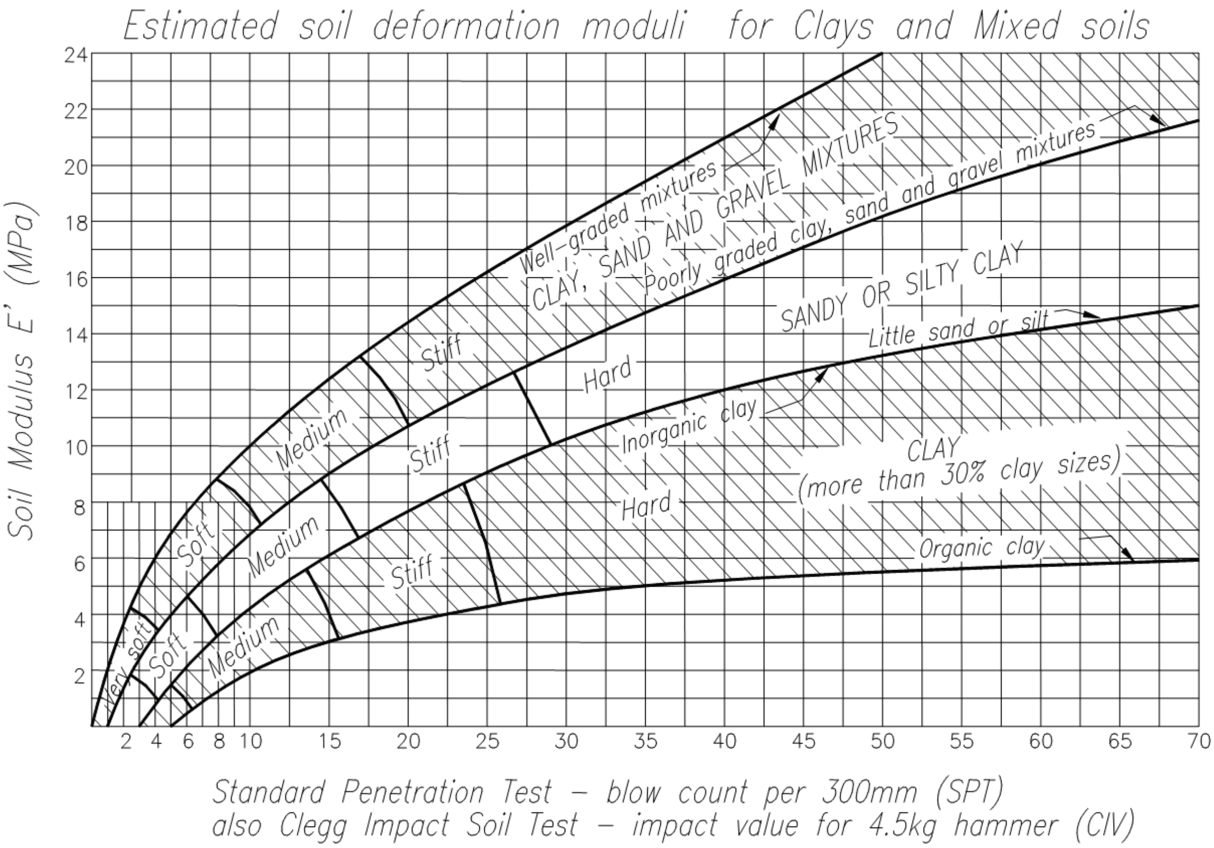


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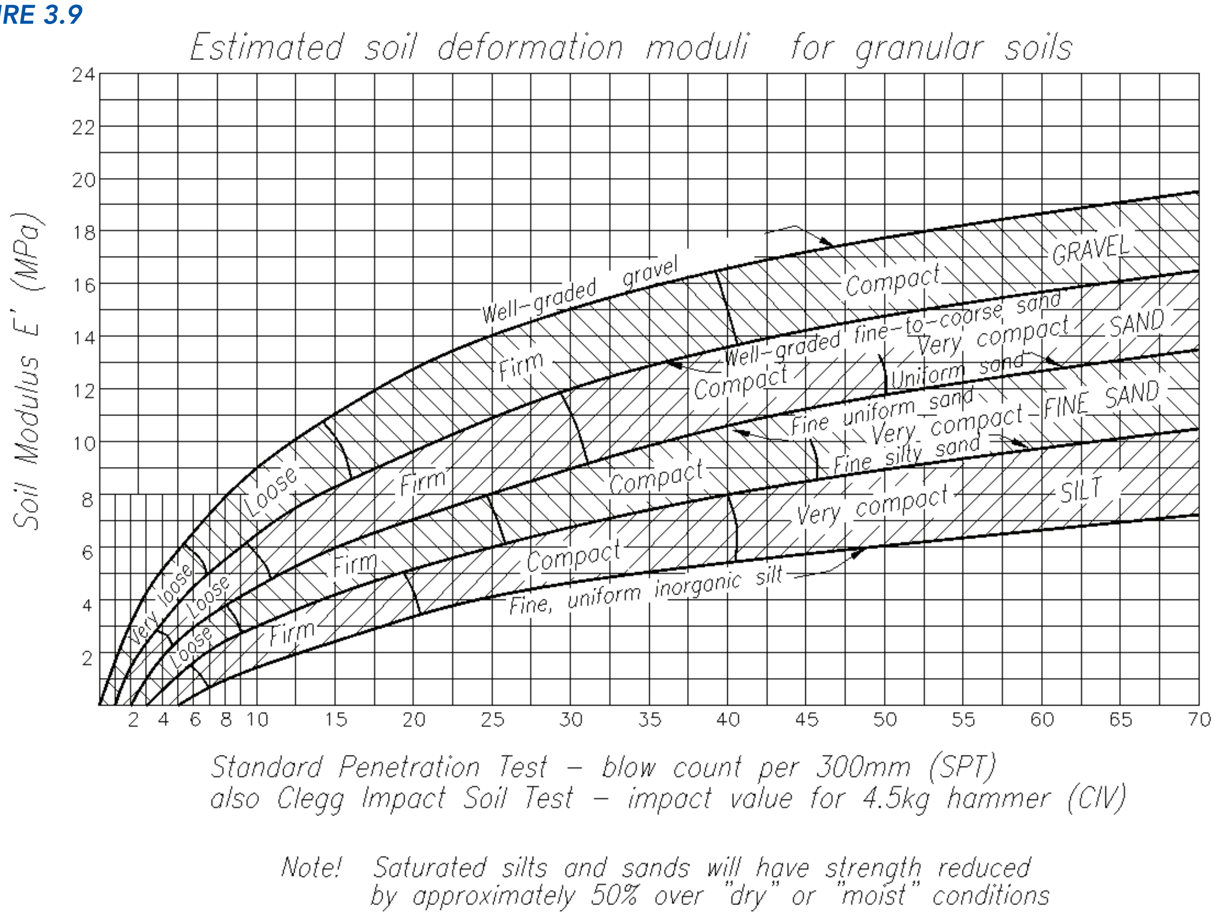
FIGURE 3.9



The graph shown is for guidance only.

TABLE 3.3 Typical allowable foundation pressures converted to native soil moduli

Soil Description	Standard Penetration Resistance – blow count over 300 mm	Allowable foundation bearing pressures p (kPa)	Derived soil deformation moduli E'_n using Eq 3.7 (MPa)
Loose sand, dry	5 - 10	70 -140	2.1 – 4.2
Firm sand, dry	11 - 20	150 – 300	4.5 – 9.0
Dense sand, dry	31 – 50	400 – 600	12 – 18
Loose sand, inundated	5 – 10*	40 – 80	1.2 – 2.4
Firm sand, inundated	11 – 20*	80 – 170	2.4 – 5.1
Dense sand, inundated	31 – 50*	240+	7+
Soft clay	2 – 4	30 – 60	0.9 – 1.8
Firm clay	5 – 8	70 – 120	2.1 – 3.6
Stiff clay	9 – 15	150 – 200	4.5 – 6.0
Hard clay	30+	400+	12+
Heavily fractured or partially weathered rock	50+	500 - 1200	15 - 36

TABLE 3.4 Embedment soil moduli

*SPT before inundation

Soil Description	Standard dry density ratio (%)	Density Index (%)	Deformation moduli E'_e (MPa)
Aggregate – single size	-	Uncompacted 50 60 70	5 6 7 10
Aggregate - graded	-	Uncompacted 50 60 70	3 5 7 10
Crushed rock	Uncompacted 85 90 95	-	1 3 5 7
Sand and coarse-grained soil with less than 12% fines	Uncompacted 85 90 95	-	1 3 5 7
Coarse grained soil with more than 12% fines	85 90 95		1 3 5

*Note: These values are given in AS/NZS2566.1 - Buried Flexible Pipelines, Part 1 Structural Design

3.2.3 EFFECTIVE SOIL MODULUS

Knowing the proportion of embedment and native soil in the side support zone, trench width to pipe diameter (B/D) and the ratio of embedment modulus to native soil modulus (E'_e/E'_n), the Leonhardt factors ξ given in Table 3.5 enable an overall effective soil modulus E' to be determined using the equation:

Equation 3.10

$$E' = \xi E'_e \qquad \text{MPa}$$

TABLE 3.5 Leonhardt correction factor ξ

B/D	E'_e/E'_n						
	0.2	0.4	0.8	1	2	4	6
1.5	2.4	1.8	1.2	1.0	0.6	0.3	0.2
2.0	1.7	1.5	1.2	1.0	0.6	0.4	0.3
2.5	1.5	1.3	1.1	1.0	0.7	0.5	0.4
3.0	1.2	1.2	1.0	1.0	0.8	0.6	0.5
4.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8
5.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

TABLE 3.6 Trench widths and pipe spring-line

DN	Trench width* at the pipe spring-line 'B'* (Figure 3.8)
225	Overall outside diameter of the pipe 'D' + 0.3m
300	
375	Overall outside diameter of the pipe 'D' + 0.4m
450	
525	Overall outside diameter of the pipe 'D' + 0.6m
600	
750	
900	Overall outside diameter of the pipe 'D' + 0.7m
1000	
1200	

*Note: The objective is to achieve uniform compaction of the embedment material. The trench widths might provide insufficient clearances for installation purposes in certain circumstances.


DANGER
DO NOT
ENTER

TABLE 3.7 Minimum cover heights (AS/NZS 2566.1)

Location	Minimum height of cover H (m)*
Not subject to vehicular loading	0.30
Subject to vehicular loading - not in roadways - in sealed roadways - in un-sealed roadways	 0.45 0.60 0.75
Pipes in embankment conditions or subject to construction equipment loading	0.75

*AS/NZS2566.1 Buried flexible pipelines Part 1: Structural design

To follow, figures 3.10 - 3.13 are applicable for SewerMax SN10 and SewerMax+ SN20 pipes with the following pipe design parameters and give an estimate of maximum safe cover heights.

