Technical Standard - TS085

Trenching and Installation of Underground Conduits and Cables (up to and including 33kV)

Published: 14/5/2020

SA Power Networks

Empowering South Australia

Revision Notice:

Date	Details	Author	Authorised
06 Feb. 2019	• Amended following Sections: ✓ 7.2 'Underground Cable Sizes' - Table 4, 7.3 'Conduit Sizes' - Table 5, 7.4 'Conduits for Directional Boring' - Table 6, 7.7 'Conduits Bends' - Table 9 and 7.8 'Conduit End Caps' - Notes for Table 10 ✓ Removed previous Section 9.8 'Bedding Sand Compaction' • Enhanced following Sections: ✓ 6.4 'Fire Hydrant and Electrical Equipment' ✓ 6.5 'Petrol/LPG Dispensing Stations and Electrical Equipment' ✓ 6.5 'Service Pillar/Pit - Safe Operating Work Zone' ✓ 8.0 'Spare Conduit Provision' - Table 11 and 12 ✓ 9.6.3 'Proving of Conduits', 9.6.4 'Sealing of Conduits - Vermin Control', 9.10 'Civil Works Forms' and 10.5 'Labels on Cable Circuits' and 10.9 'Electrical Works Forms'	A Pradhan	J Ali
14 May 2020	• Added Sections: ➢ 5. Intellectual Property ➢ 8.8. PE Conduit to PVC Conduit - Couplings ➢ 8.15. Mk7 Padmount Transformer ➢ 8.17. Mandatory Requirement for Looped HV Networks ➢ 8.17.1. Cable Marker Tape ➢ 8.17.2. Polymeric Cable Cover ➢ 9.1. Spare Conduits and Vault Arrangement • Added Tables: ➢ Table 5 ➢ Added Note for Table 6 • Updated Sections: ➢ 2. Scope ➢ 7.6. Service Pillar/Pit - Safe Operating Work Zone (Ground Level) ➢ 8.16. Typical Standard Footing Arrangement ➢ 8.16.1. Extended Vault ➢ 10.2. Trenching Requirements ➢ 10.6.4. Conduit/Cable Sealing Works for Vermin Control • Updated Tables/Appendices: ➢ Tables 4, 7, 12, 13 and 14 ➢ Appendices A and E.5	A Pradhan	M. Napolitano

SA Power Networks:

SA Power Networks, ABN 13 332 330 749, a partnership of:

Spark Infrastructure SA (No.1) Pty Ltd, ABN 54 091 142 380
Spark Infrastructure SA (No.2) Pty Ltd, ABN 19 091 143 038
Spark Infrastructure SA (No.3) Pty Ltd, ABN 50 091 142 362
each incorporated in Australia
CKI Utilities Development Limited, ABN 65 090 718 880
PAI Utilities Development Limited, ABN 82 090 718 951
each incorporated in The Bahamas

1 Anzac Highway, Keswick, South Australia, 5035.

SA Power Networks' Disclaimer:

1. The use of the information contained in this document is at your sole risk.
2. The Information within this document is subject to change without notice.
3. SA Power Networks, its agents, instrumentalities, officers and employees:
   3.1. Make no representations, express or implied, as to the accuracy of the information contained within this document;
   3.2. Accept no liability for any use of the said information or reliance placed on it; and
   3.3. Make no representations, either expressed or implied, as to the suitability of the said information for any particular purpose.
4. SA Power Networks and its agencies and instrumentalities do not endorse or in any respect warrant any third-party products or services by virtue of any information, material or content referred to or included on, or linked to this document.

SA Power Networks' Copyright©2020:

Contents

1. Purpose

This technical standard specifies the minimum requirements for trenching, installing conduits and electrical cables that operate at a voltage of 33kV or less and form part of SA Power Networks' distribution network.

2. Scope

The specifications in this technical standard are applicable to all parties, whose activities are associated with trenching, civil works and installation of conduits and underground cables, for all new installations, extensions and any alterations to the SA Power Networks' distribution cable networks.

It is important that you contact SA Power Networks in the early planning stages of your project to enable SA Power Networks to assist you in establishing your installation requirements and the most suitable method of supply.

The installation of transformer/s in the public places, reserves and or in the parklands is not permitted, therefore at preliminary design stage, obtain an approval from the relevant SA Power Networks' Project Manager.

The civil and electrical works are principally governed by the Electricity (General) Regulations 2012, other statutory authorities and AS/NZS standards requirements, and includes any specific design plans, drawings and documents that are part of the project requirements.

This technical standard does not include the requirements for the installations, within substation boundary or 66kV underground sub-transmission networks (refer to TS110).

3. Deviation from this Standard

Deviation from any specific requirement(s) of this Standard will only be permitted with the written approval of SA Power Networks' Manager Network Planning (MNP). Contact 'Standards and Equipment Team' via Hotline on (08) 8404 4200 or send an email to: networkstandards@sapowernetworks.com.au.

4. Grace Period

1. The maximum grace period acceptable by SA Power Networks for implementing this technical standard is 3 months from the date of publication.
2. All projects that are not in receipt of 'Specification Compliance' at the revised date of issue for this technical standard will need to incorporate the latest requirements. This is applicable to both the design and construction phases of the project.
3. The validity period for 'Specification Compliance' is 60 days.
4. On the expiry of 'Specification Compliance', any specification change (without a documented exemption) shall be incorporated into the design and construction of SA Power Networks' infrastructure.

5. Intellectual Property

Utilising SA Power Networks' specification for any installation other than an installation designed to be vested / connected to SA Power Networks' network without SA Power Networks' approval is an offence. We view such misuse seriously and may take legal action for any identified breach.

If anyone wishes to utilise SA Power Networks' specification for a design that is not being vested to SA Power Networks, then they shall request written approval from SA Power Networks' Manager Network Planning (MNP).

A charge may apply for the use of SA Power Networks' drawings or templates for the design or construction of assets not intended to be vested to or constructed for SA Power Networks.

For organising access, please contact 'Standards and Equipment Team' via Hotline (08) 8404 4200, and or send an email to: networkstandards@sapowernetworks.com.au.

6. Background

A trench containing SA Power Networks' cables and the associated conduits is to be positioned in the straightest possible alignment to accommodate future cable installations.

The trench containing the electrical works is a component of the asset inspection process and it is the responsibility of the customer/landowner to ensure that the trench meets the specification. SA Power Networks' Asset Compliance Officer may inspect the trench at any time.

A non-compliance notice will be issued for any civil works, where remedial work to a trench is required to meet this technical standard, including any other associated specified requirements. If there is any query relating to the requirements of this technical standard, please contact 'Standards and Equipment Team' via Hotline on (08) 8404 4200 or send an email to: networkstandards@sapowernetworks.com.au.

Any changes required to the approved works, must be submitted and be approved by the relevant SA Power Networks' Project Manager, prior to being incorporated into the design.

7. Clearances between Services

For trenching and trenchless technology installations, clearance from SA Power Networks' assets to other service utility assets shall not be less than (and preferably exceed) the minimum clearances as shown in **Table 1** (Vertical Separation) and **Table 2** (Horizontal Separation).

Refer to **Appendix J**, for additional requirements, for the typical reduced depth of cover trenching and **Appendices from C** to **I**, for separation requirements in various trenching arrangements.

7.1 Vertical Separation

The vertical minimum separations stated in **Table 1** shall be maintained, where other services utility assets, are required to be installed vertically parallel, crossing over or under the SA Power Networks' assets.

