StormPRO®

Installation Guide

- Light weight
- Easy to handle - cost effective to install
- Simple and effective joints
- Adapts to soil movement
- Domestic or industrial applications
- Used in aggressive or saline soils

StormPRO® Installation Guide

Introduction

Vinidex StormPRO® pipes are twin-wall, corrugated polypropylene pipes for non-pressure applications, and can be installed in non-trafficable and trafficable areas, including under road pavements.

Using modern co-extrusion techniques, StormPRO® is manufactured with a smooth bore for optimum hydraulic performance and a corrugated outside wall for high stiffness to weight ratio.

By combining the strength and toughness of advanced polypropylene materials with the structured wall design, StormPRO® pipes provide an environmentally sensitive, cost-effective piping system for drainage applications in sizes from DN150 to DN900.

StormPRO® pipe is available in standard rubber ring jointed spigot/socket configuration (Sp/So) in 3m and 6m nominal lengths.

This guide is intended to provide general information for the safe installation, maintenance and repair of Vinidex StormPRO® pipes. For more detailed information refer to AS/NZS 2566.2 "Buried flexible pipelines. Part 2: Installation".

For correctly designed and installed StormPRO® systems, the service life can be expected to be at least 100 years before major rehabilitation is required.

Nom. Dia. (mm)	Mean Pipe Outside Dia. (mm)	Mean Pipe Internal Dia. (mm)	Profile Pitch (mm)	Min. Profile Thickness (mm)	Inner Wall Thickness (mm)	Approx. Pipe Mass StormPRO (kg/length)	Length (Sp/So) Effective Length (m)	Number of Pipes per crate
225	259	226	26.2	1.5	1.6	10	2.92	12
300	343	300	34.9	1.85	2.0	16	2.88	6
375	428	374	44.9	2.3	2.4	25	2.87	4 or 6
450	514	448	52.8	2.8	3.1	38	2.86	2
525	600	523	66.0	3.2	3.5	49	2.80	2
600	682	596	75.4	3.7	3.9	62	2.76	3
750	835	731	88.0	4.6	5.0	98	2.82	2
900	999	873	105.6	5.2	5.7	134	2.81	2
225	259	226	26.2	1.5	1.6	19	5.99	12
300	343	300	34.9	1.85	2.0	31	5.94	6
375	428	374	44.9	2.3	2.4	48	5.93	4 or 6
450	514	448	52.8	2.8	3.1	72	5.95	2
525	600	523	66.0	3.2	3.5	94	5.89	2
600	682	596	75.4	3.7	3.9	121	5.85	3
750	835	731	88.0	4.6	5.0	190	5.92	2
900	999	873	105.6	5.2	5.7	260	5.91	2

Design

Structural Design

Under general gravity drainage pipe laying conditions, detailed calculations predicting pipe performance are not necessary. Following an extensive study of installed pipe performance, The European Plastic Pipe and Fitting Association (TEPPFA) concluded that final deflection of pipes was controlled by the settlement of the soil after installation. Where installation was controlled, or self-compacting granular material were used, pipe deflections were consistently low regardless of installation depth and traffic or other loads.

In the graph below:

"Well" compacted refers to bedding material placed and compacted around the pipe to a minimum 94% dry density ratio, in layers of maximum 300 mm thickness, to a minimum depth over the pipe of 150mm; and

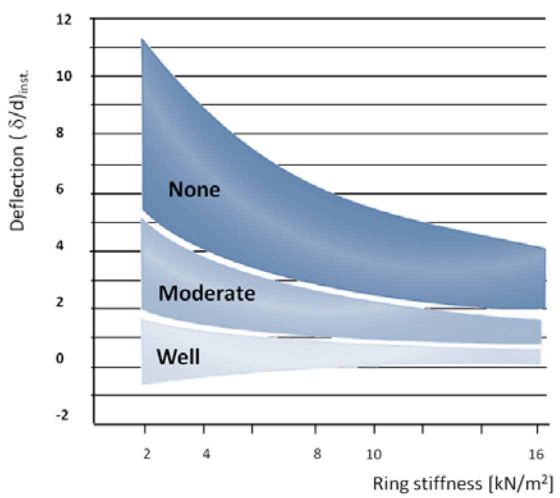
"Moderate compaction refers to bedding material placed and compacted around the pipe to 87% to 94% dry density ratio, in layers of maximum 500mm thickness, to a minimum depth over the pipe of 150mm

Where StormPRO® pipes are to be installed in normal conditions at depths up to 6m such that the depth to diameter ratio is at least 2, design calculations are not required. Simply following the recommended installation procedures will ensure that deflections are controlled. This is particularly true for installations under roadways, where the level of compaction required to prevent subsidence of the pavement also provides a highly supportive structural environment for the pipe.

For unusual conditions, or depths greater than 6 metres, design calculations may be performed in accordance with AS/NZS 2566.1. The structural design aspects of buried flexible pipes to be considered are vertical deflection, ring bending strain and buckling.

The following typical values in Table 2 may be used in pipe design.

Contact Vinidex to discuss your design criteria.



The graph shows deflection immediately after installation. Final pipe deflection after soil settlement are expected to be 1% higher for well compacted granular soil, 2% for moderately compacted granular soil and 3-4% where no compaction has taken place.

Table 2: Typical structural design properties of StormPRO®

Property	Symbol	Value
Short Term Stiffness - StormPRO®	S_{DI}	8000 N/m/m
Allowable Long Term Deflection	$\frac{\Delta_{yall}}{D}$	7.5%
Allowable Long Term Ring Bending Strain	εball	4%
Long Term (2 year) Stiffness - StormPRO®	S_{DL2}	1790 N/m/m

Hydraulic Design

StormPRO® pipes are normally sized to accommodate maximum design discharge when flowing full. The discharge rates in Tables 3 through 7 on Pages 4 to 8 for StormPRO® pipes flowing full are based on the Colebrook-White formula which is recognised by engineers throughout the world as the most accurate basis for hydraulic design over a wide range of flow conditions.

In addition to friction losses in the pipeline, a pressure drop will occur due to energy loss at any change in the direction of flow or pipeline cross section. In long pipelines, these "form losses" are usually small in comparison to friction losses. However, they may be considerable in pipelines with many fittings or in short pipes such as in culvert applications, where entry and exit losses may dominate. For more information on form losses, consult Vinidex.