- Minimum Trench widths in accordance with AS/NZS 2566.1
- Maximum long-term vertical pipe deflection 7.5%
- Buckling factor of safety of 2.5
- SM1600 Traffic loading
- Density of trench fill over the pipe 20kN/m^3

Assuming a density of 20kN/m^3 for the trench fill over the pipe, Figures 3.10 - 3.13, will then give an estimate of the maximum safe cover heights.

The graph shown is for guidance only.

FIGURE 3.10

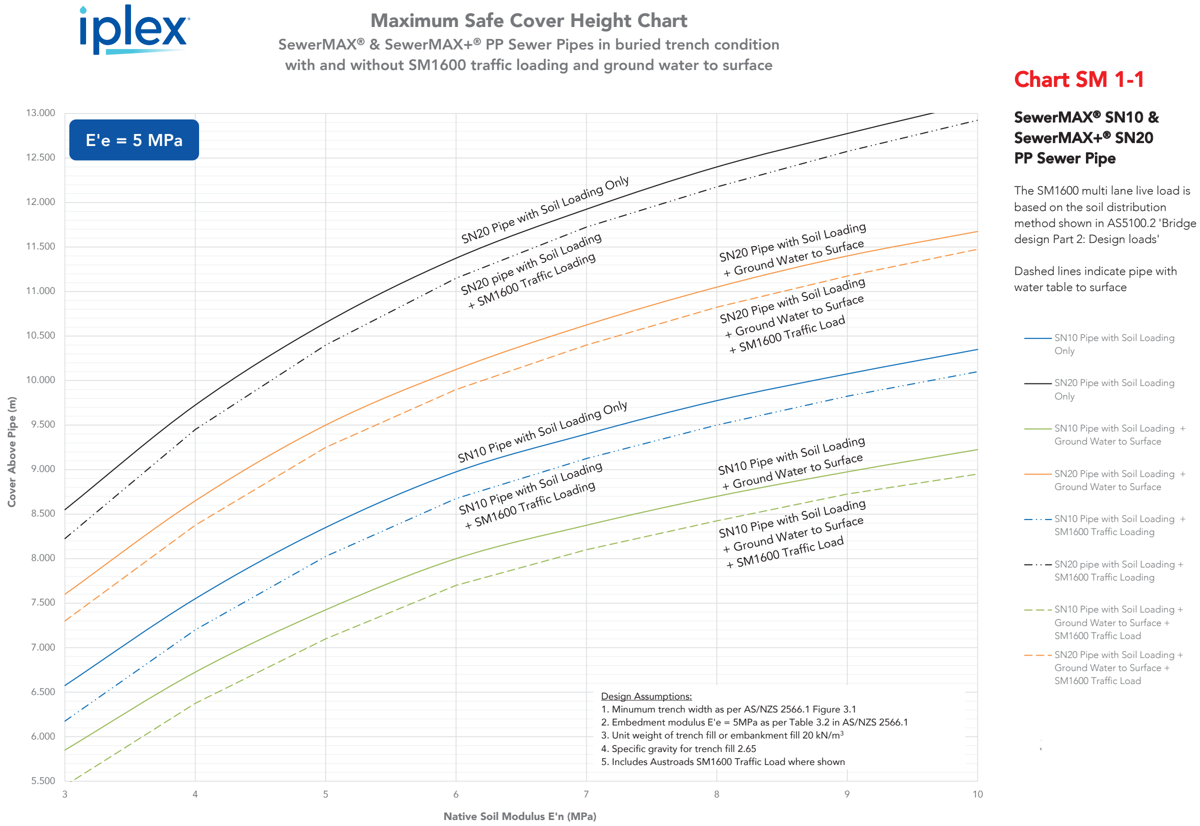


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FIGURE 3.11

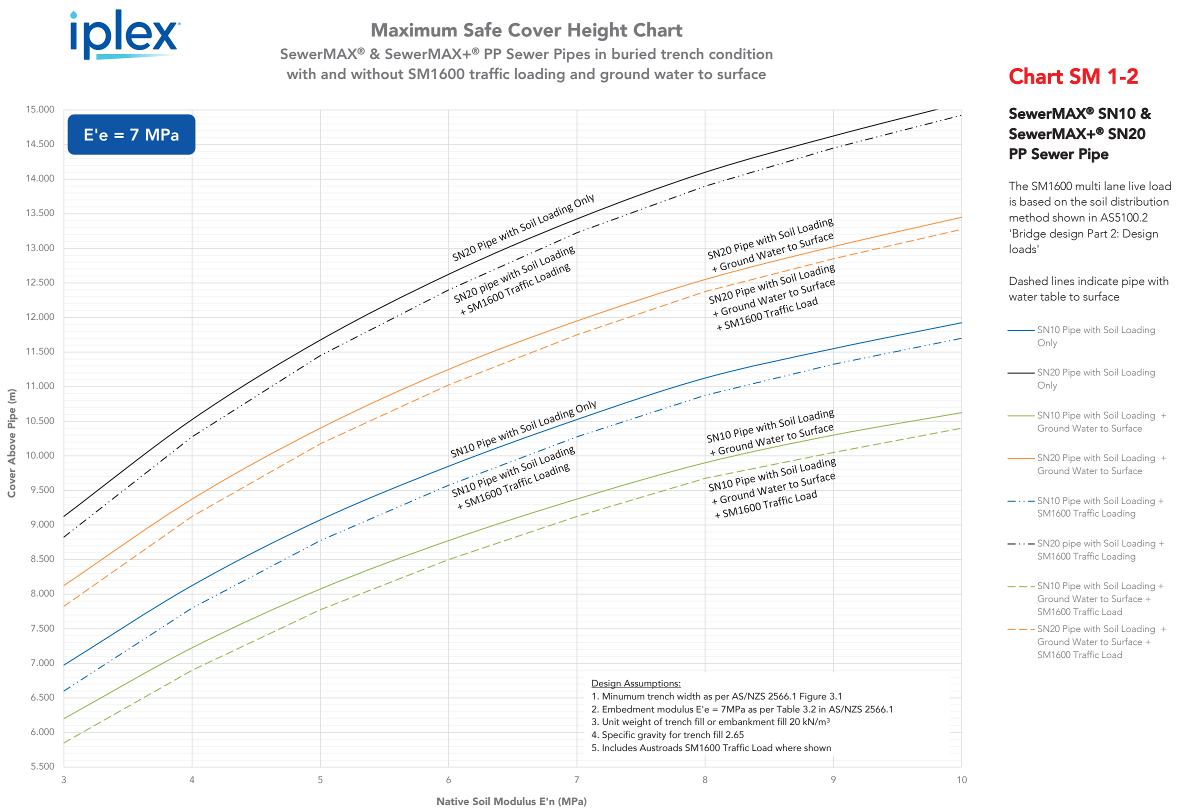

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FIGURE 3.12

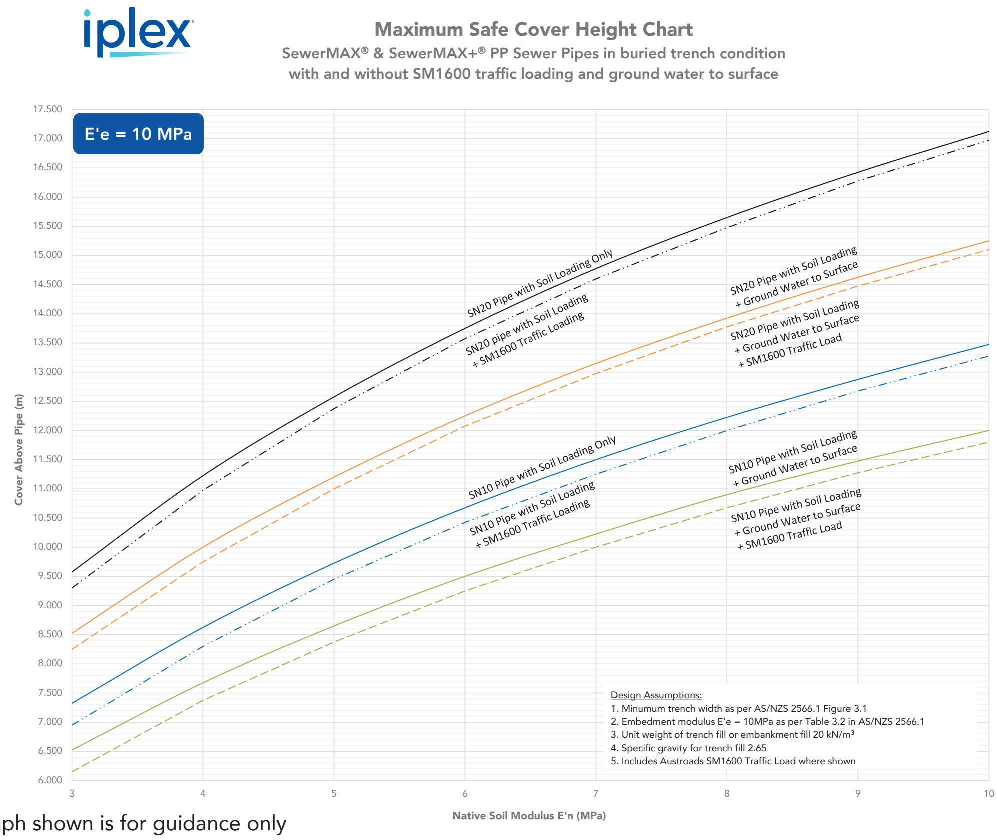

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Chart SM 1-3

SewerMAX® SN10 & SewerMAX+® SN20 PP Sewer Pipe

The SM1600 multi lane live load is based on the soil distribution method shown in AS5100.2 'Bridge design Part 2: Design loads'

Dashed lines indicate pipe with water table to surface

- SN10 Pipe with Soil Loading Only
- SN20 Pipe with Soil Loading Only
- SN10 Pipe with Soil Loading + Ground Water to Surface
- SN20 Pipe with Soil Loading + Ground Water to Surface
- SN10 Pipe with Soil Loading + SM1600 Traffic Loading
- SN20 pipe with Soil Loading + SM1600 Traffic Loading
- SN10 Pipe with Soil Loading + Ground Water to Surface + SM1600 Traffic Load
- SN20 Pipe with Soil Loading + Ground Water to Surface + SM1600 Traffic Load