Table 1 - Minimum Vertical Separation Between Services

Services Types			LV Mains (Distance in 'mm')	HV ≤ 33kV Mains (Distance in 'mm') (see Note 5)
Telecom Pipe (eg Third party Telstra, Optus, NBN)			100	300
Telecom Pit (eg Third party Telstra, Optus, NBN)			100	100
Gas Plastic Main or Service Pipeline - Laid Crossing in Shared Trench (Ref: AS/NZS 4645.3: 2018 cl. 3.11) - (see Note 4)			150	150
Gas Plastic Main or Service Pipeline - Laid Parallel in Shared Trench (Ref: AS/NZS 4645.3: 2018 cl. 3.11) - (see Note 4)			250	250
Gas Steel Pipeline - Laid in Shared Trench (Ref: AS 2885.1: cl. 10.12.2)			300	300
Gas Distribution Pipeline - High Pressure (≤350kPa) (At first instant, please contact APA group)			1500 (Exclusion Zone)	1500 (Exclusion Zone)
Gas Steel Transmission Pipeline - High Pressure (>350kPa & ≤1750kPa) (At first instant, please contact APA group)			3000 (Exclusion Zone)	3000 (Exclusion Zone)
SA Water/Private - Sewer Mains (eg Sanitary Drainage Pipeline System)	Sewer Pipe Diameter (DN ≤300)		225	225
	Any other Sewer Mains		300	300
SA Water/Private - Water Service Line (Ref: AS/NZS 3500.1: cl. 5.3; Ref: AS/NZS 3000 cl. 3.11.5)	Parallel Mechanically Protected, (see Note 1)	Pipe Diameter (DN≤ 65)	100	100
		Pipe Diameter (DN≥ 65)	300	300
	Parallel (Unprotected)		600	600
	LV Earthing System		500	Consult (MNP) (see Note 6)
SA Water/Private - Storm Water (Ref: AS/NZS 3500.3: cl. 7.2.7 f, k)	Parallel (Protected) (see Notes 1 & 3)		100	100
	Parallel (Unprotected) (see Note 3)		600	600
	Crossing (see Note 2)		100	100
NBN Co. Services - (Ref: NBN-TE-CTO-194)			100	300
Customer Public Lighting (CLER/Energy only) or Fed from a Metered Supply Point (ie Private Supply for Public Lighting) - (Ref: AS/NZS 3000: cl. 3.11.5)			100	300

Please refer to notes on next page.

Notes:

1. Mechanical protection (eg by the concrete slabs, continuous pour, bricks designed for protecting etc) for the electrical supply cables.
2. As per AS/NZS 3500.3, the minimum vertical separation between any underground storm water drain crossing another service shall –
   a) Cross at angle 90° if practicable, but not less than 45°;
   b) Have a vertical separation of not less than 100mm; and
   c) Be marked along its length for 1,000mm either side of the centerline of the service, with marker tape, complying with AS/NZS 2468.1, laid 150mm above the installed service.
3. As per AS/NZS 3500.3, the minimum horizontal separation between any underground storm water drain and an electrical supply cable shall be at least –
   a) 100mm provided the electrical supply cable is indicated along its length with orange marker tape complying with AS/NZS 2648.1 and is mechanically protected;
   or
   b) 600mm, where the electrical supply cable not mechanically protected.
4. Refer to AS/NZS 4645.3, states that:
   a) Where a plastic main or service is laid parallel to other utility assets, the minimum separation distance is required to conduct repairs. The minimum separation distance shall be 250mm;
   and
   b) Where a plastic main or service is crossed by other utility assets, the minimum separation distance shall be 150mm. Additional separation may be required for large utility assets to conduct repairs.
5. For any other authorities' infrastructure, crossing and or running parallel to the SA Power Networks 66kV cables (and associated conduits), refer to TS110 'Electrical Design, Civil/Electrical Works & Testing for 66kV UG Sub-Transmission Networks'.
6. For approval from SA Power Networks' Manager Network Planning (MNP), please contact 'Standards and Equipment Team' via Hotline on (08) 8404 4200 or send an email to: networkstandards@sapowernetworks.com.au.

7.2 Horizontal Separation

The horizontal minimum separations stated in **Table 2** shall be maintained, where other services utility assets, are required to be installed vertically parallel, crossing over or under the SA Power Networks' assets.

Table 2 - Minimum Horizontal Separation Between Services

Services Types			LV Mains (Distance in 'mm')	HV ≤ 33kV Mains (Distance in 'mm') (see Note 5)
Telecom Pipe (eg Third party Telstra, Optus, NBN)			100	300
Telecom Pit (eg Third party Telstra, Optus, NBN)			100	100
Gas Plastic Pipeline - Laid Parallel in Shared Trench (Ref: AS/NZS 4645.3: 2018 cl. 3.11) - (see Note 4)			250	250
Gas Steel Pipeline - Laid in Shared Trench (Ref: AS 2885.1: cl. 10.12.2)			300	300
Gas Distribution Pipeline - High Pressure (≤ 350kPa) (At first instant, please contact APA group)			1500 (Exclusion Zone)	1500 (Exclusion Zone)
Gas Steel Transmission Pipeline - High Pressure (> 350kPa & ≤ 1750kPa) (At first instant, please contact APA group)			3000 (Exclusion Zone)	3000 (Exclusion Zone)
SA Water/Private - Sewer Mains (eg Sanitary Drainage Pipeline System) (Ref: SA Water - Engg Stds & Guidelines)	Sewer Pipe Diameter (DN ≤ 300)		500	500
	Any other Sewer Mains		1000	1000
SA Water/Private - Water Service Line (Ref: AS/NZS 3500.1: cl. 5.3; Ref: AS/NZS 3000 cl. 3.11.5)	Parallel Mechanically Protected (see Note 1)	Pipe Diameter (DN≤ 65)	100	100
		Pipe Diameter (DN≥ 65)	300	300
	Parallel (Unprotected)		600	600
	LV Earthing System		500	Consult (MNP) (see Note 6)
SA Water/Private - Storm Water (Ref: AS/NZS 3500.3: cl. 7.2.7 f, k)	Parallel (Protected) (see Notes 1 & 3)		100	100
	Parallel (Unprotected) (see Note 3)		600	600
	Crossing (see Note 2)		100	100
SA Water/Private – Water Mains	For Water Mains Pipe Diameter ≤ 200		500	500
	Other Water Mains		1000	1000
NBN Co. Services (Ref: NBN-TE-CTO-194)			100	300
Customer Public Lighting (CLER/Energy only) or Fed from a Metered Supply Point (ie Private Supply for Public Lighting) - (Ref: AS/NZS 3000: cl. 3.11)			100	300

Please refer to Notes on next page.

Notes

1. Mechanical protection (eg by the concrete slabs, continuous pour, bricks designed for protecting etc) for the electrical supply cables.
2. As per AS/NZS 3500.3, the minimum vertical separation between any underground storm water drain crossing another service shall –
   a) Cross at angle 90° if practicable, but not less than 45°;
   b) Have a vertical separation of not less than 100mm; and
   c) Be marked along its length for 1,000mm either side of the centerline of the service, with marker tape, complying with AS/NZS 2468.1, laid 150mm above the installed service.
3. As per AS/NZS 3500.3, the minimum horizontal separation between any underground storm water drain and an electrical supply cable shall be at least –
   a) 100mm provided the electrical supply cable is indicated along its length with orange marker tape complying with AS/NZS 2648.1 and is mechanically protected; or
   b) 600mm, where the electrical supply cable not mechanically protected.
4. Refer to AS/NZS 4645.3, states that:
   a) Where a plastic main or service is laid parallel to other utility assets, the minimum separation distance is required to conduct repairs. The minimum separation distance shall be 250mm; and
   b) Where a plastic main or service is crossed by other utility assets, the minimum separation distance shall be 100mm. Additional separation may be required for large utility assets to conduct repairs.
5. For any other authorities' infrastructure, crossing and or running parallel to the SA Power Networks 66kV cables (and associated conduits), refer to TS110: Electrical Design, Civil/Electrical Works & Testing for 66kV UG Sub-Transmission Networks.
6. For approval from SA Power Networks' Manager Network Planning (MNP), please contact 'Standards and Equipment Team' via Hotline on (08) 8404 4200 or send an email to: networkstandards@sapowernetworks.com.au.