The Colebrook-White formula expresses velocity as:

$$V = -2 * \sqrt{2gD\frac{H}{L}} * \log_{10}\left[\frac{k}{3.7D} + \frac{2.51\vartheta}{D\sqrt{2gD\frac{H}{L}}}\right]$$

Where:

V	= Velocity (m/s)
H/L	= Pipe Gradient, i.e. friction head loss / pipe length (m/m)
D_i	= Internal Diameter (m)
k	= Colebrook-White roughness coefficient (m)
v	= kinematic viscosity of water (m^2/s) 1×10^{-6} m^2/s for water at 20°C
g	= acceleration due to gravity (9.8m/s^2)

And

Q = VA

Where: Q = flow rate (m^3/s)

$$Q = V * \frac{\pi D^2}{4}$$

Choice of Roughness Coefficients

AS2200 - Design charts for water

supply and sewerage - recommends k values in the range 0.003 to 0.015mm for clean, concentrically jointed thermoplastics pipes and AS/NZS 3500.3 - National plumbing and drainage, Part 3 Stormwater drainage - specifies 0.015mm for design of plastics stormwater pipe drains for normal conditions.

However, it is important to note that factors such as slime growth and accumulation of debris can affect the selection of roughness coefficient in some circumstances.

In addition, local utilities may have preferred values for design of their systems. For flow under alternative conditions contact Vinidex or use the Vinidex Friction Loss in Uniform Fluid Flow (FLUFF) software.

FIGURE A: ADJUSTMENT FACTORS

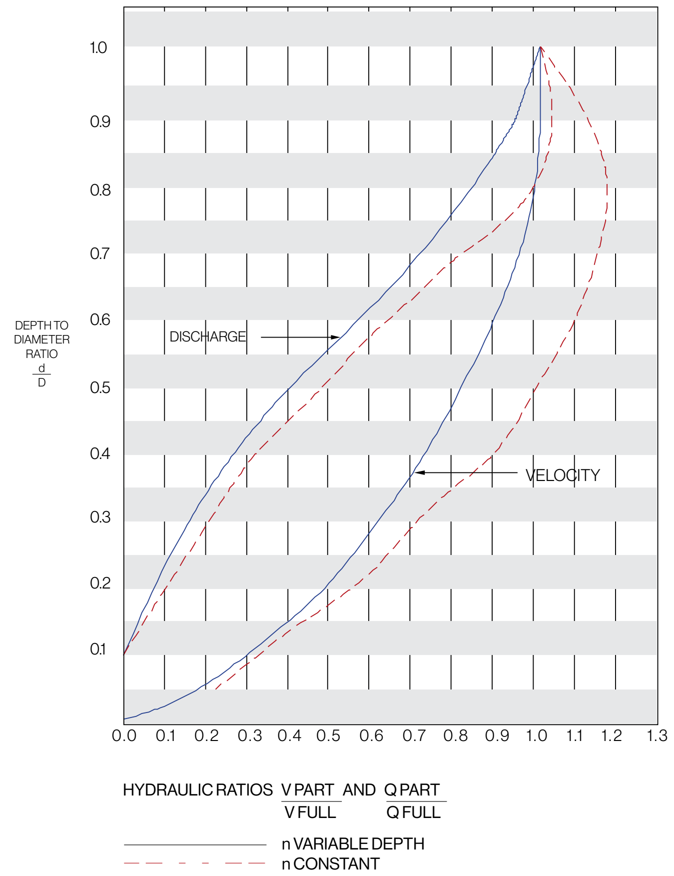


Table 3: Full discharges and velocities DN150 - DN225

Gradient H/L	Velocity/ Discharge k (mm)	DN 150 Di 0.148				DN 225 Di 0.226			
		0.003	0.006	0.015	0.03	0.003	0.006	0.015	0.03
1/20	m/s	3.3	3.2	3.2	3.1	4.3	4.2	4.1	4.0
	L/s	56	56	54	52	172	170	166	160
1/30	m/s	2.6	2.6	2.5	2.5	3.5	3.4	3.3	3.2
	L/s	45	45	44	42	138	137	134	129
1/40	m/s	2.2	2.2	2.2	2.1	3.0	2.9	2.9	2.8
	L/s	39	38	37	36	118	117	115	111
1/50	m/s	2.0	2.0	1.9	1.9	2.6	2.6	2.5	2.5
	L/s	34	34	33	32	105	104	102	99
1/60	m/s	1.8	1.8	1.8	1.7	2.4	2.3	2.3	2.2
	L/s	31	31	30	29	95	94	92	90
1/70	m/s	1.7	1.6	1.6	1.6	2.2	2.2	2.1	2.1
	L/s	28	28	28	27	87	87	85	83
1/80	m/s	1.5	1.5	1.5	1.5	2.0	2.0	2.0	1.9
	L/s	26	26	26	25	81	81	79	77
1/90	m/s	1.4	1.4	1.4	1.4	1.9	1.9	1.8	1.8
	L/s	25	25	24	24	76	76	74	72
1/100	m/s	1.4	1.3	1.3	1.3	1.8	1.8	1.7	1.7
	L/s	23	23	23	22	72	71	70	68
1/120	m/s	1.2	1.2	1.2	1.2	1.6	1.6	1.6	1.5
	L/s	21	21	21	20	65	65	64	62
1/140	m/s	1.1	1.1	1.1	1.1	1.5	1.5	1.5	1.4
	L/s	19	19	19	19	60	59	58	57
1/160	m/s	1.0	1.0	1.0	1.0	1.4	1.4	1.4	1.3
	L/s	18	18	18	17	55	55	54	53
1/180	m/s	1.0	1.0	1.0	0.9	1.3	1.3	1.3	1.2
	L/s	17	17	17	16	52	52	51	50
1/200	m/s	0.9	0.9	0.9	0.9	1.2	1.2	1.2	1.2
	L/s	16	16	16	15	49	49	48	47
1/250	m/s	0.8	0.8	0.8	0.8	1.1	1.1	1.1	1.0
	L/s	14	14	14	14	43	43	43	42
1/300	m/s	0.7	0.7	0.7	0.7	1.0	1.0	1.0	0.9
	L/s	13	13	13	12	39	39	39	38
1/400	m/s	0.6	0.6	0.6	0.6	0.8	0.8	0.8	0.8
	L/s	11	11	11	11	33	33	33	33
1/500	m/s	0.6	0.6	0.5	0.5	0.7	0.7	0.7	0.7
	L/s	10	10	9	9	30	29	29	29