FIGURE 3.13

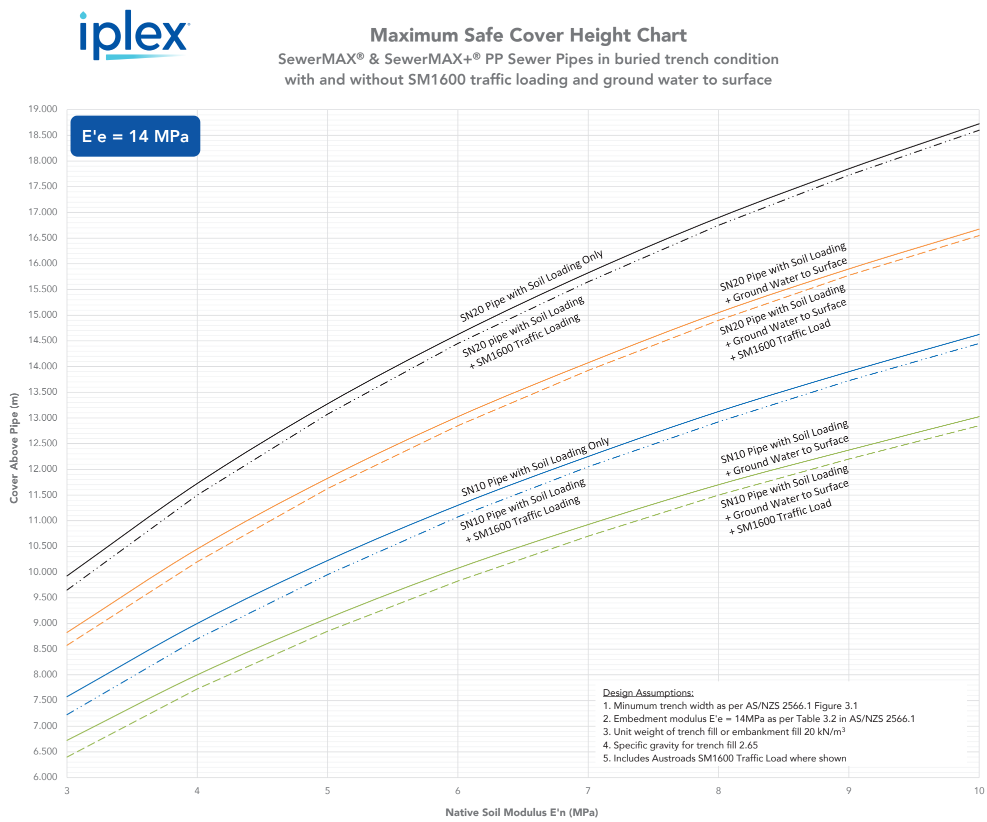


Chart SM 1-4

SewerMAX® SN10 & SewerMAX+® SN20 PP Sewer Pipe

The SM1600 multi lane live load is based on the soil distribution method shown in AS5100.2 'Bridge design Part 2: Design loads'

Dashed lines indicate pipe with water table to surface

- SN10 Pipe with Soil Loading Only
- SN20 Pipe with Soil Loading Only
- SN10 Pipe with Soil Loading + Ground Water to Surface
- SN20 Pipe with Soil Loading + Ground Water to Surface
- SN10 Pipe with Soil Loading + SM1600 Traffic Loading
- SN20 pipe with Soil Loading + SM1600 Traffic Loading
- SN10 Pipe with Soil Loading + Ground Water to Surface + SM1600 Traffic Load
- SN20 Pipe with Soil Loading + Ground Water to Surface + SM1600 Traffic Load

The graph shown is for guidance only

3.2.4 EFFECTS OF CONSTRUCTION LOADS ON BURIED SEWERMAX AND SEWERMAX+ (PP) PIPES

The recommended minimum (final) cover heights for buried flexible pipelines in different installation conditions are tabulated in Australian Standard AS/NZS 2566.2 and are empirically derived from accepted installation practice. They are similar for rigid pipes.

However, some government authorities have requested information on the performance of flexible pipes under construction loads where cover heights may be considerably lower. A theoretical evaluation is possible using the design procedures for flexible pipes given in AS/NZS 2566.1 Clause 4.7 'Super-imposed Live Loads' provided that these covers may be less than the prescribed design minimum. That is at covers less than 400mm where loads are due to compaction equipment, it is reasonable to assume there will be some load dispersion, but this will reduce progressively in a linear fashion to zero, as covers reduce from 400mm to zero.

Minimum (construction) cover heights have been calculated using this approach. Assumptions have been made with the native soil modulus values of 3MPa being considered appropriate. This corresponds to a firm clay with a presumptive foundation bearing pressure of about 100kPa or SPT blow count of 6+ per 300mm. A firm inundated sand would have a similar modulus. The embedment modulus has been taken to be 7MPa from AS/NZS 2566.1 as this is typical of good quality embedment material. The calculated minimum covers for the range of compaction equipment are given in Table 3.8.

TABLE 3.8 Compaction equipment with minimum cover heights calculations B/D ≥ 1.66

Type	Vibratory Rammer (75kg)	Vibratory Trench Roller (2T)	Excavator compaction wheel (25T)	Vibratory Smooth drum Roller (17T)	Vibratory Smooth drum Roller (7T)	Vibrating Plate (240kg)
Model	BS62Y			CAT CS653		
Number of axles	1	2	1	1	1	1
Axle spacings	N/A	970mm	N/A	N/A	N/A	N/A
Bearing length 'a'	330mm	200mm	200mm	200mm	100mm	500mm
Bearing length 'b'	330mm	865mm	580mm	2200mm	1676mm	500mm
Wheel load 'P'	33KN	72KN	155KN	218KN	162kN	37kN
	Minimum Cover Heights using compaction equipment (mm)					
Pipe Stiffness (N/m/m)	Vibratory Rammer (75kg)	Vibratory Trench Roller (2T)	Excavator compaction wheel (25T)	Vibratory Smooth drum Roller (17T)	Vibratory Smooth drum Roller (7T)	Vibrating Plate (240kg)
SN10	250mm	375mm	800mm	600mm	600mm	175mm
SN20	200mm	300mm	675mm	475mm	475mm	100mm

On site, the effect of compaction equipment on flexible pipes can be checked by monitoring changes in ring deflection. Details of allowable deflections are given in Clause 5.7 of AS/NZS 2566.2. Although higher ring deflections will not damage polypropylene pipes, excessive initial ring deflections, e.g. more than 4%, must be avoided as the magnitude of the deflection after installation is often used as the prime indicator of whether the specified side support compaction has been achieved. Compaction of the side support zone before allowing the compaction equipment to operate on the overlay above the pipe will assist in this respect. Where the allowable limit has been exceeded the pipeline installation may be rejected. In these circumstances it may be acceptable to recover and re use the same pipes with increased side support compaction.

PocketENGINEER™ Structural Design Tool

To assist designers with the specification of structurally effective flexible pipeline installations, Iplex has developed a web based flexible pipe structural design tool. Alongside several other helpful design tools, this is accessible to customers via the Iplex PocketENGINEER portal (www.pocketengineer.com.au).

The structural design tool considers project specific inputs such as pipe types and sizes, trench and loading conditions and advises if the installation design meets the relevant requirements of AS2566.

A design report can be prepared and shared with other PocketENGINEER users for review. Various saved designs can also be collated into a useful comparison report to help establish the most efficient system possible.

To access the tool, simply visit **www.pocketengineer.com.au** to register.

4.0 INSTALLATION

4.1 PLANNING

Some thought and care must be given in preparing the site prior to receiving the pipes and fittings. Choose flat areas for pipe storage with safe vehicle access and ensure that it is possible to safely unload the pipes and fittings at the sites you have chosen. For example, crane trucks near overhead powerlines. Refer to Iplex's 'Exclusion Zones at Customer Sites' document for guidance which is available at www.iplex.com.au.

Note: The pack sizes and weights can be large and heavy, and may require suitable lifting equipment and machines to complete unloading safety.

4.2 TRANSPORATION AND STORAGE

Storing pipes correctly will limit any damage and help lead to safe working practices. Tins of pipe jointing lubricants must be stored securely, preferably in a lockable shed or container attached with their chemical safety data sheet . Petroleum products, solvents and greases can damage rubber products and must not be stored with rubber sealing rings.

When receiving the load at the job site, check the timber packs. Wear puncture and cut proof gloves for protection against protruding nails. If the timber packs are broken and/or have moved, inspect each pipe for damage. Any damaged or missing items must be noted and quarantined for inspection.

4.3 UNLOADING

Before unloading pipes and fittings, it is critical that exclusion zones are implemented between the mobile plant and people on site.

Unloading packed pipes and loose pipes will require care to protect the loads and provide safety for the workers. Use approved and suitable lifting equipment. For example, forklift with padded tynes, crane, backhoe, or excavator with certified and currently tagged nylon slings.

Always follow safe unloading requirements. Forklift and attachments must be load rated to suit the lifting requirements and attachment lengths of the product being unloaded. For example, ensure the length of the tynes **DO NOT** push against the adjacent crates and or pipes on the far side of the truck. Do not stand under or near the pipe pack, pipe or fitting that is being lifted. Enforce **SAFE** exclusion zones around the pipes and fittings being lifted. If unsure speak with the forklift manufacturer for advice and information for your needs.

Webbing slings must be placed under and around the pipe pack. Do not use the pack's frame or straps for lifting. It is not designed for unloading.

Do not climb on the pipes for safety reasons. The surface can be slippery especially in wet or frosty conditions.

4.4 HANDLING

When handling SewerMax and SewerMax+ pipes and fittings always wear approved Personal Protective Equipment (PPE).

Although SewerMax and SewerMax+ pipes are notably resistant to impact, they must not be rolled, dropped, thrown, or encounter sharp objects likely to cause damage. Always avoid impact loads and always lower the pipes to the ground carefully.

When pipes are unloaded for storage they must be kept in their packs until required. The storage site must be level and free of obstructions. Allow enough space in between each pipe pack for lifting equipment to safely manoeuvre without causing accidental damage.

If pipes are not crated, they must be kept on horizontal supporting timbers at approximately 1 metre centres. These timbers can also be used to separate layers when pipes are stacked individually, which will facilitate the safe placement and removal of currently tagged and certified lifting slings.

Stack heights must be limited to prevent excessive deformation. **ALL PIPES MUST BE RESTRAINED TO PREVENT ROLLING BY UNEVEN GROUND, WIND LOADS OR OTHER EXTERNAL FORCES.**

Sockets must be protected from distortion during storage by ensuring all the sockets are placed at alternate ends and raised clear from ground and each other.