7.3 Clearance to Buildings

The Electricity (General) Regulations 2012, requires a separation between a building or a structure and underground powerlines:

- At a voltage of 33kV or less, shall be minimum of 2000mm; and
- At a voltage, greater than of 33kV, shall be minimum of 3000mm.

Any installation not meeting these requirements, will be non-compliant without an exemption from the OTR. The associated party will need to supply the OTR exemption as a component of civil works 'Compliance Form'.

7.4 Fire Hydrant System and Electrical equipment

Padmount transformers and switching cubicles cannot be located within 10m of a fire hydrant which located external to a building. Refer to AS2419.1 for further details.

For clearance to fire hydrants within a building refer to the Building Code of Australia (BCA).

7.5 Petrol/LPG Dispensing Stations and Electrical equipment

The above ground minimum horizontal separation between Petrol/LPG dispensing stations and electrical equipment, where **adequate ventilation** (eg natural open-air area, where vapour are rapidly dispersed by wind and natural convection) is available then **4m** (minimum) separation is required. Refer to AS/NZS 60079.10.1:2009, cl. ZA.4.4.2.2 for more details.

Where the ventilation is **inadequate** (eg area limited by topography, nearby structures, weather conditions), then separation shall be **8m** (minimum). Refer to AS/NZS 60079.10.1:2009, cl. ZA.4.4.2.4 for more details.

7.6 Service Pillar/Pit - Safe Operating Work Zone (Ground Level)

Customers are to refer to 'Service and Installation Rules - Section 7.3.5.4' for more details. A safe operating work zone clear of obstructions with minimum dimensions of 1m x 1m located immediately behind or adjacent and at the same ground level as at the pit/pillar must be provided.

The safe operating work zone is the direction that the fuse panel faces and able to be worked on or operated from within the property. Alternative safe operating work zone from the side position is also acceptable.

Refer to **Figure 1**, for more details.

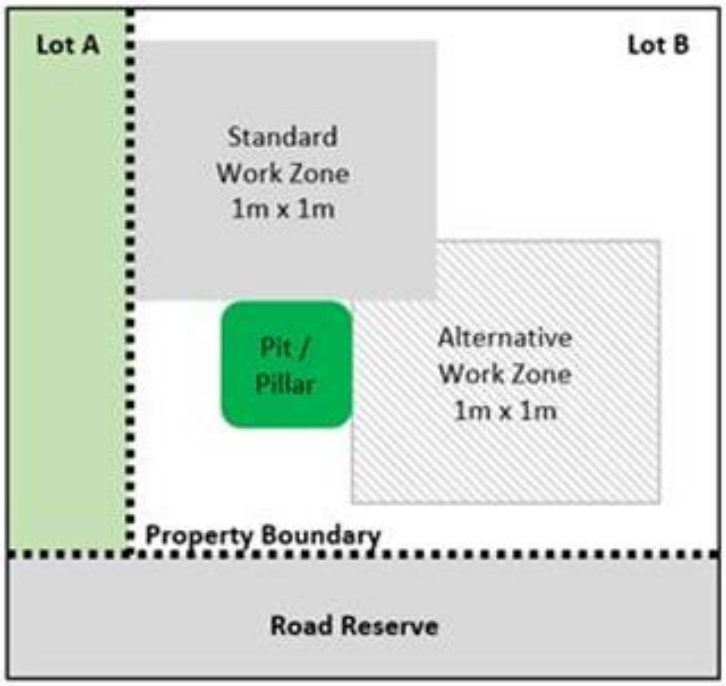


Figure 1: Safe Operating Work Zone

In a rare cases, where a front safe operating work zone is required when access only from roadside is possible (eg retaining wall/land feature) the pillar is required to be rotated 180° with fuse panel facing roadside with no fence, then approval is required from the relevant SA Power Networks' Project Manager and E-SP drawing shall be developed on case-by-case basis.

Where the pillar is rotated, then it will also require a non-standard orientation label.

7.7 Vegetation Clearance

The OTR's website (eg Trees and Powerlines), specify the type of vegetation plantation and minimum clearance requirements to the electrical infrastructure, which shall be complied with.

7.8 Bulk Flammable Liquid Storage Tank

AS/NZS 60079.10.1 (cl. ZA.5.2.1.2 and cl. ZA.9.2.2.3) indicates horizontal clearance zone for flammable liquid bulk storage tanks (eg Petrol station underground and/or above ground bulk storage tanks) and electrical system shall be as stated in **Table 3**.

Table 3
Storage Tank Capacity Vs Lateral Clearance

Capacity of Tank, kL	Lateral Distance, m
2	4
4	5
7	6
10	7
25	8
50	9
200	12
≥ 500	15

7.9 Clearance on the Service Bridge

On a 'Service Bridge', the following are the minimum clearances requirements from SA Power Networks' (HV and or LV) assets:

1. When installing SA Power Networks' two or more (HV and or LV) feeders, along the same route, maintain clearance between feeders:
   a) Parallel separation = 1000mm
   b) Crossing separation = Negligible
   c) For critical circuits, more detailed analysis may be required
2. Third Party Telco separation:
   a) Single-core cable = 450mm
   b) Multi-core cable = 300mm
   c) Multi core cable = 150mm, (where there is an imposing barrier that is either durable insulating material or metal earthed)
3. SA Water separation:
   a) Mains (for pipe diameter DN63 ≤ DN150) = 1200mm
   b) Service lines separation = 25mm
4. APA gas steel pipe separation = 300mm

7.10 Consumers Mains Clearance

For the consumers' mains clearance and installation, please comply with SA Power Networks' Service and Installations Rules and AS/NZS 3000 requirements.

8. Materials

8.1 Conduits and Couplings Compliance

The conduits/couplings shall be UPVC material (ie unplasticised PolyVinyl Chloride, also known as rigid PVC) and shall comply with AS/NZS 2053 Parts 1 and 2 (for rigid plain designation), and AS/NZS 1462.3 & AS/NZS 1477 (for 20°C impact test).

The conduit shall be marked with the word 'Electrical', the conduit size and class, eg 'Electrical Ducting 100mm LD'.

SA Power Networks reserves rights to refuse lower grade and or inferior quality of conduit/ coupling's installation.

8.1.1 Identification of Conduit Sizes

The nominal sizes for rigid straight lengths conduits:

1. Conduit sizes between Ø16mm and Ø63mm are identified as 'Conduit with outside diameter (OD)'.
2. Whereas, conduit sizes greater than Ø63mm are identified as 'Conduit with internal diameter (ID)'.