Table 4: Full discharges and velocities DN300 - DN375

Gradient H/L	Velocity/ Discharge k (mm)	DN 300 Di 0.3				DN 375 Di 0.347			
		0.003	0.006	0.015	0.03	0.003	0.006	0.015	0.03
1/20	m/s	5.1	5.1	4.9	4.7	5.9	5.8	5.6	5.4
	L/s	364	359	348	335	649	640	620	597
1/30	m/s	4.1	4.1	4.0	3.8	4.8	4.7	4.6	4.4
	L/s	292	289	281	272	522	516	501	484
1/40	m/s	3.5	3.5	3.4	3.3	4.1	4.0	3.9	3.8
	L/s	250	248	241	234	447	442	431	417
1/50	m/s	3.1	3.1	3.0	2.9	3.6	3.6	3.5	3.4
	L/s	222	220	214	208	396	392	383	371
1/60	m/s	2.8	2.8	2.8	2.7	3.3	3.2	3.2	3.1
	L/s	201	199	195	189	359	356	347	337
1/70	m/s	2.6	2.6	2.5	2.5	3.0	3.0	2.9	2.8
	L/s	184	183	179	174	330	327	320	311
1/80	m/s	2.4	2.4	2.4	2.3	2.8	2.8	2.7	2.6
	L/s	172	170	167	162	307	305	298	290
1/90	m/s	2.3	2.3	2.2	2.2	2.6	2.6	2.5	2.5
	L/s	161	160	157	153	288	286	280	273
1/100	m/s	2.1	2.1	2.1	2.0	2.5	2.5	2.4	2.3
	L/s	152	151	148	144	272	270	265	258
1/120	m/s	1.9	1.9	1.9	1.9	2.2	2.2	2.2	2.1
	L/s	138	137	134	131	246	245	240	234
1/140	m/s	1.8	1.8	1.7	1.7	2.1	2.0	2.0	2.0
	L/s	126	126	124	121	226	225	221	216
1/160	m/s	1.7	1.7	1.6	1.6	1.9	1.9	1.9	1.8
	L/s	118	117	115	113	211	209	206	201
1/180	m/s	1.6	1.6	1.5	1.5	1.8	1.8	1.8	1.7
	L/s	110	110	108	106	197	196	193	189
1/200	m/s	1.5	1.5	1.4	1.4	1.7	1.7	1.7	1.6
	L/s	104	103	102	100	186	185	183	179
1/250	m/s	1.3	1.3	1.3	1.3	1.5	1.5	1.5	1.4
	L/s	92	92	90	89	165	164	162	159
1/300	m/s	1.2	1.2	1.2	1.1	1.4	1.4	1.3	1.3
	L/s	83	83	82	80	149	149	147	144
1/400	m/s	1.0	1.0	1.0	1.0	1.2	1.2	1.1	1.1
	L/s	71	71	70	69	128	127	126	123
1/500	m/s	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0
	L/s	63	63	62	61	113	112	111	109

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Table 5: Full discharges and velocities DN450 - DN525

Gradient H/L	Velocity/ Discharge k (mm)	DN 450 Di 0.448				DN 525 Di 0.523			
		0.003	0.006	0.015	0.03	0.003	0.006	0.015	0.03
1/20	m/s								
	L/s								
1/30	m/s	5.3	5.3	5.1	4.9	5.9	5.8	5.6	5.4
	L/s	839	828	804	776	1259	1243	1205	1162
1/40	m/s	4.6	4.5	4.4	4.2	5.0	5.0	4.8	4.7
	L/s	718	710	691	668	1079	1066	1037	1002
1/50	m/s	4.0	4.0	3.9	3.8	4.5	4.4	4.3	4.2
	L/s	637	630	615	595	957	947	922	892
1/60	m/s	3.7	3.6	3.5	3.4	4.0	4.0	3.9	3.8
	L/s	577	572	558	541	867	859	837	811
1/70	m/s	3.4	3.3	3.3	3.2	3.7	3.7	3.6	3.5
	L/s	531	526	514	499	798	791	772	749
1/80	m/s	3.1	3.1	3.0	3.0	3.5	3.4	3.3	3.3
	L/s	494	490	479	466	742	736	719	698
1/90	m/s	2.9	2.9	2.9	2.8	3.2	3.2	3.1	3.1
	L/s	463	460	450	438	697	691	676	657
1/100	m/s	2.8	2.8	2.7	2.6	3.1	3.0	3.0	2.9
	L/s	438	434	426	414	658	653	639	622
1/120	m/s	2.5	2.5	2.4	2.4	2.8	2.8	2.7	2.6
	L/s	397	394	386	376	596	592	580	565
1/140	m/s	2.3	2.3	2.3	2.2	2.6	2.5	2.5	2.4
	L/s	365	362	356	347	548	544	534	521
1/160	m/s	2.2	2.1	2.1	2.1	2.4	2.4	2.3	2.3
	L/s	339	337	331	323	510	507	498	486
1/180	m/s	2.0	2.0	2.0	1.9	2.2	2.2	2.2	2.1
	L/s	318	316	311	304	478	475	467	456
1/200	m/s	1.9	1.9	1.9	1.8	2.1	2.1	2.1	2.0
	L/s	300	299	294	287	452	449	442	432
1/250	m/s	1.7	1.7	1.7	1.6	1.9	1.9	1.8	1.8
	L/s	266	265	261	255	400	398	392	384
1/300	m/s	1.5	1.5	1.5	1.5	1.7	1.7	1.7	1.6
	L/s	241	240	236	232	362	360	355	348
1/400	m/s	1.3	1.3	1.3	1.3	1.4	1.4	1.4	1.4
	L/s	206	205	202	199	310	308	304	299
1/500	m/s	1.2	1.2	1.1	1.1	1.3	1.3	1.3	1.2
	L/s	182	181	179	176	274	273	270	265