TABLE 4.1 Pack specifications for SewerMax & SewerMax+ pipes

DN	Approximate pack sizes			Pipes per pack (No)	Approximate mass of pack SewerMax SN10 (Without timbers) (kg)	Approximate mass of pack SewerMax+ SN20 (Without timbers) (kg)	Pipes per semi-trailer
	Width (mm)	Height (mm)	Length (mm)				
225	1100	610	3300	8	96	128	256
300	1100	770	3300	6	132	174	108
375	920 or 1345	940	3400	4 or 6	129 or 192	196 or 294	90
450	1130	595	3500	2	84	120	48
525	1890	715	3500	3	165	243	36
600	2130	770	3400	3	201	NA	27
750	TBC*	TBC*	TBC*	TBC*	TBC*	NA	TBC*
900	TBC*	TBC*	TBC*	TBC*	TBC*	NA	TBC*
1000	TBC*	TBC*	TBC*	TBC*	TBC*	NA	TBC*
1200	TBC*	TBC*	TBC*	TBC*	TBC*	NA	TBC*

*Contact Iplex for more information

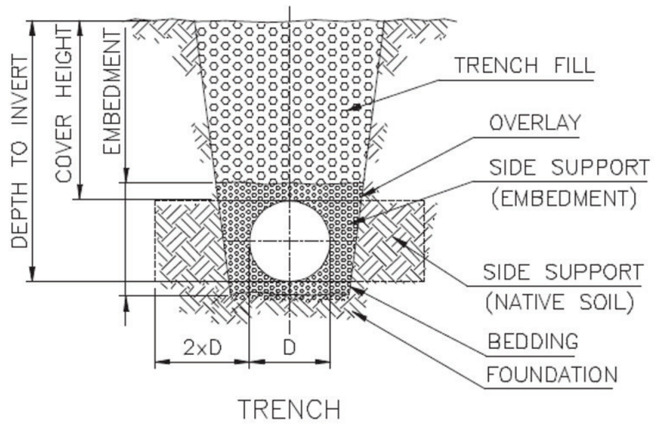
Typical SewerMax and SewerMax+ pack method ready for road transport

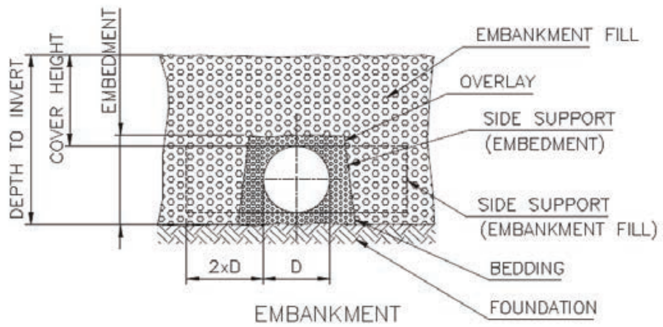
4.5 INSTALLATION GUIDELINES

SewerMax and SewerMax+ are flexible pipes which are designed for controlled deflection under vertical soil loads. These loads are transferred to the soil in the side support zone, providing a very efficient pipe to soil interaction and high structural performance. Australian Standard AS/NZS 2566.2 'Buried flexible pipelines -Part 2 Installation' provides detailed information on appropriate methods for ensuring the side support zone is correctly constructed.

The most critical aspect for the successful installation of these pipes is the selection and compaction of the embedment, i.e. the material in contact with the pipe. Embedment material must be of a granular nature, which is readily compactable. Crushed rock, aggregate and graded sand are commonly used but occasionally native soils, (e.g. beach and Mallee sand) may also be suitable provided they are free flowing and readily compacted and provide permanent support over the service life of the pipeline. Appendices G and H of AS/NZS 2566.2 provide extensive guidance on the selection and use of a wide range of embedment materials.

FIGURE 4.1 Buried pipeline terminology





All images are indicative only and not to scale.

4.6 EXCAVATION AND ASSOCIATED WORKS

4.6.1 TRENCH EXCAVATION

Excavate the trench to the line and grade specified. The trench width must be enough to permit compaction of the pipe embedment materials with suitable equipment. The minimum pipe trench width required is dependent on the pipe diameter. Refer to Section 3.2.3, Table 3.6 for further information. The trench bottom must be even and free of soil clods and rocks.

4.6.2 FOUNDATION

The native soil in the foundation zone must be carefully excavated to grade permitting the pipeline to be correctly aligned and allowing for bedding material with a minimum thickness of 100mm (DN225 to DN375) and 150mm (DN450 to DN1200) beneath the pipe. If the bearing capacity of the foundation soil is thought to be less than 50 KPa it will need to be replaced with a mattress of embedment material. In this situation, geotechnical advice should be obtained.

4.6.3 UNSTABLE AND WET GROUND CONDITIONS

Wet and/or unstable soil conditions will require precautions to maintain firm and permanent side support for the pipes once installed. Where groundwater is present, there may be a risk of the fine soil particles migrating across the interface between the native and embedment soils. In this situation the embedment must be fully enveloped with geo-textile material. Details of soil gradings where this can occur are given in AS/NZS 2566.2.

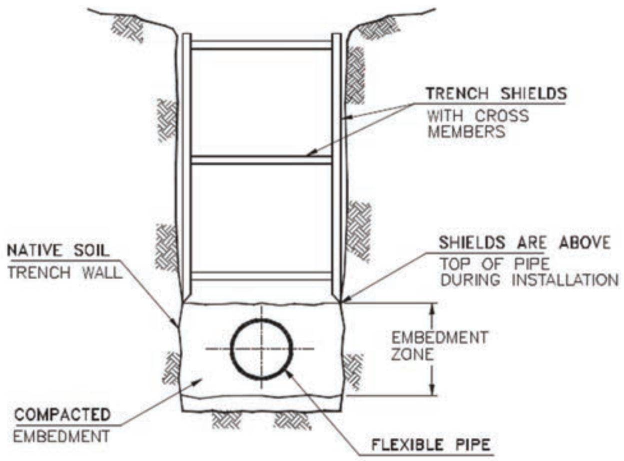
Pipe installation must be carried out in a trench free of water. Where there is continuous ground water inflow, it will be necessary to facilitate drainage of the trench with approved dewatering equipment and using a porous layer of bedding material in the foundation zone. Generally, this will be a coarse granular material, which will need to be fully encapsulated in a geo-textile fabric. It is sometimes described as a drainage mattress.

4.6.4 TRENCH SHIELDS

Trench shields or soil boxes must be a close fit against the excavated trench walls and the bottom edges kept above the top of the pipe. If for safety reasons they must extend to the bottom of the trench, compaction of the embedment material after the shields are lifted will be necessary to eliminate any voids that may otherwise develop (see Figures 4.2 and 4.3).

Trench shields used in open excavations are prone to accumulate loose debris between the box and the trench wall. As this poor-quality material can adversely affect the available side support, it is good practice to place high quality embedment material to form part of the side support zone as soon as possible. This will exclude any debris or material which may slough from the trench wall (see Figure 4.4).

FIGURE 4.2 Shields kept above side support



All images are indicative only and not to scale.

FIGURE 4.3 Shields kept below pipe during installation

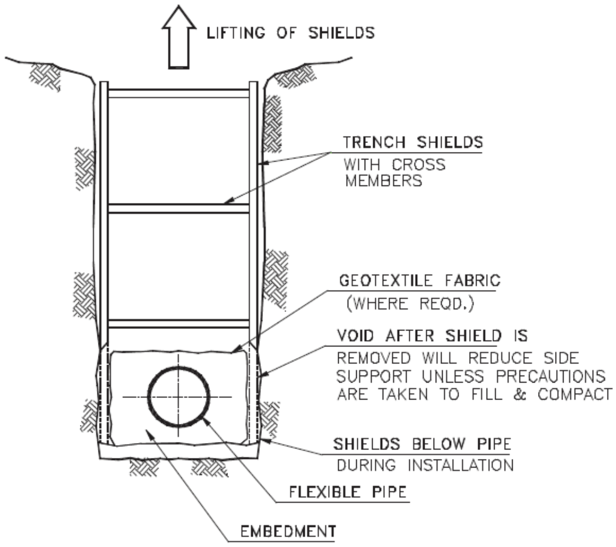
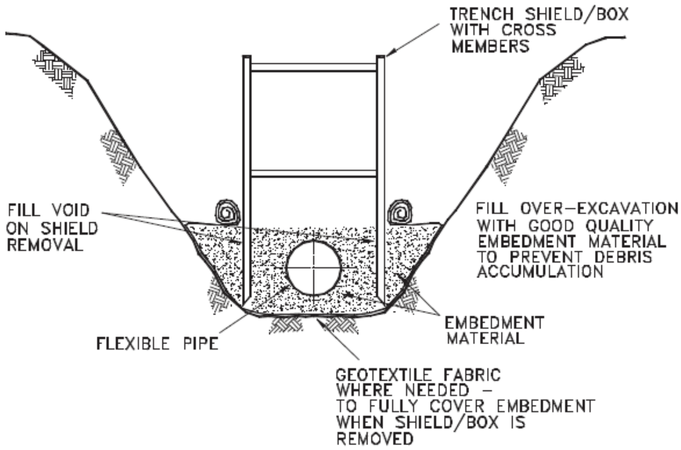


FIGURE 4.4 Shields in wide trench



4.7 PIPE LAYING

4.7.1 BEDDING

The bedding material must be the same as the embedment used to surround the pipe. Its purpose is to provide uniform support and load distribution underneath the pipe barrel, the remaining embedment material and the backfill.

A layer of embedment material must be placed and compacted as the bedding. The bedding thickness must be a minimum of 100mm for pipe sizes DN225 to DN375 and 150mm for sizes DN450 to DN1200 or as specified. A small depression must be formed under each socket to ensure that the pipe barrel is evenly supported along its entire length. When laid to the specified alignment the pipes must be at the centreline of the trench.

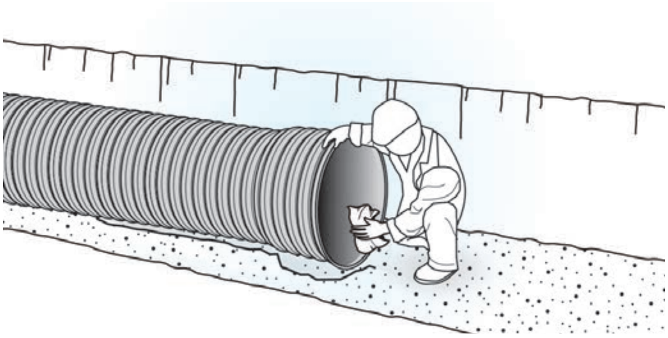
If groundwater is present, the trench must be drained so that the pipes can be joined and installed in relatively dry conditions. In low strength soils, additional bedding material will be required as a replacement for unsatisfactory native material in the foundation zone.