8.1.2 Colours of Conduits/Couplings

Conduits and couplings shall be compliant with AS 1345, which states that:

1. Electrical conduits/couplings = 'Orange' colour; and
2. Telecommunications conduits/couplings = 'White' colour.

8.2 Underground LV and HV Cable Sizes

Table 4
Underground Cable Sizes and Stock Item Numbers

Voltage	Underground Cable Sizes	Screen Type	SAPN Stock Item Number	
			AL Cond.	Cu Cond.
Low Voltage 600V/1.0kV	4x150mm^2 LV AL XLPE/HDPE UBC	N/A	CK5310	--
	4x240mm^2 LV AL XLPE/HDPE UBC	N/A	CK5350	--
	4x240mm^2 LV Cu XLPE/HDPE UBC**	N/A	--	CK5340
	185mm^2 3.5C LV Cu XLPE/PVC (For CBD)	N/A	--	CK1185
	240mm^2 3.5C LV Cu XLPE/PVC (For CBD)	N/A	--	CK1240
6.35/11kV	95mm^2 1C AL XLPE/HDPE, Cu Screen	Screen Cu 35mm^2	CK6005	--
	95mm^2 3x1C AL Bundled XLPE/HDPE Triplex, Cu Screen	Screen Cu 35mm^2	CK6006	--
	185mm^2 3C Cu XLPE/HDPE, Cu Screen (For CBD and Approved Industrial Developments)	Individually screened Cu 90mm^2 Total	--	CK3185
	240mm^2 3C Cu XLPE/HDPE, Cu Screen (For CBD and Approved Industrial Developments)	Individually screened Cu 90mm^2 Total	--	CK3240
	300mm^2 1C AL XLPE/HDPE, Cu Screen	Screen Cu 70mm^2	CK6025	--
	630mm^2 1C AL XLPE/HDPE, Cu Screen	Screen Cu 95mm^2	CK6039	--
	630mm^2 1C Cu XLPE/HDPE, Cu Screen	Screen Cu 95mm^2	--	CK6050
19/33kV (For CBD and Approved Industrial Developments)	50mm^2 1C AL XLPE/HDPE, Cu Screen	Screen Cu 25mm^2	CK8090	--
	70mm^2 1C Cu XLPE/HDPE, Cu Screen	Screen Cu 65mm^2	--	CK8070
	95mm^{2}1C AL XLPE/HDPE, Cu Screen	Screen Cu 65mm^2	CK8092	--
	120mm^2 1C Cu XLPE/HDPE, Cu Screen	Screen Cu 65mm^2	--	CK8120
	240mm^2 1C Cu XLPE/HDPE, Cu Screen	Screen Cu 65mm^2	--	CK8240
	300mm^2 1C AL XLPE/HDPE, Cu Screen	Screen Cu 95mm^2	CK8095	--

Note: Al = Aluminum; Cu = Copper; and N/A = Not Applicable

**4x240mm^2 LV Cu XLPE/HDPE UBC (CK5340) is available for special projects requiring large current connection (eg 400A).

Table 5
Cable Sizes for LV Public Lighting Applications

Cable Description:		SA Power Networks' Supply Item Nos.
		Cu Cond.
450V/750V Low Voltage	2.5mm^2, 2C, LV Cu PVC Insulated, Red/Black Cores, White Sheath (100m Length)	CD7240
	4.0mm^2, 2C, LV Cu PVC Insulated, Red/Black Cores, White Sheath (100m Length)	CD7250
	6.0mm^2, 2C, LV Cu PVC Insulated, Red/Black Cores, White Sheath (100m Length)	CD7253
	6.0mm^2, 2C, LV Cu PVC Insulated, Red/Black Cores, White Sheath (500m Length)	CD7254
	6.0mm^2, 1C, LV Cu PVC Insulated, Green/Yellow Cores, Black Sheath (100m Length)	CD7061
	6.0mm^2, 1C, LV Cu PVC Insulated, Green/Yellow Cores, Black Sheath (500m Length)	CD7062

8.3 Conduit Sizes

Selection of the conduit size is based on factors, such as, ease of cable installation, achieving desired cable ratings, operating environmental conditions, functional and safety against surrounding other services, future development, extension and external loading requirements.

Care shall be taken in joining conduits, as different grades of conduits have different internal diameters and the resultant raised internal edge has the potential to damage the outer layer of cable during cable pulling.

Encasing conduits and or conduit bends in concrete, is not recommended for open trenching, as they can create various issues at the time of the cable installation. **Tables 6** and **7** provides lists of the SA Power Networks' standard conduit sizes, for various cable sizes.

Table 6
Conduit Sizes - Straight Lengths PVC, Rigid, Electrical/Telecom with Bell End

Conduit Nominal Size (See Note 3)	Conduit Type (See Notes 4 & 5)	Conduit Required	For use with the following Cable Sizes Only	Conduit Technical Data			SAPN Conduit Stock Item
				Inside Diam. (mm)	Avg. Wall Thick. (mm)	Straight Length (m)	
40mm, HD (Public Lighting & Customers Service)	HD PVC (Orange)	1	Public Lighting and Customers Mains to Service Pillars	33.6	3.2	4	EA8046 (See Notes 1 & 2)
100mm, LD (Electrical)	LD PVC (Orange)	1	CK5310, CK5350, CK6006, CK3185 (Bundled/Triplex & 3-Core Cables)	107.8	3.0	6	NC2505
		1	CK6005, CK8090 (Shared conduit - 3 cables installed in a single conduit)				
		3	CK6005, CK6025, CK6039, CK6050, CK8070, CK8240, CK8090, CK8092, CK8095, CK8120 (Individual conduit - 1 cable in single conduit)				
125mm, LD (Electrical)	LD PVC (Orange)	1	CK3240 (Bundled/Triplex & 3-Core Cables)	132.2	3.7	6	NC2509
		1	CK6025, CK8070, CK8092, CK8120 (Shared conduit - 3 cables installed in a single conduit)				
150mm, LD (Electrical)	LD PVC (Orange)	1	CK6039, CK6050, CK8240, CK8095 (Shared conduit - 3 cables installed in a single conduit)	151.3	4.2	6	NC2518
100mm, MD (Telecom)	MD PVC (White)	1	Optic Fibre Cable	104.6	4.9	6	NC4527

Notes:

1. 32 (OD) HD PVC (EA8045), orange conduit is required by AS/NZS 3000 as minimum for public lighting circuits and required for connection to the service fuse box, at the over/under pole.
2. Where 40 (OD) (EA8046) is used as the underground conduit, use plain reducer eg Clipsal 264/4SM or similar, to connect 32 (OD) conduit. Refer to E1710 series for service arrangement.
3. **Table 6** list minimum conduit sizes for each cable, larger conduit sizes may be used.
4. LD = Light Duty; MD = Medium Duty; and HD = Heavy Duty
5. More conduit sizes are available in TS110, however, prior to use, it shall be specified with the project scope and will require approval from the relevant SA Power Networks' Project Manager.

8.4 Conduits for Directional Boring

The Polyethylene (PE, flexible) conduits used for directional boring shall comply with AS/NZS 4130. The following **Table 7** provides list of conduits required for directional boring.

The polyethylene material has a 'Memory' and will attempt to coil up, which has potential to introduce stress on the conduit at the start, transition and end locations of boring installation. Therefore, the conduits shall be anchored appropriately at the conduit entry/exit points to maintain its horizontal configuration.

Refer to **Figure 2**, for more details.