Table 6: Full discharges and velocities DN600 - DN750

Gradient H/L	Velocity/ Discharge k (mm)	DN 600 Di 0.596				DN 750 Di 0.731			
		0.003	0.006	0.015	0.03	0.003	0.006	0.015	0.03
1/20	m/s								
	L/s								
1/30	m/s								
	L/s								
1/40	m/s	5.4	5.4	5.2	5.0				
	L/s	1520	1502	1459	1409				
1/50	m/s	4.8	4.8	4.7	4.5	5.5	5.4	5.3	5.1
	L/s	1348	1333	1298	1255	2303	2276	2213	2138
1/60	m/s	4.4	4.3	4.2	4.1	5.0	4.9	4.8	4.6
	L/s	1222	1210	1179	1142	2089	2066	2011	1946
1/70	m/s	4.0	4.0	3.9	3.8	4.6	4.5	4.4	4.3
	L/s	1125	1114	1087	1054	1923	1903	1855	1797
1/80	m/s	3.8	3.7	3.6	3.5	4.3	4.2	4.1	4.0
	L/s	1047	1037	1013	983	1789	1772	1729	1676
1/90	m/s	3.5	3.5	3.4	3.3	4.0	4.0	3.9	3.8
	L/s	982	974	952	925	1680	1664	1625	1577
1/100	m/s	3.3	3.3	3.2	3.1	3.8	3.7	3.7	3.6
	L/s	928	920	900	875	1587	1573	1537	1493
1/120	m/s	3.0	3.0	2.9	2.9	3.4	3.4	3.3	3.2
	L/s	841	834	817	795	1438	1426	1396	1357
1/140	m/s	2.8	2.8	2.7	2.6	3.2	3.1	3.1	3.0
	L/s	774	768	753	734	1324	1313	1286	1252
1/160	m/s	2.6	2.6	2.5	2.5	2.9	2.9	2.9	2.8
	L/s	720	715	701	684	1231	1222	1198	1168
1/180	m/s	2.4	2.4	2.4	2.3	2.8	2.7	2.7	2.6
	L/s	675	671	659	643	1155	1147	1126	1098
1/200	m/s	2.3	2.3	2.2	2.2	2.6	2.6	2.5	2.5
	L/s	638	634	623	608	1091	1084	1064	1039
1/250	m/s	2.0	2.0	2.0	1.9	2.3	2.3	2.3	2.2
	L/s	565	562	553	541	967	961	945	924
1/300	m/s	1.8	1.8	1.8	1.8	2.1	2.1	2.0	2.0
	L/s	512	509	501	491	876	871	858	839
1/400	m/s	1.6	1.6	1.5	1.5	1.8	1.8	1.8	1.7
	L/s	437	435	430	421	749	746	735	721
1/500	m/s	1.4	1.4	1.4	1.3	1.6	1.6	1.6	1.5
	L/s	387	386	381	374	664	661	652	640

Table 7: Full discharges and velocities DN900

Gradient H/L	Velocity/ Discharge k (mm)	DN 900 Di = 0.873			
		0.003	0.006	0.015	0.03
1/20	m/s				
	L/s				
1/30	m/s				
	L/s				
1/40	m/s				
	L/s				
1/50	m/s				
	L/s				
1/60	m/s	5.6	5.5	5.3	5.2
	L/s	3326	3288	3197	3092
1/70	m/s	5.1	5.1	4.9	4.8
	L/s	3062	3029	2949	2855
1/80	m/s	4.8	4.7	4.6	4.5
	L/s	2850	2821	2750	2664
1/90	m/s	4.5	4.4	4.3	4.2
	L/s	2676	2649	2585	2506
1/100	m/s	4.2	4.2	4.1	4.0
	L/s	2528	2505	2445	2373
1/120	m/s	3.8	3.8	3.7	3.6
	L/s	2292	2272	2221	2158
1/140	m/s	3.5	3.5	3.4	3.3
	L/s	2110	2092	2048	1992
1/160	m/s	3.3	3.3	3.2	3.1
	L/s	1963	1948	1908	1858
1/180	m/s	3.1	3.1	3.0	2.9
	L/s	1842	1828	1793	1747
1/200	m/s	2.9	2.9	2.8	2.8
	L/s	1741	1728	1695	1653
1/250	m/s	2.6	2.6	2.5	2.5
	L/s	1543	1533	1506	1471
1/300	m/s	2.3	2.3	2.3	2.2
	L/s	1398	1389	1367	1336
1/400	m/s	2.0	2.0	2.0	1.9
	L/s	1196	1190	1172	1148
1/500	m/s	1.8	1.8	1.7	1.7
	L/s	1060	1055	1040	1020

Installation

Flexible Pipes

Vinidex StormPRO® is a flexible pipe. This means that as vertical loads are applied, the pipe will deflect and take advantage of horizontal soil pressure to provide additional support to the system. The interaction of the pipe and the embedment material means that both play an important role in the structural performance of the pipeline.

Flexible pipes have shown excellent performance in buried applications and have been thoroughly researched in both field installations and laboratory studies.

Well-installed pipes, in which the specified embedment material is placed and compacted to the required level, have characteristically low deflections because the pipe deflection follows the soil settlement.

After initial compaction and settlement, applied vertical loads have very little effect on deflection. The use of flexible pipes in all buried applications including under road pavements is well established in Australia and throughout the world.

Where StormPRO® pipes are installed at depths between 0.8m and 6m in normal soils and recommended installation practices are followed there is generally no need for structural design calculations. In these typical installations, deflection can be reliably predicted from a design chart based on the compaction level of the embedment.

For installation conditions at greater

depths or in poor soils, a design methodology for flexible pipes is clearly set out in AS/NZS 2566.1 "Buried flexible pipelines. Part 1: Design". This Standard uses the pipe characteristics and material properties, installation conditions and external loads to predict pipe deflection, strain in the pipe wall and resistance to buckling which are compared against conservative allowable limits.

Handling & Storage

StormPRO® pipes are relatively light weight and smaller sizes can be lifted manually. Note that correct PPE and safe lifting practices should always be used. Care should also be taken when pipes are loaded, unloaded, stacked or distributed on sites to avoid damage to the pipe.
When pipes are lifted mechanically, approved and certified web or rope slings should be used. Transport should not have sharp projections which could cause damage to pipes. Pipes should not be dragged along the ground as this can damage the pipe, causing difficulty with jointing and testing.

StormPRO® pipes should be stacked on flat firm ground, which has been cleared of debris and hazardous combustible vegetation. Pipes should be laid flat on transverse bearers at least 75mm wide at maximum 1.5m centres.

Pipe sockets should be supported so that the ends are free from loading, with sockets in each layer opposite to the previous layer. Different sizes are best stacked separately. If this is not practical, then stack with the largest pipes at the base. Framed crates must be stored timber on timber (sizes 150, 225 and 300 only). The height of the pipe stacks should be limited to prevent distortion and excessive ovalisation.

If pipes are to be nested (smaller diameter pipes stored inside larger diameter pipes) for long periods, stacks should not exceed 2m in height.