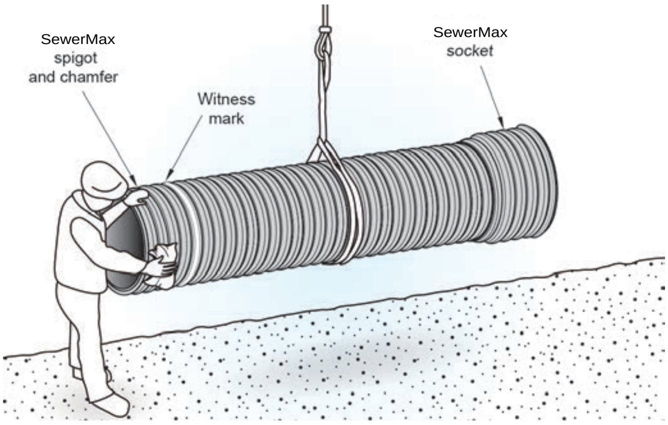
4.7.2 JOINTING OF PIPES

Once the trench and bedding has been prepared, pipes can be lowered into the trench with the aid of suitable slings or ropes. Chains must not be used to avoid potential slippage between the pipe and chains. Manual handling and lifting is possible with most SewerMax and SewerMax+ pipe sizes. Refer to your local safe handling work practices and guidelines when handling pipes and weights referenced in Tables 2.2 and 2.3. Alternatively, an excavator can be used with a nylon sling at the pipe mid-point.

The following rubber ring joint procedure is required for the quality assembly of the SewerMax and SewerMax+ pipe joint pipes:

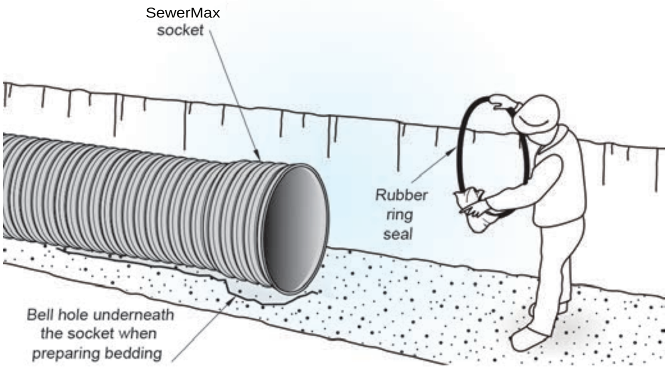
1. Clean the pipe socket and spigot grooves, making sure both are free of soil and foreign material.

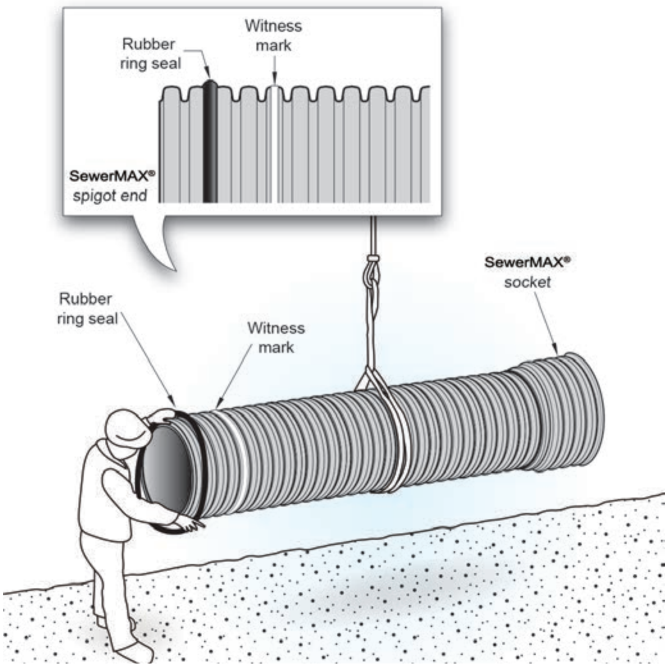




All images are indicative only and not to scale.

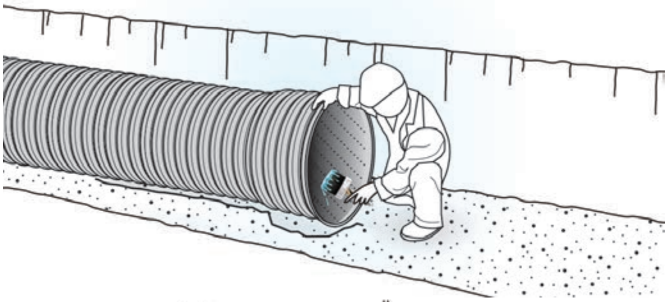
2. Clean the rubber ring seal and ensure the ring is free from any soil and foreign matter. Install the rubber ring by stretching it over the spigot in the second trough from the end of the pipe. Ensure the rubber ring sits evenly inside the trough by running your hands and fingers around its full circumference.

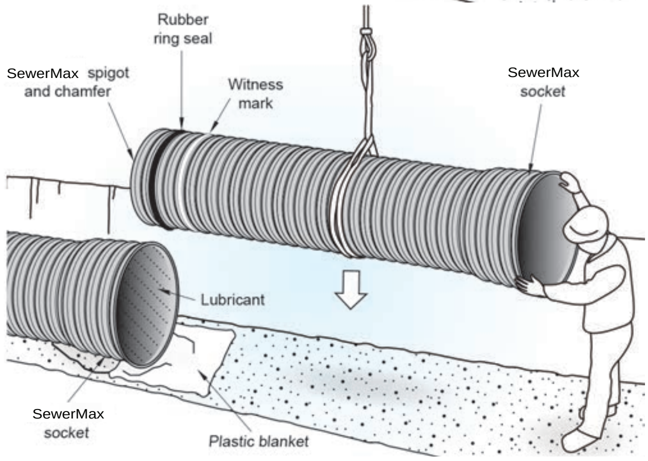




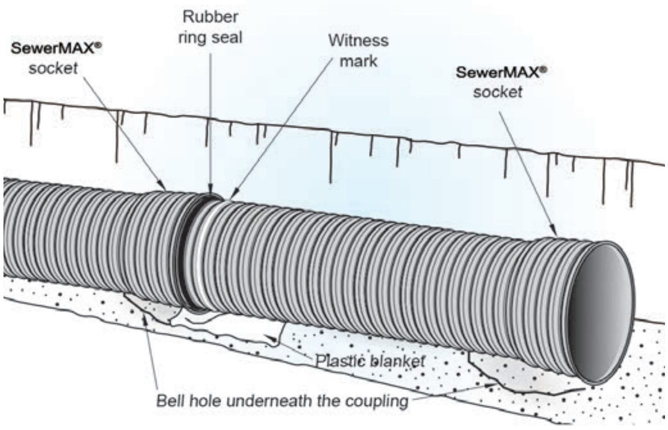
3. Although pipes may show some out-of-roundness due to storage loads, this is usually minimal. Where it is present, it is advantageous to orientate the larger pipe diameter in the vertical plane. This will ease the jointing process and helps offset any deflection after backfilling.

4. Apply Iplex pipe jointing lubricant liberally to the inside of the socket and lead-in flare. Avoid lubricating the ring itself to ensure it does not pick up dirt while the joint is being made. (MINERAL OILS OR GREASES MUST NOT BE USED UNDER ANY CIRCUMSTANCES, AS THESE COMPOUNDS WILL CAUSE LONG-TERM DEGRADATION OF THE RUBBER SEAL. IN AN EMERGENCY COMMON SOAP CAN BE USED). Only use pipe lubricants in accordance with the manufacturer's directions.





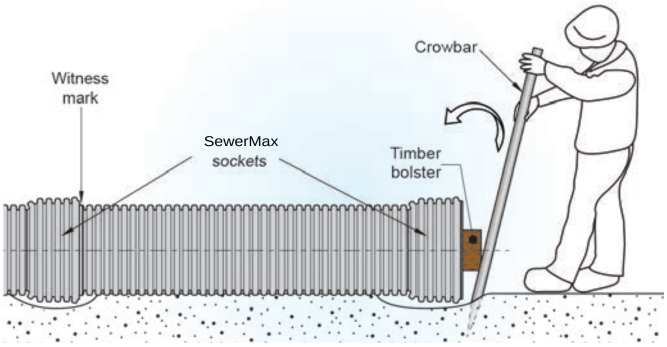
5. Insert the leading edge of the spigot into the socket mouth. It is essential that pipes are aligned in a straight line before attempting to make the joint.



The normal convention is to lay pipes by starting from the down-stream end with the socket facing in the up-stream direction. After laying, pipes must be held in position to line and grade by placing enough embedment material over each pipe before joining the next one.

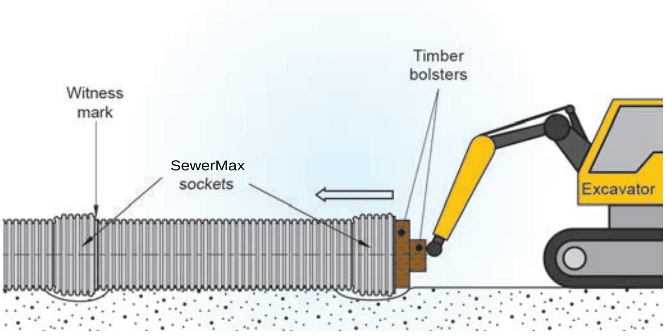
All images are indicative only and not to scale.

6. Apply force evenly on a timber-bridging piece protecting the end of the pipe.



Generally smaller pipes can be pushed home with a crowbar.

7. Push home to the spigot witness mark.



Larger pipes require mechanical force during the jointing procedure.

4.7.2.1 PIPE CUTTING

SewerMax and SewerMax+ pipes can be cut anywhere along their length as required. Always ensure that safe work practices are observed and wear appropriate PPE, such as impact resistant Type F gloves. The cut must be made in the valley between the corrugations at right angles to the axis of the pipe. No end treatment or chamfer is required. SewerMax and SewerMax+ pipes can be safely cut using any saw suitable for cutting timber. This can be a manual or powered saw.
IMPORTANT SAFETY INFORMATION: When using saws ensure the pipe is secure and stable from any movement. Both hands must be on the saw, not the pipe, as saws can bounce and lacerate a guiding hand. After cutting the pipe, it is important to place a new witness mark at the end of the spigot at a distance shown in Tables 2.2 and 2.3. Then repeat steps 1 to 7.

4.8 PIPE SIDE SUPPORT AND OVERLAY

4.8.1 EMBEDMENT - HAUNCHING AND SIDE SUPPORT

Material used in the embedment zone should be uniform selected non cohesive soils. Information regarding selection is given in Appendices G and H of AS/NZS 2566.2.

The embedment must be evenly compacted between the pipe and the surrounding native soil given that the complete side support zone extends horizontally beyond the pipe for approximately twice the pipe diameter at pipe depth. Care must be taken not to disturb the pipe alignment when compacting the embedment material.