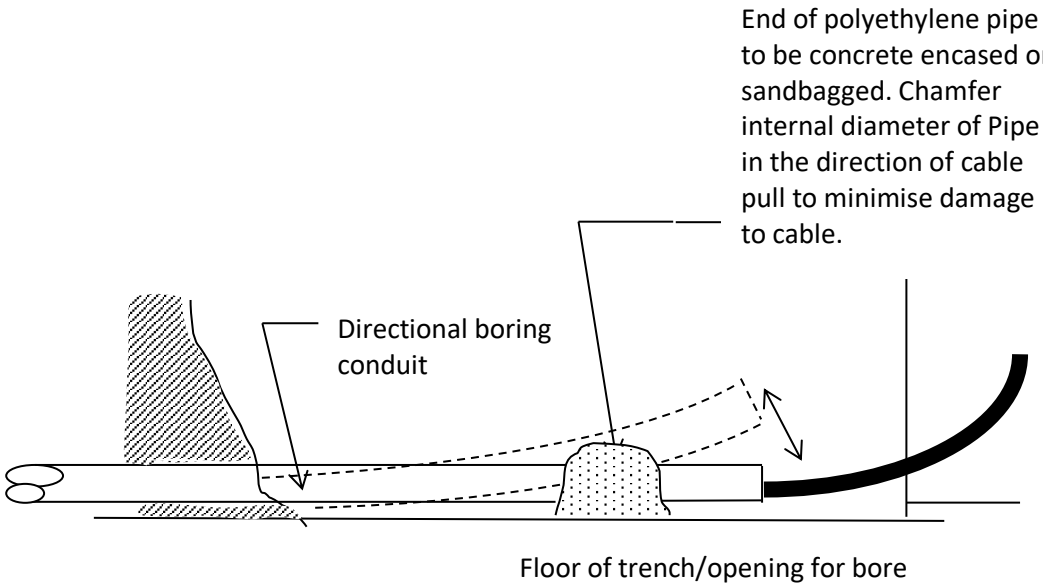


Figure 2: Securing the End of Directional Boring Conduit

Table 7
PE Polyethylene Conduits HDPE for Directional Boring/Drilling
(Reference AS/NZS 4130:2018 Table 2)

Conduit Nominal Size (mm) (See Note 4)	Cond. Type (See Notes 1 & 4)	Cond. Reqd.	For use with the following Cable Sizes Only	Maxi. Pull Force (kN)	Conduit Technical Data (Comply with AS/NZS 4130) (See Notes 2, 3, 4 & 5)						SAPN Stock Item Nos (Comply with AS/NZS 4130) (See Notes 2, 3, 4)
					Wall Thickness (mm)		Inside Diam. (mm)		Mean Outer Diam. (mm)	Coil Length (m)	
					Min.	Max.	Min.	Max.			
110	PE Coils SDR 17 Orange	1	**CK5310, CK5350, CK6006, CK3185** (Bundled/Triplex & 3-Core Cables)	22.0	6.6	7.4	6.6	7.4	110.5	100	NC5800
		1	**CK6005, CK8090** (Shared conduit - 3 cables installed in a single conduit)								
		3	**CK6005, CK6025, CK6039, CK6050, CK8070, CK8240, CK8090, CK8092, CK8095, CK8120** (Individual conduit - 1 cable in single conduit)								
125	PE Coils SDR 17 Orange	1	**CK3240** (Bundled/Triplex & 3-Core Cables)	28.2	7.4	8.3	7.4	8.3	125.6	100	NC5801
		1	**CK6025, CK8070, CK8092, CK8120** (Shared conduit - 3 cables installed in a single conduit)								
110 (Telecom)	PE Coils SDR 17 White	1	**Optic Fibre Cable**	22.0	6.6	7.4	6.6	7.4	110.5	100	NC5802

Notes:

1. SDR = Standard Dimension Ratio, PE = Polyethylene, HDPE = High Density Polyethylene
2. Install a polypropylene draw rope compliant with AS 4142.1, through each conduit (including spare conduits, where specified) for cable pulling. Under no circumstances shall a draw rope be loaded in excess of its 'Safe Working Load' (SWL). The minimum breaking load should never be considered as being the SWL. Draw rope should be capable of pulling hauling rope for specified cable size thru relevant cable length.
3. All conduits installed shall be clean and free from debris or internal rough edges which may cause damage to the cable's outer sheath during cable installation. Similarly, all PE pipe joints shall be internally 'de-beaded' to prevent damage to the outer serving of the cable.
4. More conduit sizes are available in TS110, however, prior to use, it shall be specified with the project scope and will require approval from the relevant SA Power Networks' Project Manager.

8.5 Conduit Spacers

Conduit spacers assist in maintaining the required separation between the conduits and spare conduits. Conduit spacers will help ensuring proper heat dissipation and will prevent conduits from being disturbed during bedding and backfilling compaction works.

Conduits and conduit spacers are to be securely staked or anchored to limit movement at the start and end of conduits run, and at 2m to 3m intervals, however, the required numbers of conduit spacers and their installation method, shall be followed as per manufacturer's instructions.

Use of conduit spacers are not mandatory but recommended by SA Power Networks, who will also consider other alternatives for conduit spacers; however, the preferred solution is to use prefabricated spacer systems, refer to **Figure 3** for an example. Note that baffle spacers (ie cut outs made from 15mm PVC sheet) are not permitted.

Figure 3: Example of Conduit Spacers

8.6 Conduits within Railway Network Boundaries

Refer to AS 4799 'Installation of Underground Utility Services and Pipelines within Railway Boundaries', which specifies the requirements in detail for both the design and installation of electrical infrastructure within a railway property. There are specific design information requirements and approvals needed to gain right of entry as well as easement agreements within railway boundaries/corridors. Refer to TS100 for specific details.

Where more than one conduit is required for an underground crossing of a railway network, the conduits shall be grouped in a single bore, where practical, by ensuring a 25mm minimum separation between all conduits.

Any directional bored conduits shall mate with the SA Power Networks' standard conduits, using a suitable sealed coupling method. All draw ropes to be marked at each end with respective matching identification. The following requirements shall be considered for telecommunication conduits installation, crossing under railway networks:

1. Pits shall be P8 size (RA5461)
2. Outer bore pipe is to enter pit body using a bell-mouth spigot diam. Ø63mm
3. Pole side of pit is to have bell-mouth installed in preparation for the SA Power Networks' installers to extend conduit to pole
4. Pits to be installed nominally 3m from the edge of pole

For single telecom pilot and or fibre optic only installation, the following are the approval requirements:

8.6.1 Telecommunications Pilot Cable Only

Where there is a single pilot cable underground rail crossing and where the civil works must be completed with an under-bore, prior to the installation of a single Ø63mm OD bore pipe, a written approval from the SA Power Networks' Telecom Manager is required.

8.6.2 Telecommunications Fibre Optic Only

Where there is a single fibre optic underground rail crossing and where the civil works must be completed with an under-bore, the use of a single Ø63mm OD bore pipe can be installed, without an approval.

8.7 Conduit Bends

The following **Tables 8** to **10** provides the requirements for conduit bends. Refer to the manufacturer's specifications for the installation requirements.

Table 8
Conduit Bend Requirements

Situation	Requirement
Trench T-Intersections	No Bend Required (use appropriate 'Pit')
Trench Direction Changes greater than 90 Deg	No Bend Required
Trench Direction Changes 90 Deg or Less	Bend Required
Transformer Vaults - General	Bend Required
Transformer Vault for a Future Stage	Bend Required
Road Crossing - Cable Run	Continuous

Table 9
Conduit Bends Sizes for Directional Boring/Drilling - Guide Only

CONDUIT Nominal Size	CONDUIT BENDS Requirements	SAPN CONDUIT BENDS (Stock Item)
110mm Flexible Coils, Polyethylene (Non-Stock Item)	Minimum **Conduit Bending Radius** shall be **greater than** the minimum **Bending Radius of the Cable** (See Note 1)	Non-Stock Item (See Notes 2 & 3)
125mm Flexible Coils, Polyethylene (Non-Stock Item)		Non-Stock Item (See Notes 2 & 3)

Notes:

1. The conduit bending radius shall be greater than the minimum bending radius of the cable and shall match the conduit size to assist in cable installation. For the cable's minimum bending radius, refer to the manufacturer's cable data or to relevant E-drawing.
2. SA Power Networks does not stock larger size conduit bends.
3. When required, non-stock items shall be specified with the project scope and will require approval from the relevant SA Power Networks' Project Manager.