Prior to installation, all pipes should be inspected for serious defects. Serious defects are defined as:

- scratches in the inner or outer wall greater than 2mm deep; or
- a hole in the inner or outer wall; or
- any damage to the spigot or socket that could compromise the joint integrity

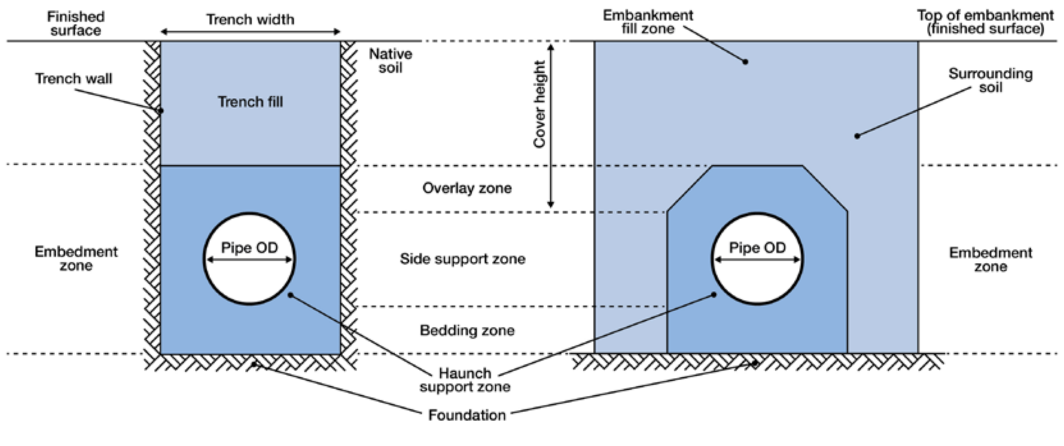
Any pipes found to have serious defects should be quarantined for replacement. Other minor defects that will not affect the long term integrity of the pipeline require no repairs.

Trench Excavation
All trenches are potentially dangerous and proper care should be taken to ensure the stability of the trench wall and the safety of all workers. The trench should not be excavated too far in advance of pipe laying and should be backfilled as soon as possible.

Minimum Trench Width
The trench width should be as narrow as is practicable, but wide enough to allow adequate compaction of the haunch zone and the making and inspection of joints. AS/NZS 2566.2 sets out the minimum trench dimensions for StormPRO® as shown in Table 8.

Table 8: Minimum trench dimensions

Nominal Diameter (mm)	Minimum Trench Width (mm)	Minimum Depth of Bedding Zone (mm)	Minimum Depth of Overlay Zone (mm)
150	470	100	150
225	560	100	150
300	745	100	150
375	830	100	150
450	1115	150	150
525	1200	150	150
600	1280	150	150
750	1435	150	150
900	1700	150	200



a) Trench

b) Embankment

Pipes in Parallel
Where pipes are laid in parallel, the minimum spacings between pipelines are given below.

Table 9: Minimum spacings between parallel pipelines

Nominal Diameter (mm)	Minimum Spacing (mm)
150	150
225	150
300	200
375	200
450	300
525	300
600	300
750	300
900	350

The trench should be excavated deep enough to allow for the specified grade, the required depth of underlay and the minimum cover.

Selection of Embedment Material
Embedment material for StormPRO® pipes should preferably be granular, free-flowing material. This type of embedment material requires less compactive effort to provide support for the pipe and minimises soil settlement.

The table below provides typical gradings for single-size aggregates suitable for use as embedment material for StormPRO®.

Table 10: Typical aggregate grading

SIEVE SIZE (mm)	% PASSING BY MASS Nominal size of single-size aggregate		
	10mm	7mm	5mm
26.5	-	-	-
19	-	-	-
13.2	100	-	-
9.5	85-100	100	
6.7	-	85-100	100
4.75	0-20	-	85-100
2.36	0-5	0-20	0-40
0.075	0-2	0-2	0-2

Where sand is more readily available, a typical sand grading is shown below.

Table 11: Typical sand grading

SIEVE SIZE (mm)	% PASSING BY MASS
4.75	100
2.36	90-100
1.18	85-100
0.6	70-100
0.3	50-100
0.15	0-40
0.075	0-5

In cases of reduced cover, it may be preferable to use a cement stabilised sand/gravel as the embedment material (including bedding, side support and overlay zones). According to Table L2 of AS/NZS 2566.2, the cement stabilised material should have a cement content of 6-10%, a moisture content of 10%, and have an unconfined compression strength of 1.7MPa, as determined from cylinder specimen at 7 days.

In cases where it is difficult to achieve mechanical compaction of the bedding material, controlled low strength material (CLSM) may be used as an alternative material. CLSM, also known as slurry fill, flowable fill, flowable mortar, soil-cement slurry, unshrinkable fill or controlled density fill, should achieve a compressive strength in the range of 0.6 MPa to 3.0 MPa, depending on cement content.

When placing CLSM, care should be taken to prevent flotation of the pipe by selecting a lift thickness appropriate to the diameter of the pipe, or ballasting the pipe with sandbags. Further details are available in Appendix K of AS/NZS 2566.2.

Placing and Compacting Embedment Material

The embedment material should be placed and graded to invert level, and compacted to the specified Modified Maximum Dry Density or Density Index, depending on the selected material. In conditions where the trench bottom is wet, soft or irregular, it may be necessary to first stabilise, fill and level, and compact the base. Place and compact material in the pipe bedding zone to minimum depth of 75mm beneath the pipe.
Side support and overlay material should be placed in a manner to ensure:

a. uniform distribution and compaction of embedment material, especially under the haunches of the pipe;

b. the material relative compaction is consistent with design;

c. pipe distortion is minimized;

d. the pipe is not damaged; and

e. the specified pipe alignment, level and grade is maintained

In order to ensure uniform support along the pipe barrel, a small indentation should be excavated in the pipe bedding zone to accommodate the pipe sockets.

The pipe side support material should be placed evenly on both sides of the pipeline and compacted such that relative compaction is consistent with design. Side support material should be worked under the sides of the pipe to minimise voids and provide maximum pipe haunching, taking care to minimise distortion of the pipe and maintain alignment and grade.

The pipe overlay material should be levelled and compacted in layers, to a minimum height of 150mm above the crown of the pipe, or as specified.

Cutting of Pipes

DN150 to DN600 StormPRO® pipes may be cut anywhere along their length as required, always ensuring that safe work practices are followed.
The cut should be made in the valley between the corrugations at right angles to the axis of the pipe. No end treatment or chamfer is required.

StormPRO® pipes can be safely cut using any saw suitable for cutting timber. This can be a manual or powered saw.

Due to the reduced spigot diameter, cutting of DN750 and DN900 StormPRO® pipe is not recommended unless absolutely necessary. Special slip couplings and rubber rings are required to connect cut DN750 and DN900 StormPRO® pipe.

Jointing

StormPRO® pipes have a simple and effective rubber ring joint system which is easy to assemble, leak-tight and protects against tree root intrusion.