Where trench shields or boxes are used, special care is necessary to fill any voids resulting from their removal and must be filled with the same compacted embedment material.

If there is a possibility of migration of fines between the embedment and native soil, geotextile fabric must be used at the interface to completely envelope the embedment including the bedding. Refer to Section 4 and Appendix J of AS/NZS 2566.2 for further information.

Attention to the quality and degree of compaction of the embedment material placed on each side of a SewerMax and SewerMax+ pipeline is fundamental to its structural integrity. Table 4.2 shows the default values given in AS/NZS 2566.2 for the appropriate degree of relative compaction of the embedment bedding and side support zone.

All images are indicative only and not to scale.

TABLE 4.2 Minimum relative compactions (AS/NZS2566.2)

Soil Types	Test Method	Trafficable areas		Non trafficable areas	
		Embedment material %	Trench / embankment fill material %	Embedment material %	Trench / embankment fill material %
Cohesionless	Density Index	70	70	60	Compaction to suit site requirements
Cohesion	Standard Dry Density Ratio, or Hilf Density Ratio	95	95	90	

4.8.2 OVERLAY

The embedment material must extend to a cover height of 150mm (DN225 to DN750) and 200mm (DN900 to DN1200) above the pipe to provide protection from the placement of overburden material. For minimum cover heights above pipe during the operation of compaction equipment, see Table 3.8.

4.9 TRENCH & EMBANKMENT FILL

Backfilling the pipeline may involve the use of the excavated material. Ensure the thickness of the overlay is adequate. Care must be taken to avoid the inclusion of large stones, rocks or hard clumps that may cause point loading on the pipeline.

Overburden compaction with large vibrating power compactors must be avoided until there is adequate height of fill over the pipe (Refer to Section 3.2.4). This will vary depending on the capacity of the machine.

4.9.1 MONITORING DIAMETRAL DEFLECTIONS

Once the backfilling operation is complete, the adequacy of the embedment and compaction and the use of correct backfilling techniques may be assessed by measuring the vertical deflection within the pipe. The deflection check described in Section 5.2 is useful in the initial construction period as this provides an opportunity for bench-marking appropriate compaction procedures.

Maximum allowable initial deflection values are given in AS/NZS 2566.2 for differing time intervals after completion of the fill operation e.g. the maximum allowable deflection at 24 hours is 3.5 % and at 30 days 5.0 %. Refer to Tables 5.3 and 5.4.

Note: Compaction of the embedment in the pipe embedment zone may increase the vertical pipe diameter and decrease the horizontal pipe diameter. This is not detrimental, providing the magnitude of the horizontal diametrical deformation does not exceed the prescribed allowable deflections. See Section 5.2 for test procedure.

4.10 BORE CASING

When SewerMax and SewerMax+ pipes are installed in casings, skids or approved spacers must be used to prevent damage to the pipe and socket joints during installation. They must properly position the pipe in the casing. Figure 4.5 shows a typical arrangement of spacers assembled on SewerMax pipes ready for installation.

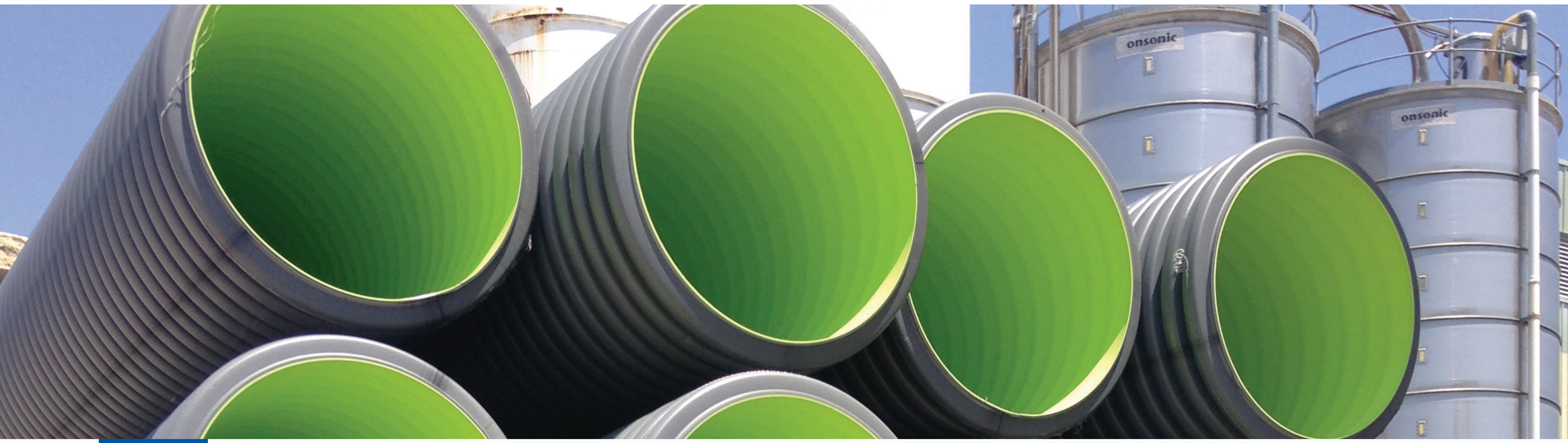
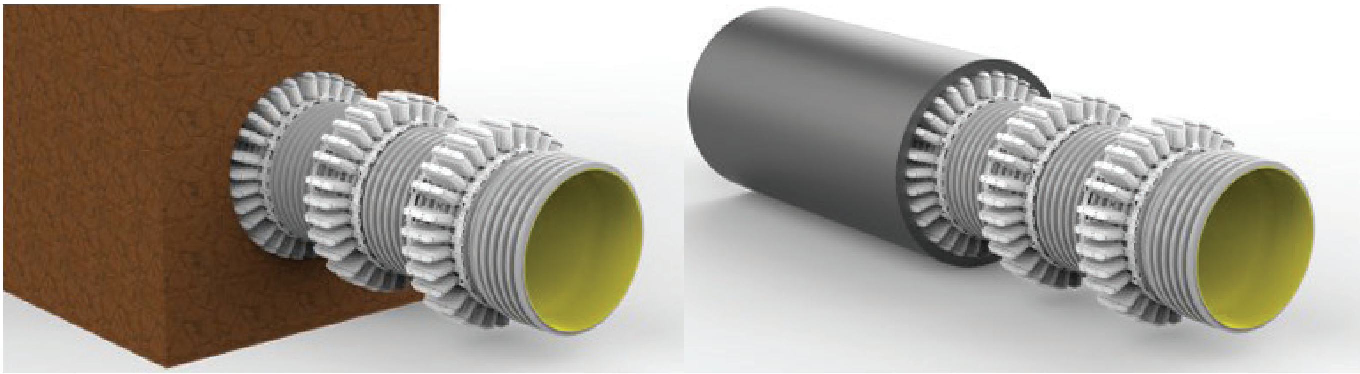


FIGURE 4.5 Approved Plastic Spacer Arrangement for SewerMax pipes



Spacers must be assembled in accordance with the manufacturer's recommendations. Skids must extend for the full length of the pipe, except for the socket and spigot (up to the witness mark). Spacers or skids must provide enough height to permit clearance between the pipe socket and casing wall. Casings are normally sized to provide an inside diameter which is at least 50mm greater than the Maximum outside diameter of the pipe socket, spacers or skids, whichever is the greatest.

Skids or spacers must be fastened securely to the pipe. Use Iplex pipe lubricant between the skids and casing for ease of installation. Upon completion of pipe insertion, grouting of the void in accordance with design requirements can be accomplished.

For further information with lengths and maximum loading contact Iplex.

4.10.1 GROUTING

Where it is necessary to pressure grout an annulus between the pipe and enveloping conduit, it is important to ensure that the grout is introduced into the annulus evenly. The pipe must be properly restrained to resist flotation, deformation and bending. In addition, the hydrostatic grout pressure must not exceed 70kPa for SewerMax SN10 or 130kPa for SewerMax+ SN20, to ensure there is an adequate factor of safety against buckling instability. If necessary, the effect of grout pressures can be nearly halved by filling the pipeline with water. Alternatively, it may be possible to stage the grouting process in two or three lifts, allowing the grout to solidify in the annulus below the spring-line before the top section is filled. This method is illustrated in Appendix K of AS/NZS 2566.2.

4.11 JOINTING TO RIGID STRUCTURES

4.11.1 RELATIVE SETTLEMENT

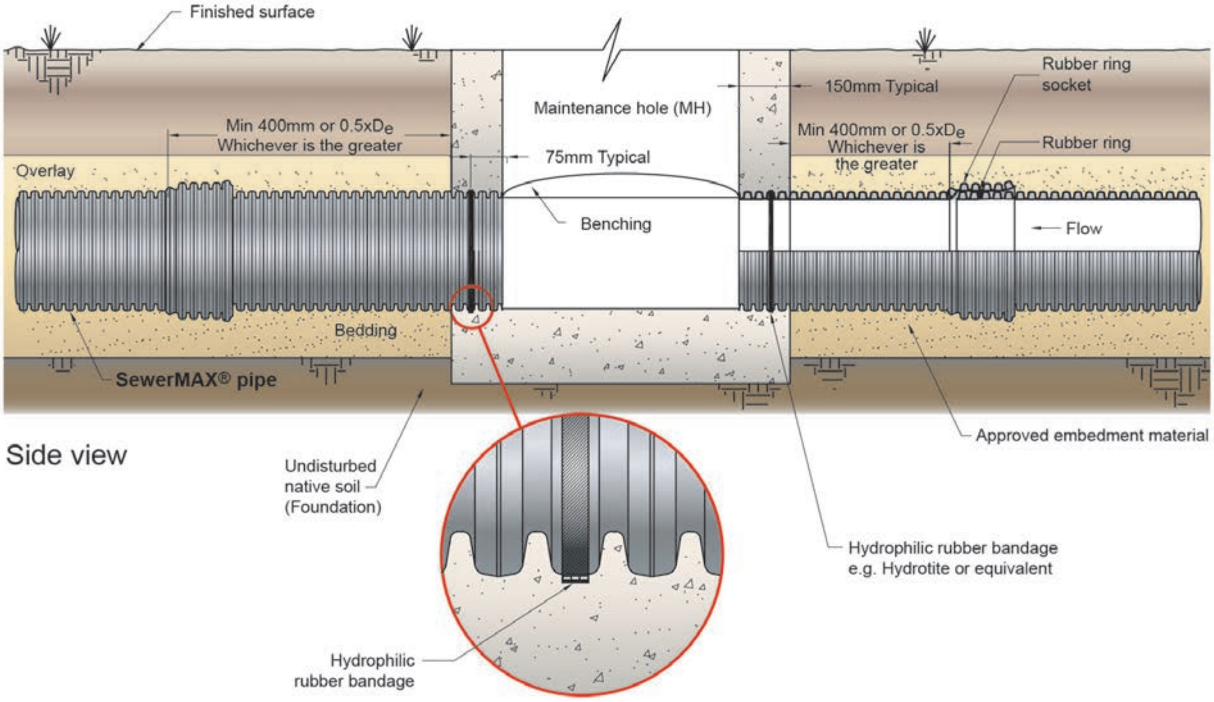
Where SewerMax and SewerMax+ pipes are connected to concrete structures there is unlikely to be any need for MH connectors or rocker pipes due to the high straining (ductile) capability of polypropylene. This will allow the pipes to accommodate differential settlement within specified limits without damage.