8.8 PE Conduit to PVC Conduit - Couplings

Table 10 - PE Conduit to PVC Conduit - Couplings

PE Conduit Type	PVC Conduit Type	Couplings Length (mm)	SA Power Networks' Stock Item Number Couplings
PE 110, Orange	LD PVC 100, Orange	250	NC8160
PE 125, Orange	LD PVC 100, Orange	300	NC8161
PE 180, Orange	LD PVC 150, Orange	370	NC8162
PE 110, White	LD PVC 100, White	250	NC8164

Table 11 - SA Power Networks' Heavy-Duty Conduit Bend Sizes

CONDUIT SIZE (mm)	CONDUIT BEND 'BENDING RADIUS' (mm) (See Note 1)	CONDUIT BEND 'BEND ANGLE' (Degrees) (See Note 4)	CONDUIT BEND BELL END TYPE (See Note 2)	SAPN STOCK ITEMS NUMBER CONDUIT BEND	FOR USE WITH THE FOLLOWING CABLE ONLY (See Note 3)
40	312	90	F-F	**EA8061**	Public Lighting and LV Consumers' Mains Cables
	312	90	F-F	**EA8101**	
	312	90	F-F	**EA8111**	
100	600	22	M-F	**NC5713**	CK5310 only
	600	30	M-F	**NC5721**	
	600	45	F-F	**NC5729**	
	600	90	F-F	**NC5742**	
	900	90	F-F	**NC5741**	CK5310, CK5350, CK6005
	1200	15	M-F	**NC5770**	CK5310, CK5350, CK6005, CK6006, CK6025, CK8070, CK8090, CK8092
	1200	30	M-F	**NC5771**	
	1200	45	F-F	**NC5772**	
	1200	90	F-F	**NC5773**	
	1830	15	M-F	**NC5774**	CK5310, CK5350, CK6005, CK6006, CK6025, CK6039, CK6050, CK3185, CK8070, CK8240, CK8090, CK8092, CK8095, CK8120
	1830	30	M-F	**NC5775**	
	1830	45	F-F	**NC5776**	
	1830	90	F-F	**NC5743**	
100	800	45	F-F	**Non-Stock Item**	Telecommunication Cables
	800	90	F-F	**Non-Stock Item**	
125	1830	15	M-F	**NC5777**	CK5310, CK5350, CK6005, CK6006, CK6025, CK6039, CK6050, CK3185, CK3240, CK8070, CK8240, CK8090, CK8092, CK8095, CK8120
	1830	30	M-F	**NC5778**	
	1830	45	F-F	**NC5779**	
	1830	90	F-F	**NC5780**	
150	1830	45	F-F	**NC5781**	CK5310, CK5350, CK6005, CK6006, CK6025, CK6039, CK6050, CK3185, CK3240, CK8070, CK8240, CK8090, CK8092, CK8095, CK8120
	1830	90	F-F	**NC5782**	

Notes:

1. The conduit bending radius shall be greater than the minimum bending radius of the cable to assist in cable installation. For the cable's minimum bending radius, refer to relevant E-drawing.
2. 'M-F' = Male to Female and 'F-F' = Female to Female.
3. Conduit Diameter is for individual installation ie. Bundled, triplex, 3-core cable or single core per conduit. For shared conduit (ie. 3 cables per conduit) Refer to **Table 6** for suitable conduit diameter. The bending radius remains as listed in **Table 11**.
4. The conduit bending radius does not change when 2 or more bends are added together.

8.9 Conduit End Caps

To prevent the entry of water, dirt and or other foreign matter entering the conduits, the conduit end caps shall be installed for all conduits that remains vacant and or left empty overnight.

For all empty conduits, the exposed ends shall be squarely cut and cleaned, to enable correct fitting of the conduit caps.

Refer to **Table 12** for conduit cap stock item numbers.

Table 12 - Conduit Cap (Push On)

Cap Types	Minimum Cap Length (mm)	SAPN Stock Item Number
40 PVC, Orange	--	Non-Stock
50 PVC, Orange	--	NC6462
100 PVC, White	91	NC6501
125 PVC, White	--	NC6502
100 PVC, Orange	35	NC6503
150 PVC, Orange	35	NC6504
150 PVC, Gray	38	NC6505

Note:

When required, non-stock items shall be specified with the project scope and will require approval from the relevant SA Power Networks' Project Manager.

8.10 Pit/Pillar - Selection Priorities

The service / junction pit or pillar selection priorities are considered at the LV design stage. Refer to TS100 - section titled: LV Equipment - Design Consideration, for more details and refer to E1921 E-drawings series for the installation requirements. Note that for the 'Footpath Pit for Residential Driveway' have specific requirements, refer to TS100 and E1921 series for more details.

8.11 Footpath Pits - Access Cover/Lid Plugs

The footpath service or junction pits when installed in footpath shall have appropriate accessible covers and or lids installed flush with the ground level. These access covers and or lids which have lifting slots (for lifting handle KL3602) shall be blocked with plugs (RA5447). To overcome any loose fittings around plugs, use of butyl rubber (EK7665). Refer to E1921 series for the installation details.

8.12 Polypropylene Draw Rope

Install a polypropylene draw rope (XX7740), that complies with AS 4142, through each conduit and spare conduit, for cable pulling. SA Power Networks' stock item XX7740, has monofilament, blue/yellow strands, 400m length, min. 6mm diameter, min. breaking strain 602kg (ie 5.9kN).

The draw ropes shall not be jointed without approval from SA Power Networks' Project Manager and shall not be loaded more than its 'Safe Working Load' (SWL). The minimum breaking load (breaking strain) shall not be considered as being the SWL. AS 4142 specifies the required 'Factor of Safety' to be applied.

8.13 Polypropylene Straps

At suitable intervals, use non- metallic/non-conductive straps to hold conduits prior to their insertion into borehole. The acceptable Polypropylene (PP) straps are:

1. 12mm (wide) x 0.55mm (thick) x 1000mm (long), 80kg (breaking strain), or
2. 15mm (wide) x 0.55mm (thick) x 1000mm (long), 110kg (breaking strain).

8.14 Cable Location Markers

The cable location markers, includes, 'Surface Marker Disc' (KS3722), 'Star Dropper' (JA6440) with 'Warning Sign' (KS1149) and cable 'Identification Post' (KS3720), which will be installed as stated in **Appendix A**, for clear and visible identification of the SA Power Networks' underground assets. The cable location markers are required in the following instances:

1. where URD/UID development is likely to remain unoccupied for an extended period,
2. in rural areas,
3. for private properties, and or
4. where the natural vegetation will prevent the obvious identification of the SA Power Networks' equipment.

For reduced depth of cover conduit installation, surface marker discs (KS3722) are required (installed centrally on the conduits) at the start and finish at spacing of 20m to 30m (where practical) for the full length of the reduced depth of cover.

8.15 Mk7 Padmount Transformer

The standard Mk7 padmount transformer for residential, industrial and or commercial developments is 315kVA (Stock Item LC7309).

For new residential high-density sites, the 500kVA Mk7 padmount transformer (Stock Item LC7310) can be used with an approval from the relevant SA Power Networks' Project Manager.

For any brownfield applications prior to 1980s, proposed design will require written approval from the Manager Network Planning (MNP). Contact 'Standards and Equipment Hotline' on (08) 8404 4200 and or send an email to: networkstandards@sapowernetworks.com.au. Figure 4 shows Typical Mk7 Transformer with 'Wilson Ring Main Unit'. Refer to TS100 and NICC802, for further details

Figure 4: Typical Mk7 Transformer with 'Wilson Ring Main Unit'

Transformer Rating: 315kVA to 2000kVA, Voltage Ratio: 11kV/0.4kV, 11kV and 7.6kV/0.4kV

8.16 Typical Standard Footing Arrangement

A padmount transformer is installed on a concrete pad-footing, which incorporates a cable vault under the HV and LV compartments, refer to Figure 5.