Vinidex PRO2 is a new jointing system designed for easier installation and leak-tight joint performance. The PRO2 joint design uses a new redesigned rubber ring to match new socket geometry. Ensure that only PRO2 rubber rings are used with PRO2 sockets. PRO2 sockets can be identified by a label on the socket and PRO2 rubber rings can be identified by PRO2 marking on the ring.

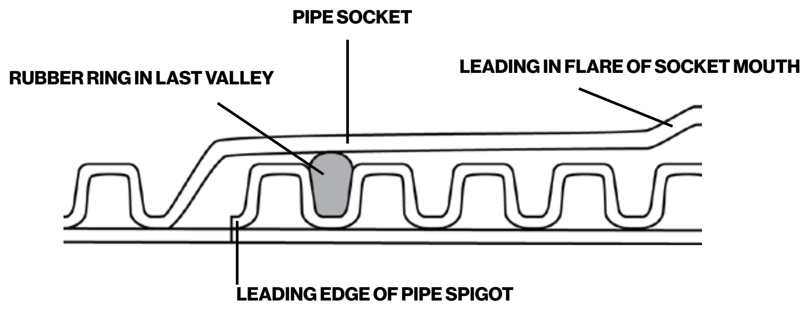
For DN150 to DN600 pipes, the rubber ring is located on the spigot in the last valley between the corrugations.

For DN750 and DN900 pipes, two rings are used and are located in the last two valleys. The ring in the last valley is the sealing ring whereas the second ring is a mechanical support ring which has the dual benefit of providing redundant sealing capacity.

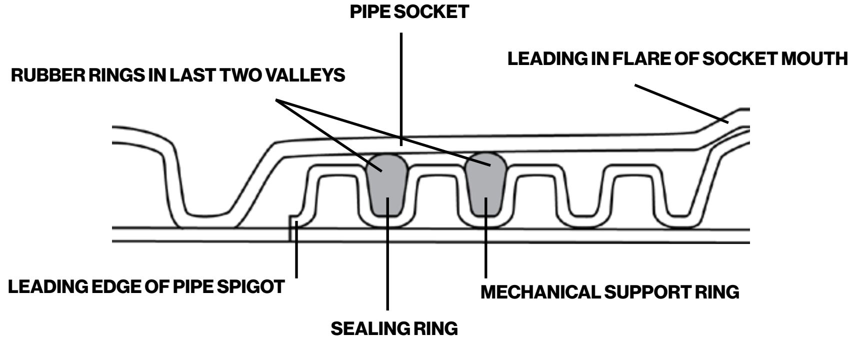
The Figure below shows the joint details in cross section.

Figure B: Joint cross section

DN150 to 600



DN750 to 900



Jointing Instructions

The following procedure is recommended when jointing StormPRO® rubber ring jointed pipes:

1. Clean the pipe socket and spigot end, making sure both are free of any dirt and grit. Any foreign matter trapped in the joint will compromise joint performance and leak-tightness of the system.

2. For DN150 – DN600 - Install the rubber ring by stretching it over the spigot so that it seats between the first and second corrugations from pipe spigot end.
For DN750 and DN900 pipes – Install two rubber rings, one in the valley between the first and second corrugations and one in the adjacent valley between the second and third corrugations from the spigot end.

3. Ensure rubber rings are evenly fitted by running fingers around the full circumference of the pipe.

4. Apply a generous quantity of Vinidex jointing lubricant to the inside of the receiving socket. Do not lubricate the rubber ring or the valley under the rubber ring. Avoid getting lubricant under the rubber ring. This will ensure that the ring does not pick up dirt and introduce contaminants to the joint or become displaced during jointing.

HINT: To further minimize the risk of introducing grit from the embedment material into the joint, a small piece of rubber mat, poly tarp or equivalent can be temporarily placed under the socket/spigot during joint assembly.

5. Insert the leading edge of the spigot into the receiving socket. It is essential that pipes are in a straight line before attempting to make the joint. Double check that the ring and spigot is free from any grit or embedment material so as not to compromise the joint.

6. Do not apply jointing force directly to the socket. Insert a short stub of pipe in the opposite socket. The short stub can be an off-cut, 50mm longer than the socket, and can be re-used.

7. Apply even jointing force. Subject to pipe diameter and local conditions, use a crowbar (see Note) to push on a timber block on the end of the short pipe.

8. Push home the pipe until the spigot end comes into contact with the inner wall of the socket.

NOTE: The jointing force required increases with the nominal diameter of the pipe. A leverage tool such as a crowbar is generally sufficient for StormPRO® pipes up to 375mm nominal diameter. For larger sizes, mechanical assistance is required. Where applying a jointing force is not practical, consideration should be given to the use of come-along or winch and rope devices.

Angular Deflection

The pipe may be deflected at the joint after jointing has been completed. Any deflection should be limited to a maximum of 1º.

Witness Mark

The rubber ring is held in position by the corrugations. When the joint is assembled, the inner walls of the pipe butt together so it is not necessary to joint to a witness mark in the same way as it is for pipe joints designed with a laying gap. However, if required as a visual indication of correct jointing depth, a witness mark can be applied to the spigot end.

Depending on manufacturing tolerances, a witness mark on the crest of the 5th rib for sizes DN150 to DN300 and on the crest of the 4th rib for sizes DN375 to DN900 will be either wholly within the socket, or just visible at the mouth at the completion of jointing.

Internal Lining

When the StormPRO® pipe is pushed fully home during assembly, the spigot end and the internal lining at the back of the socket are generally in contact. However, due to manufacturing tolerances or where there is angular deflection at the joint a small gap may sometimes be observed. This has no effect on the sealing capability of the joint.

Backfilling

Where the finished surface is not to be paved, and surface settlement is not considered critical, ordinary fill material is suitable up to the finished surface. Under pavements where settlement of the fill material is to be controlled, a fill material that can be compacted to the required density should be used.

Trench fill should be placed on the pipe overlay and compacted as specified but generally not in layers in excess of 300mm. Complete the backfilling operation to finished surface level.

Allowable Cover

Minimum cover in Table 12 reflects industry standards for various design load cases. StormPRO® pipes are not limited to these standards and designers should refer to Vinidex engineers if reduced cover is required

Table 12: Minimum cover over pipe as per AS/NZS 2566.1 or AS/3500.1 where stated.