4.11.2 PIPE TO CONCRETE INTERFACE

SewerMax and SewerMax+ pipes can be directly embedded into concrete maintenance holes, or other concrete structures. For a water-tight seal, use an approved hydrophilic rubber compound in strip form. Figure 4.6.

All images are indicative only and not to scale.

FIGURE 4.6 Typical connection to a concrete sewer maintenance hole (MH) with SewerMax and SewerMax+ pipe



The following procedure outlines the steps to be followed when connecting SewerMax or SewerMax+ pipes to concrete maintenance holes, using the Hydrotite® Water Seal.

1. Prior to fixing the Hydrotite® seal to the SewerMax pipe, ensure the contact surface is free of dust, grime, or any foreign matter.

2. Select the corrugation nominated in Table 4.3 which will give approximately 75mm of cover (min 50mm) to the Hydrotite® seal when encased in the concrete wall. Figure 4.6.

3. Lightly roughen the pipe surface where the Hydrotite® is to be affixed with some fine sandpaper.

4. Remove the protective tape from the self-adhesive backing on the Hydrotite® and fix the Hydrotite® around the circumference of the pre prepared corrugation on the pipe. Start with the centre of the pipe and work around until you are approximately ¾ around the corrugation.

5. Apply a thin film of Loctite adhesive to each end of the Hydrotite® and stretching the two ends, butt them together then hold for approximately 30 seconds until adhesive sets. Lower the Hydrotite® to the surface of the corrugation.

6. With the heel of the hand press the Hydrotite® firmly onto the surface of the pipe corrugation.

7. Place the pipe with the assembled Hydrotite® seal into the structure ready for concrete to be placed around the joint. Before concrete is poured, ensure the hydrophilic rubber bandage is positioned at a minimum distance of 75mm inside the formwork to ensure all potential water paths are intercepted. (figure 4.6)

Note: Standard work practices must be observed when using adhesives or similar substances.

All images are indicative only and not to scale.

TABLE 4.3

Pipe size (DN)	Corrugation No.	Minimum Wall thicknesses of concrete structures
225	3	150mm
300	3	150mm
375	2	150mm
450	2	150mm
525	2	150mm
600	2	200mm

4.11.3 CONNECTIONS FOR INCOMING SIDELINES

4.11.3.1 SEWERMAX JUNCTIONS

A standard range of SewerMax junctions is available for lateral side connections. Junctions are prefabricated with socket ends suitable for rubber ring jointing with SewerMax pipes. The branch-off takes are normally at 45° to the main body with sockets suitable for connection with SewerMax or PVC DWV pipes (Refer to Section 2.4).

The method for connecting to existing sewer mains is shown in Figure 4.7 and the 'Sewerage Code of Australia WSA 02'.

4.12 REPAIR METHODS

The condition and size of the damaged area is important to determine the type of repair needed.

4.12.1 FOR MINOR REPAIRS

If the damage is minor or small in the pipe wall, then it may be repaired by using a SewerMax repair clamp (Refer to Section 2.4.3 Product Codes C37018…).

The repair clamp can be wrapped around the pipe at the point of damage with minimal disturbance to the pipeline. The profile ribbed gasket is preformed to match the external pipe wall profile and provides a watertight seal. The pipe surface profiles must be clean and free of dirt, mud and any foreign matter prior to installing the repair clamp.

The procedure for installation is as follows:

1. Loosen all nuts on the clamp, but do not remove from the studs. Slide the locking plate towards the nuts and open the clamp.

2. Position the clamp centrally over the damaged area ensuring that no foreign matter will be trapped between the matting surfaces. Special attention must be given to cleaning the troughs in the pipe profile.

3. Wrap the clamp around the pipe and bring both ends together by using the locking washer plate.

4. Lock into place and squeeze the lugs together while tightening the nuts by hand. Prior to tightening the nuts with a torque wrench, ensure the damaged area is correctly centred under the clamp.

5. Tighten the nuts with the torque wrench to the required torque as indicated by the installation instructions attached to the clamp.

6. Re-establish the specified embedment material in the embedment zone and backfill to the required standard and compaction.

4.12.2 MAJOR REPAIRS

If damage is severe, then the damaged pipe wall section must be removed and replaced with a new pipe section of the same length. The pipe ends can be joined using SewerMax joining clamps (refer to section 2.4.3 Product Codes C37019… and Figure 4.8). The joining clamp is comprised of a stainless-steel body with a flat rubber sleeve and utilises two SewerMax sealing rings to make the joint.

The procedure for installation is as follows:

1. Locate and expose the whole length of the damaged pipe.

2. Cut and remove the damaged pipe section. Cut the pipes in the trough of the pipe at both ends, using a hand saw or circular disc.

3. Clean and trim the intact pipe ends, leaving these ends smooth and square.

4. Cut a length of replacement pipe of the same distance between the prepared ends less the length of a single profile.

5. Fit the SewerMax rubber rings in the first trough at each pipe end (Figure 4.8)

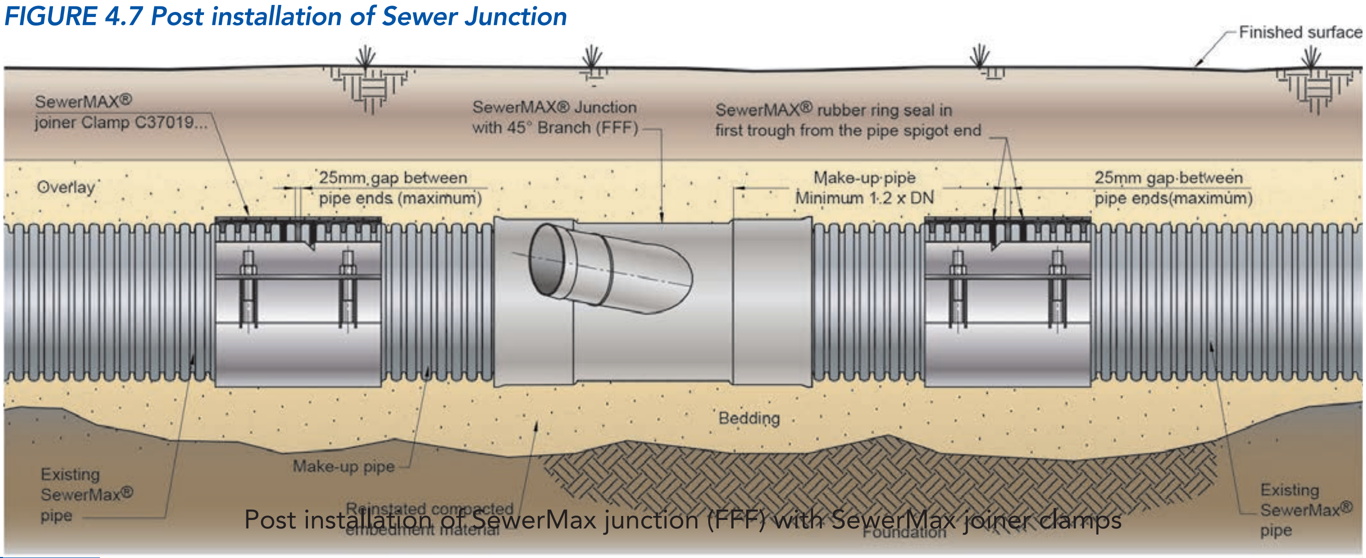
6. Fit the clamps symmetrically over each joint. Ensure the clamps are positioned centrally over each joint.

7. Tighten the nuts with the torque wrench to the specified torque as labeled on the clamp.

8. Pressure or vaccum test the repaired section.

9. Re establish the embedment and backfill as specified.

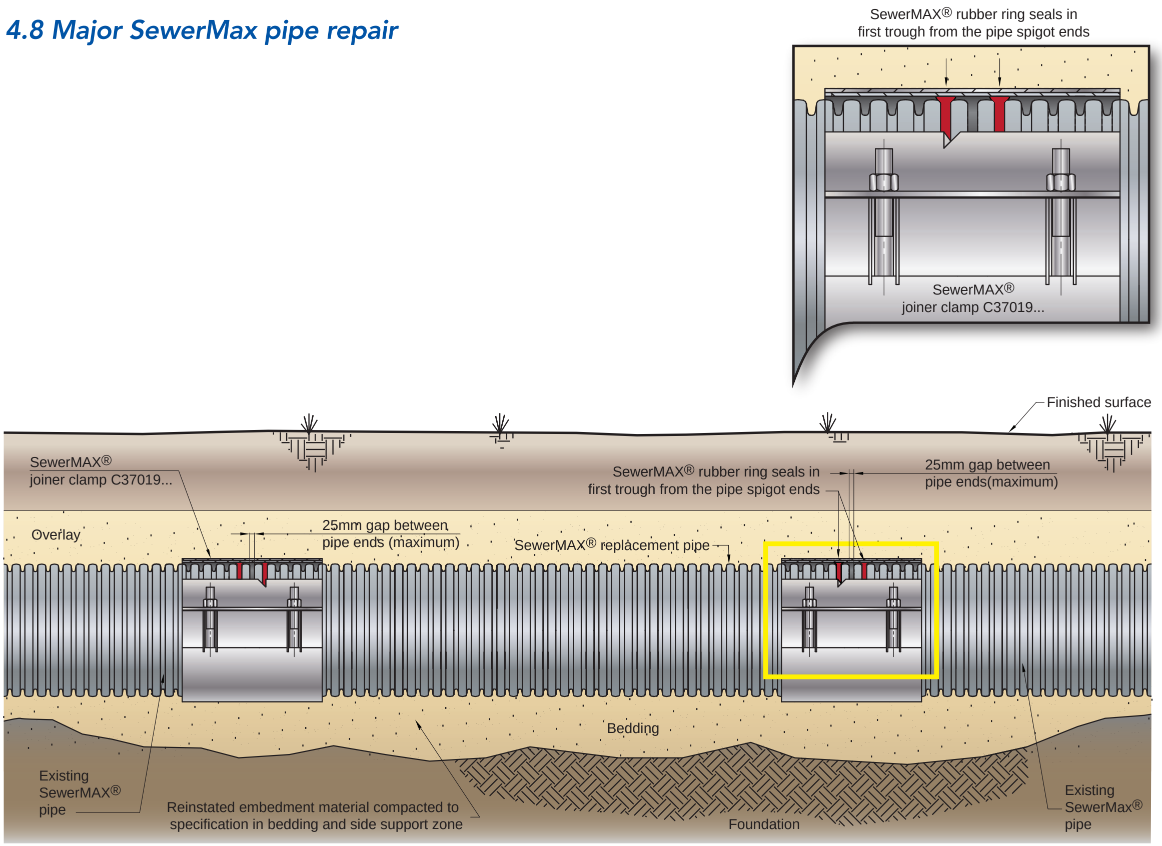
FIGURE 4.7 Post installation of Sewer Junction



Post installation of SewerMax junction (FFF) with SewerMax joiner clamps

All images are indicative only and not to scale.