Any floor supporting a transformer shall be capable of safely supporting the weight of the transformer. The height from the ground level to the top of the padmount transformer base shall be 75mm (E1982 sheet 3.3) and 150mm for a switching cubicle vault (E1981 sheet 3.0), this is to ensure the switchgear and fuses are positioned at the correct height for operational purposes and the vault is not compromised.

The standard footing and extended vault requirements are specified in E Drawings Group: 40 - Civil Construction. The padmount transformer technical details are specified in TS100 - App C.

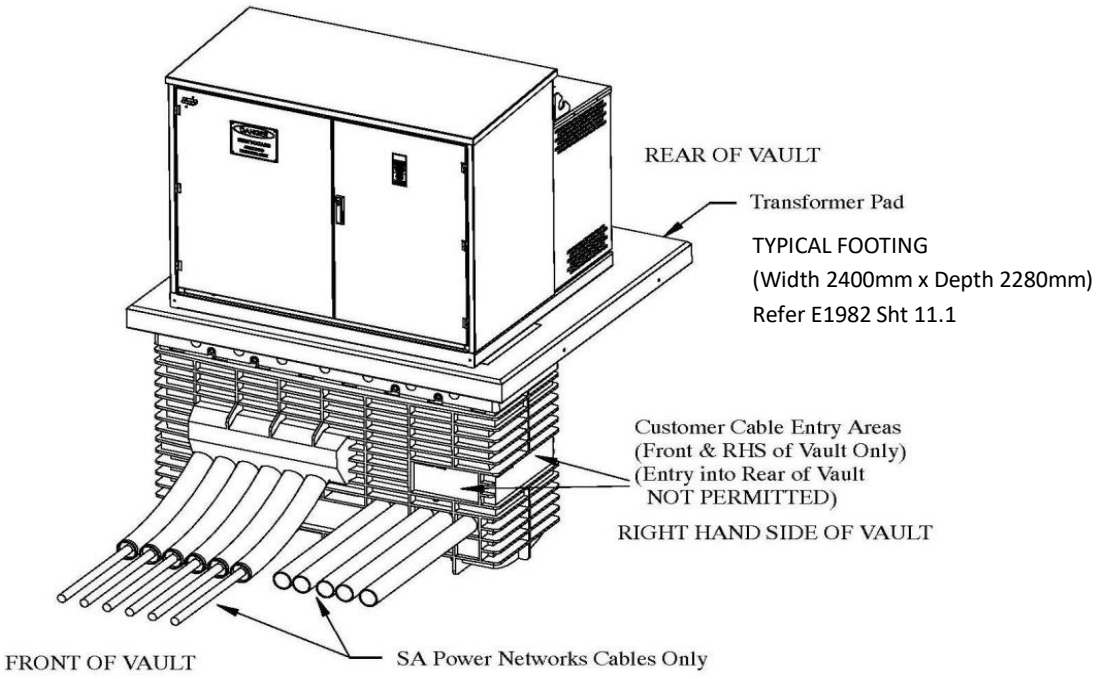


Figure 5 - Typical Footing Arrangement for the Mk7 Padmount Transformer

Notes:

1. All the SA Power Networks' distribution cables shall enter the front of the vault via the designated areas (ie LV and HV separate compartments). The entry of LV cables in the HV compartment is not permitted and vice versa.
2. Where cables have been installed in conduits, the conduits entry shall be adequately sealed (ie around conduits and inside conduits end around cables) to prevent the entrance of dirt, stones, white ants and moisture into the vault and through the conduits. Refer to **Section 10.6.7**, for the details.
3. Enter via a drilled entry holes for a neat fitment for cables/conduits.
   (a) Installer shall produce such neat drilled entry holes by using holesaw, or similar to suit conduit sizes being used.
4. Consumer mains shall:
   (a) Enter the vault through the front or right-hand side of the vault via the designated areas only.

(b) Not be permitted to enter via the rear (ie behind) of the vault.
(c) Only enter the LV compartment of an energised transformer with a 'Network Access Permit'.

5. Contact Network Access Officer on (08) 8329 2631 for an assessment, prior to commencing works, to determine the need for de-energisation of transformer.
6. The SA Power Networks' authorised representative may be required to remain present on site.

8.16.1 Extended Vault

Where standard footing and vault are not feasible due to the transformer location (eg in basements), the relevant SA Power Networks' Project Manager shall be consulted for alternative arrangement.

In CBD area, there may be an additional requirement for an extended vault in front of the padmount transformer. This extended vault will facilitate safe access to the cabling arrangements.

The designer shall first seek approval from the relevant SA Power Networks' Project Manager before considering need for an extended vault.

8.17 Mandatory Requirement for Looped HV Networks

Where looped HV cable networks deviate from the 'Common Service Trench (CST)' alignment, they must be protected by 'Polymeric Cable Cover' and 'Cable Marker Tapes'.

The cable marker tapes, and protective cable cover must be installed for the entirety of the deviated loop and extend at least 1 metre along the main CST also, as stated in **Sections 8.17.1** and **8.17.2** respectively.

8.17.1 Cable Marker Tape

Cable Marker tape (Stock Item No. KS3765) is required mandatorily for all projects.

Where looped HV cable networks deviate from the CST alignment, the 'Cable Marker Tapes' must be installed for the entirety of the deviated loop and extend at least 1 metre along the main CST.

The cable marker tapes must be installed measured halfway between the ground level and on the top of polymeric cable covers.

8.17.2 Polymeric Cable Cover

The polymeric cable cover (Stock Item No. RN0202), is 5mm thick, 15m long roll, 300mm wide, orange colour, inscribed 'Danger - Electrical Cable'. Normally, the polymeric cable covers are only required when specified in a project.

However, where looped HV cable networks deviate from the CST alignment, the 'Protective Cable Cover' must be installed for the entirety of the deviated loop and extend at least 1 metre along the main CST.

The polymeric cable cover must be installed at 75mm above looped HV cable networks and overhanging sideways by minimum 40mm.

Where, more than one polymeric cable cover is required, then they shall overlap each other by minimum 50mm.

Refer to **Figure 6**: 'Typical Polymeric Cable Cover Laid over HV Cables'.

Figure 6 - Typical Polymeric Cable Cover Laid over HV Cables

9. Spare Conduit Provision

Tables 13 and **14** specify minimum numbers of conduits and spare conduits requirements.

When 3 or more circuits of HV large cables circuits (eg 300mm^2 3x1c or 630mm^2 3x1c) exist, the total number of spares required is reduced to maximum number of 6, however, the designer in consultation with the relevant SA Power Networks' Project Manager may specify the need for 'additional conduits' if there is a logical need ie. high road traffic or congested utilities within the ground location where future earthworks should be avoided.

The road crossing installation shall be fully conduited system with enough numbers of spares conduits that are specified in the design. The conduits and spare conduits requirements for the Adelaide CBD network and for retrospective undergrounding projects shall be in consultation with the relevant SA Power Networks' Project Manager.

9.1 Spare Conduits and Vault Arrangement

Unless otherwise specified, all spare conduits shall be capped between 1.5m to 2.0m in front of the Padmount Transformer and Switching Cubicle vault (ie spare conduits do not need to be entered through the vault and shall be project specific). Refer to **Figure 7**, for more details.