Loading Condition	Minimum Cover (m)
Not subject to vehicular loading:	
a) Without pavement -	
i. for single dwellings; or	100
ii. for other than single dwellings	300
b) With pavement of brick orunreinforced concrete	100*
Subject to vehicular loading:	
a) Other than roads:	
i. Without pavement	450
ii. With pavement of -	
A. reinforced concrete for heavy vehicular loading	100*
B. brick or unreinforced concrete for light vehicular loading	75*
b) Roads-	
i. sealed; or	600
ii. unsealed	750
Subject to construction equipment loading or in embankment conditions**	750
Land zone for agricultural use	600

*Below the underside of the pavement
** Please refer in more detail to Construction Loads Table 13

NOTE: Values shown in red are to be used only where AS/NZS 3500.3 is applicable.

Construction Loads

During construction, consideration of loading during placement and compaction of fill around the pipe and any other construction loading is critical. Care must be taken to ensure that any construction loading from trench compaction and road construction equipment does not overload the pipe.

The following minimum depths of compacted fill over the pipe apply for the placement and compaction of fill around of StormPRO®.

Table 13: Minimum depths of compacted fill over StormPRO® for construction loads

CONSTRUCTION LOAD	MINIMUM COVER	
	StormPRO^	StormFLO^
CAT140H Grader (17t)	400mm	400mm
CAT325B Excavator (25.9t)	400mm	400mm
CAT815F Compactor (20.9t)	400mm	400mm
Vibratory Trench Roller (2t)	400mm	400mm
Vibratory Plate (135kg)	400mm	400mm
Vibratory Rammer (75kg)	400mm	400mm
Smooth Drum Vibratory Roller (10t)	700mm	700mm
CATD25D Articulated Truck (42.3t)	650mm	650mm
25t Excavator and Compaction Wheel	1000mm	1000mm

^ Values derived from AS/NZS 2566.1 (short-term ring bending stiffness)

Flotation

The possibility of pipe flotation exists when StormPRO® is installed in areas which will be inundated, such as creek crossings, flood plains and high groundwater areas. To prevent flotation, a minimum cover equivalent to 75% of the nominal diameter is required.

Concrete Encasement

Where concrete encasement is required, StormPRO® pipes should be laid to the correct alignment and grade, supported on hessian bags filled with stabilised sand or on concrete blocks or cradles. The concrete surround should be placed so as to provide uniform and continuous support around the entire circumference of the pipe.

StormPRO® joints for concrete encasement should be made with an additional rubber ring. For pipe sizes up to and including DN300, a gap should be left and the extra ring placed in the valley between the third and fourth corrugations from the spigot end. For sizes DN375 and greater, the second ring should be placed adjacent to the first ring in the valley between the second and third corrugations. DN750 and DN900 have rings in the first two valleys as usual. Table 14 outlines placement of additional rings.

The completed joint should also be sealed with tape to prevent concrete entering the socket during encasement.

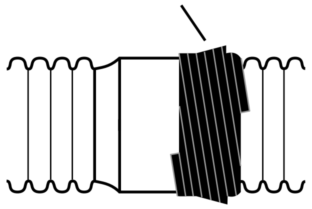


Table 14: Placement of additional rubber ring for concrete encasement

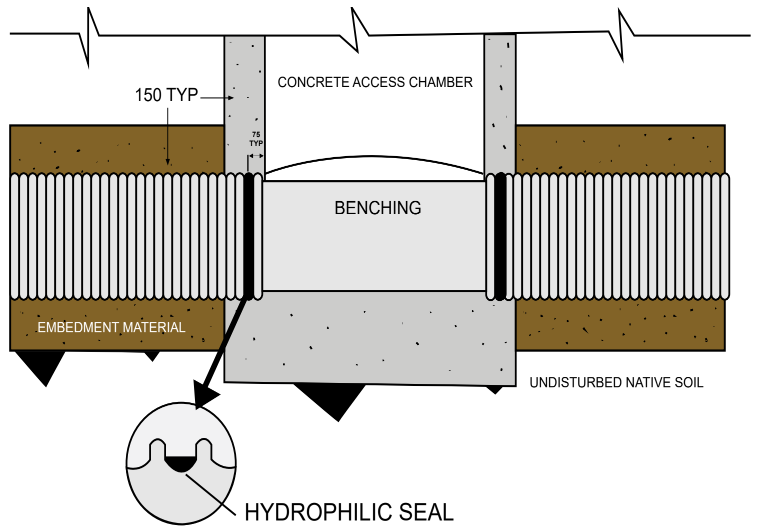
DN150 to DN300	DN375 to DN600	DN750 to DN900
		

The pipe shall be restrained and care taken to prevent movement, misalignment, distortion and / or flotation during the encasement process.

Connection to Structures

StormPRO® pipes may generally be connected to rigid structures such as pits, headwalls and endwalls, both pre-cast and cast in situ. StormPRO® pipes have sufficient flexibility and strain tolerance to accommodate differential settlement at the interface. The figure below shows a typical entry or exit to a concrete structure.

Note that the hydrophilic seal is required only where a waterproof seal is critical. When required, use Hydrotite DSS0220 or equivalent.



Stormwater Connections

Vinidex has two systems for making stormwater connections to StormPRO pipes - PROgrommets and PROsaddles.

The Vinidex PROgrommet range of stormwater service connections provide 100mm and 150mm diameter connections to StormPRO® pipe up to 900mm nominal diameter. The following procedure is recommended when installing the PROgrommet:

1.	Drill hole in StormPRO® pipe using the PROsaw. Hole centre must be located in the valley between corrugations.
2.	Inspect marking on PROgrommet to ensure the correct size for selected StormPRO® pipe.
3.	Present PROgrommet to hole with PROgrommet flange to the inside and locating wings to the outside of the StormPRO® pipe.
4.	Squash the PROgrommet by hand whereby the two locating wings align in the centre.
5.	With the flattened PROgrommet, form a "C" shape and offer it to the prepared hole.
6.	Position locating wings in the valley of the StormPRO® pipe profile.
7.	Apply Vinidex Lubricant to the inside diameter of the PROgrommet.
8.	Cut lead-in chamfer on pipe which is to be offered to PROgrommet.
9.	Mark a line on pipe showing the required insertion depth.
10.	Apply Vinidex Lubricant to outside diameter of pipe.
11.	Insert prepared pipe to pre-marked insertion depth.

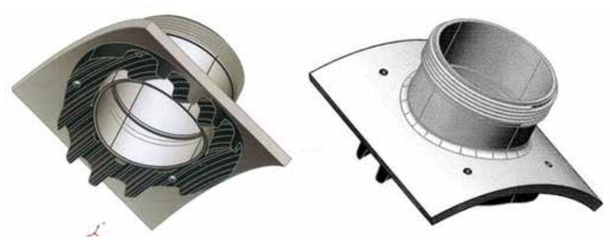
The Vinidex PROsaddle range of stormwater service connections provide 100mm and 150mm diameter connections to StormPRO® pipe up to 450mm nominal diameter.