FIGURE 4.8 Major SewerMax pipe repair



SewerMax pipe repair with SewerMax joiner clamps

5.0 FIELD ACCEPTANCE TESTING

Field-testing is used for identifying installation problems such as damaged pipes, poor embedment placement and/or compaction and jointing deficiencies. Where a fully water-tight system is required as in the case for sewers, a properly structured leakage testing program is usually required to obtain acceptance. However, this is not usually needed in the case of underground stormwater drains. A diametrical deflection check as the principle indicator can easily assess the structural integrity of a SewerMax and SewerMax+ pipe, surrounding embedment and compaction soil system.

5.1 LEAKAGE TESTING

A leakage check on a buried sewer pipeline can be completed using any one of the following methods:

- Hydrostatic Pressure Test
- Vacuum Test
- Low Pressure Air Test
- Infiltration Test

The air and vacuum tests are usually more convenient as they do not require water. An infiltration observation or test measurement is a further option where a pipeline is installed well below the water table.

5.1.1 HYDROSTATIC (EX-FILTRATION) TESTING

The sewer pipeline must be filled with water to a height of not less than 1m above the natural ground level at the highest point of the test length but not exceeding 6m at the lowest point of the test length. A minimum of 2 hours must elapse to allow temperatures to stabilise. Then during a minimum time span of 30 minutes any fall in water level in the test vessel must not exceed the hourly allowance amount shown in Table 5.1.

If this is not achieved the pipeline must be carefully examined visually for leaks and any defects repaired. The pipeline must then be retested.

All images are indicative only and not to scale.

TABLE 5.1 Hydrostatic pressure test leakage limits

DN	Make- up allowance* (Litres /m/hour)
225	0.11
300	0.14
375	0.18
450	0.21
525	0.25
600	0.28
750	0.37
900	0.44
1000	-
1200	0.59

*Based on the allowance of 0.5 litres per hour per mm diameter per km (Reference AS/NZS2566.2)

5.1.2 LOW PRESSURE AIR (EXFILTRATION) TESTING

The test length of a sewer pipeline is generally restricted to lengths between maintenance holes (the most convenient places for fixing temporary bulkheads).

The procedure for low-pressure air testing of larger diameter pipelines is potentially hazardous because of the large forces exerted during testing. Temporary bulkheads must resist these forces as there could be serious safety consequences should there be an accidental bulkhead blow-out.

The procedure is as follows:

1. Pump in air slowly until a pressure of 28 kPa above any external ground water pressure is reached. (Do not exceed 50kPa gauge in any case)
2. Maintain the pressure for at least 3 minutes
3. If no leaks are detected during this phase, shut off the air supply.

The low-pressure air test for a sewer pipeline is satisfactory if the test pressure does not drop more than 7kPa within the time shown in Table 5.2 from air supply shut-off. Should there be no discernible pressure loss after one hour has elapsed, the test can be considered satisfactory and terminated.

If the pipeline fails the air test, re-pressurise the sewer pipeline to 28kPa and check for leaks. This may be assisted by using leak detecting equipment. Leaks in shallow installations with joints exposed may be detected by pouring a concentrated solution of soft soap and water over joints and fittings. Repair and then repeat the test.

TABLE 5.2 Minimum allowable times for test for 7 kPa pressure drop

	Minimum allowable time* (minutes) for test length shown		
DN	50m	100m	150m
225	4	5	8
300	6	9	14
375	7	14	22
450	10	21	31
525	14	28	42
600	18	37	55
750	29	57	86
900	41	83	124
1000	51	102	153
1200	73	147	220

Note: Minimum available time may be halved where a pressure drops of 3 kPa is used.
*Gravity Sewerage Code of Australia Part 2 Construction. Table 21.3 ‘Vacuum Testing Acceptance Times.

5.1.3 INFILTRATION TESTING

Where a freestanding water table exists at a level of at least 1.5m above the sewer pipeline and 150mm above any lateral connections, the absence of infiltration can remove the need for either of the previous pressure tests. In all cases where infiltration is observed, the source must be investigated and the leak plugged. Where the size of the catchment and number of side connections precludes this approach then the inflow must be measured over a 24-hour period and the site inspector informed for determination of the acceptable allowable inflow. This should not exceed 5 litres / mm / diameter / km / day.

5.2 STRUCTURAL ASSESSMENT

5.2.1 DEFLECTION TESTING

Deflection measurements are often used as additional quality control to indirectly assess the relative compactions achieved during installation and whether the required structural performance has been achieved. A visual line-of-site inspection will usually indicate any abnormal deflections, which must be investigated. An acceptance test requiring a pull-through Go or No-go proving tool may be specified to ensure that the actual short-term vertical deflections do not exceed the allowable vertical deflection given in Tables 5.3 and 5.4.

Where required, a prover with an external diameter equivalent to the allowable deflected internal diameter, less a further tolerance of 2.5 millimetres, must be pulled through the pipeline by hand or hand operated winch.

Where actual deflections have exceeded the allowable deflections, the cause must be investigated, and appropriate remedial construction undertaken. This may require the exposure of the affected section of the pipeline and the recompaction of the side support material without removing pipes.

5.2.2 PROVER DESIGN

Suitable types of provers are described in AS/NZS 2566.2. A lightweight vaned type with a minimum of eight vanes between 1.0 and 1.3 pipe diameters in length may be used. The acceptable prover diameter must be determined after considering the effect of different time periods after completion of construction. These are given in Tables 5.3 and 5.4.

Where a prover cannot pass along the test length, the cause of the obstruction must be ascertained by remote TV investigation and appropriate remedial construction undertaken. This may require the exposure of the affected section of the pipeline and the re-compaction of the side support material without removing pipes. SewerMax and SewerMax+ pipes are not usually damaged by excessive deflections and a visual inspection should be enough to determine if any pipe replacement is required.

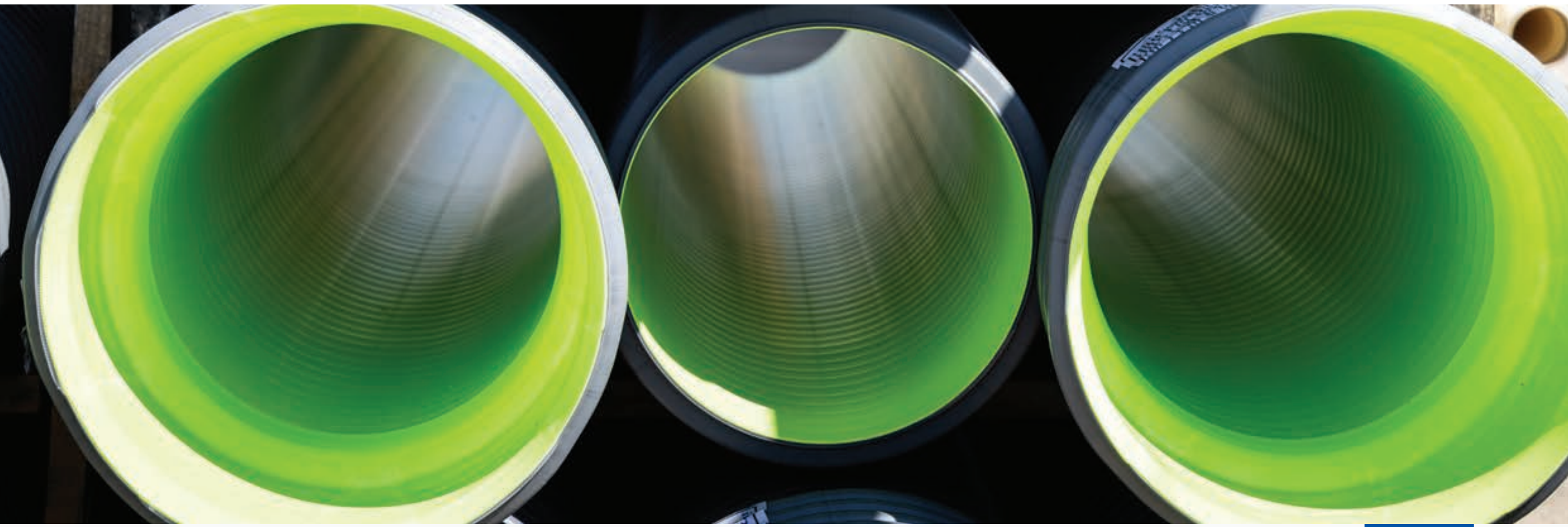


TABLE 5.3 Maximum allowable SewerMax prover diameters for nominated times after completion of the backfill

		24 hours	3 days	7 days	14 days	30 days	3 months	1 year
Adjustment Factor		0.7	0.75	0.85	0.95	1	1.1	1.2
Deflection (%)		3.5	3.8	4.3	4.8	5.00	5.5	6.0
DN	Pipe ID (mm)							
225	225	215	214	213	212	211	210	209
300	300	286	285	284	282	282	280	279
375	373	357	357	355	353	352	350	348
450	447	429	428	426	423	422	420	418
525	522	501	500	497	495	493	491	488
600	596	573	571	568	565	564	561	558

TABLE 5.4 Maximum allowable SewerMax+ prover diameters for nominated times after completion of the backfill

		24 hours	3 days	7 days	14 days	30 days	3 months	1 year
Adjustment Factor		0.7	0.75	0.85	0.95	1	1.1	1.2
Deflection (%)		3.5	3.8	4.3	4.8	5.00	5.5	6.0
DN	Pipe ID (mm)							
225	224	214	213	212	211	210	209	208
300	297	284	283	282	280	280	278	277
375	370	355	353	352	350	349	347	345
450	433	415	414	412	410	409	407	405
525	516	495	494	491	489	488	485	483

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