The following procedure is recommended when installing PROsaddles:

1.	Drill a hole in the StormPRO® pipe at the required location as per PROsaw user instructions – pilot drill must be positioned in the valley between corrugations.
2.	Inspect the label on the PROsaddle to ensure the correct size for the selected StormPRO® pipe.
3.	Apply a thin bead of Butyl Mastic along the raised sealing faces of the gasket and in the holes (top and bottom).
4.	Place the gasket and saddle in position.
5.	Secure with the four fasteners provided – do not overtighten.
6.	Remove the access cap.
7.	Before joining the branch pipe to the saddle, check that the branch pipe has been cut square and all the burrs are removed from the inside and outside edge. Remove all dirt, swarf, and moisture from the branch pipe and the PROsaddle socket.
8.	Mark the spigot of the branch pipe with a witness mark at a distance equal to the internal depth of the PROsaddle socket.
9.	Dry, degrease and prime the branch pipe spigot and the PROsaddle socket with a lint-free cloth dampened with Vinidex priming fluid.
10.	Apply a thin even coat of Vinidex Type N solvent cement to the internal surface of the PROsaddle socket first, then apply a heavier, even coat of Vinidex Type N solvent cement up to the witness mark on the branch pipe spigot.
11.	Insert the branch pipe spigot home to the full depth of the PRO saddle socket
12.	Hold the joint against movement and rejection of the spigot for a minimum of 30 seconds, then wipe off excess solvent cement from the outside of the joint.

Embedment material should be placed around the branch pipe and saddle, and compacted to a minimum 90% Modified Maximum Dry Density or 60% Density Index, depending on the selected material.

The branch pipe support material should be placed evenly around the pipe and compacted such that relative compaction is consistent with design.



Connection to Other Pipes
In most cases, it is simplest and most economical to transition from StormPRO® to other pipe types (SRCP, FRC, etc.) at a pit or manhole.

Mine Subsidence
In ground subject to earth movement or in areas affected by underground mining, pipes can be subjected to longitudinal stresses. These stresses can occur at any time after installation and result in axial stress in the pipe. StormPRO® rubber ring jointed pipe is capable of absorbing significant strains and the pipe joint can also accommodate a certain amount of the strain associated with mine subsidence.

Table 15: Allowable Ground Strain % for StormPRO® pipe (mm/m)

SIZE DN								
150	225	300	375	450	525	600	750	900
1	1.5	2.5	2	2.5	4	5.5	2.5	1.5

NOTE: For StormPRO® pipes the table represents tensile ground strains withdrawing the spigot from the socket. Further insertion of the joint is not possible as the pipe is fully homed when jointed. Compressive ground strains are likely to result in longitudinal stresses in the pipe wall which will then be subject to stress relaxation with time.

This table assumes that the ground strain is uniformly transferred along the pipe. Pothole subsidence or large localised fissures may result in damage to the pipe or joint.

Above-Ground Installation
For above-ground applications, StormPRO® must be adequately supported in order to prevent sagging and excessive distortion.

Clamp, saddle, angle, spring or other standard types of supports and hangers may be used where necessary. Pipe hangers should not be overtightened.

StormPRO® should be supported at regular intervals as detailed in the table below, always with one support located directly behind the socket. These support spacings are based on StormPRO® carrying water at 20°C. Note that where temperatures in excess of 20°C are likely, the support spacing should be reduced.

The supports should provide a bearing surface of 120° under the base of the pipes and should be at least two corrugations wide. The pipes should be protected from damage at the supports with the provision of a membrane of PE, PVC or rubber. Table 16 refers to the maximum support spacings for above-ground installations.

Water Jet Cleaning
High-pressure water jet cleaning of internal pipeline surfaces is common, but if not properly managed, water emitted under high-pressure through a jet nozzle has the potential to damage any pipe surface, including those manufactured from plastics, metallic, ceramic and concrete materials.

PIPA Industry Guidelines POP205 provides information based on experience and research, as to the maximum pressures that may be used to avoid damage to StormPRO® pipes. The guidelines can be downloaded at https://pipa.com.au/technical/pop-guidelines/

Table 16: Maxiumum support spacings

Nominal Diameter (mm)	150	225	300	375	450	525	600	750	900
Minimum Horizontal Support Spacing (m)	1.25	1.60	1.90	2.15	2.50	2.75	3.00	3.00	3.00

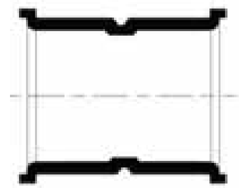
Pipe Repair
If StormPRO® is damaged, the repair method will depend on the nature and severity of the damage. Table 17 below provides guidance on the most suitable method relative to the extent of damage.

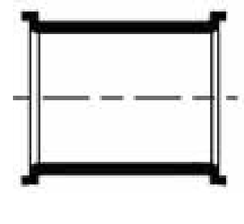
Contact Vinidex or refer to VIN347 for Quick Installation instructions for Slip coupler repair method for StormPRO® pipes.

Standard and Slip Couplings
Standard socket/socket couplings and slip couplings are available in all sizes. Refer product catalogue for further information.

Table 17: Suitable methods of pipe repair

	EXTENT OF DAMAGE	REPAIR METHOD
INTERNAL	Minor damage to inner wall (no penetration)	No repair required
	Penetration of the inner wall	Cut remove and replace affected section of pipe using Slip coupler repair method
EXTERNAL	Minor damage to outer wall (no penetration of the outer corrugated wall)	No repair required
	Minor damage to outer wall (penetration of the outer corrugated wall)	Cut remove and replace affected section of pipe using Slip coupler repair method
	Penetration of both inner and outer walls	Cut, remove and replace affected section of pipe



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For over six decades, we've been leading the way – setting the industry benchmark for pipeline systems and solutions. Our legacy spans across building, infrastructure, and agriculture sectors. We make life flow with groundbreaking, high-quality products, connecting everything from water, gas and energy throughout Australia.

Today, we maintain our commitment to innovative solutions that meet our customers' needs and exceed their expectations. Core to our approach are smarter solutions that are more sustainable throughout the manufacturing process and over their lifetime. Globally backed by Aliaxis, and a wide-reaching national footprint, our team of passionate technical experts support our customers throughout their projects – working to deliver solutions for today and the future.

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