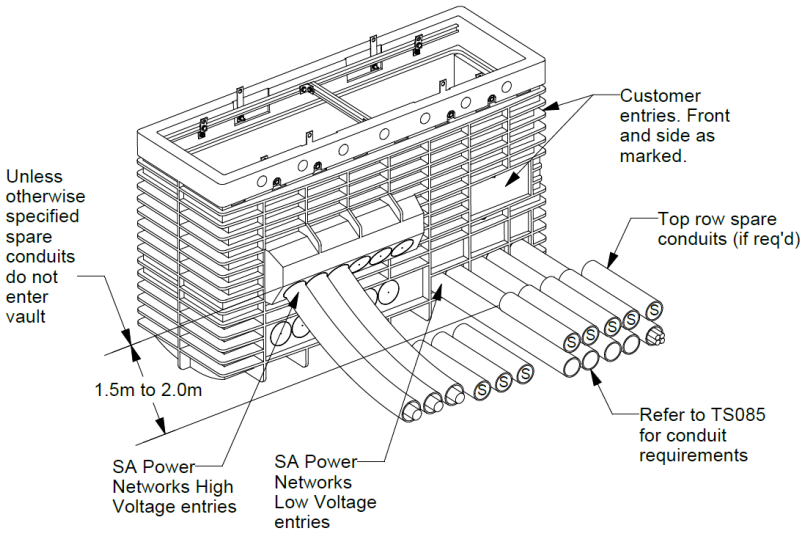


Figure 7: Spare Conduits and Vault Arrangement

9.2 Directly Buried Cables

Where cables are direct buried, the minimum spare conduits, shall be as per **Table 13**.

Table 13 - Spare Conduits for Cables 'Direct Buried'

Types of Direct Buried Cables	Spare Conduits			
	HV	LV	Spare SCADA/Comms	
			LV Supply to SCADA/ Comms (Orange)	SCADA/ Comms (White)
Small Individual Cable Circuits				
1 LV cable eg 4x240mm² LV AL XLPE/HDPE UBC or 4x150mm² LV AL XLPE/HDPE UBC	-	1	-	-
2 LV cables eg 2 Ckts of 4x240mm² LV AL XLPE/HDPE UBC or 2 Ckts of 4x150mm² LV AL XLPE/HDPE UBC	-	2	- -	-
1 LV Parallel cables eg 1 Ckt of 2x(4x240mm² LV AL XLPE/HDPE UBC) or 1 Ckt of 2x(4x150mm² LV AL XLPE/HDPE UBC)	-	1 (Note 3)	-	-
1 HV cable eg 95mm² 3x1c (bundled) or 185mm² 3c or 240mm² 3c + SCADA/Comms	1 (Note 1)	-	1 (Note 2)	1
Larger Individual Cable Circuits				
1 HV (Larger) cable eg 1 Ckt of 300mm² 3x1c or 1 Ckt of 630mm² 3x1c + SCADA/Comms	3 (Note 1)	-	1 (Note 2)	1
2 HV (Larger) cable eg 2 Ckts of 300mm² 3x1c or 2 Ckts of 630mm² 3x1c + SCADA/Comms	6 (Note 1)	-	1 (Note 2)	1
3 HV (Larger) cable eg 3 Ckts of 300mm² 3x1c or 3 Ckts of 630mm² 3x1c + SCADA/Comms	6 (Note 1)	-	1 (Note 2)	1
More than 3 HV (Larger) cable eg 4 Ckts of 300mm² 3x1c or 4 Ckts of 630mm² 3x1c + SCADA/Comms	6 (Note 1)	-	1 (Note 2)	1
Mixed Cable Circuits - Examples				
4 Mixed HV Circuits eg 1 Ckt of 95mm² 3x1c (bundled) + 3 Ckts of 300mm² 3x1c + SCADA/Comms	6 (Note 1)	-	1 (Note 2)	1
4 Mixed HV & 2 LV Mixed Circuits eg 1 Ckt of 95mm² 3x1c (bundled) + 3 Ckts of 300mm² 3x1c + 1 LV parallel Ckt {1 Ckt 2x(4x240mm² LV AL XLPE/HDPE UBC) or 1 Ckt 2x(4x150mm² LV AL XLPE/HDPE UBC)} + 1 LV Ckt (4x240mm² LV AL XLPE/HDPE UBC or 4x150mm² LV AL XLPE/HDPE UBC) + SCADA/Comms	6 (Note 1)	2 (Note 3)	1 (Notes 2)	1

Notes:

1. Install minimum 1 spare conduit per HV circuit and follow that HV cable circuit route. When 3 or more circuits of HV large cables circuits (eg 300mm² 3x1c or 630mm² 3x1c) exist, the total number of spares required is reduced to maximum number of 6, however, the designer in consultation with the relevant SA Power Networks' Project Manager may specify the need for 'additional conduits' if there is a logical need ie. high road traffic or congested utilities within the ground location where future earthworks should be avoided.
2. Where project specify that SCADA/Comms is NOT required, then LV conduit for supply to SCADA/Comms (Orange) and SCADA/Comms conduit (White) is not required to be installed.
3. Where LV parallel cables is installed as buried direct, provide 1 spare conduit following that LV parallel cable route. However, for each LV individual circuit, provide 1 spare conduit for each LV circuit and shall follow their individual cable route.

9.3 Fully Conduited System

Where cables are fully conduited, the minimum spare conduits, shall be as per **Table 14**.

Table 14 - Spare Conduits for Fully Conduited System

Types of Cables Installed in Conduits	Conduits Required		Spare Conduits			
					Spare SCADA/Comms	
	HV	LV	HV	LV	LV Supply to SCADA/Comms (Orange)	SCADA/ Comms (White)
Small Individual Cable Circuits						
1 LV cable eg 4x240mm² LV AL XLPE/HDPE UBC or 4x150mm² LV AL XLPE/HDPE UBC	-	1	-	1	-	-
2 LV cables eg 2 Ckts 4x240mm² LV AL XLPE/HDPE UBC or 2 Ckts 4x150mm² LV AL XLPE/HDPE UBC	-	2	-	2	-	-
1 LV parallel cables eg 1 Ckt 2x(4x240mm² LV AL XLPE/HDPE UBC) or 1 Ckt 2x(4x150mm² LV AL XLPE/HDPE UBC)	-	2	-	1 (Note 3)	-	-
1 HV cable eg 95mm² 3x1c (bundled) or 185mm² 3c or 240mm² 3c + SCADA/Comms	1	-	1 (Note 1)	-	1 (Note 2)	1
Larger Individual Cable Circuits						
1 HV (Larger) cable eg 1 Ckt of 300mm² 3x1c or 1 Ckt of 630mm² 3x1c + SCADA/Comms	3	-	3 (Note 1)	-	1 (Note 2)	1
2 HV (Larger) cable eg 2 Ckts of 300mm² 3x1c or 2 Ckts of 630mm² 3x1c + SCADA/Comms	6	-	6 (Note 1)	-	1 (Note 2)	1
3 HV (Larger) cable eg 3 Ckts of 300mm² 3x1c or 3 Ckts of 630mm² 3x1c + SCADA/Comms	9	-	6 (Note 1)	-	1 (Note 2)	1
More than 3 HV (Larger) cable eg 4 Ckts of 300mm² 3x1c or 4 Ckts of 630mm² 3x1c + SCADA/Comms	12	-	6 (Note 1)	-	1 (Note 2)	1
Mixed Cable Circuits - Examples						
4 Mixed HV Circuits eg 1 Ckt of 95mm² 3x1c (bundled) + 3 Ckts of 3x300mm² 3x1c + SCADA/Comms	10	-	6 (Note 1)	-	1 (Note 2)	1
4 Mixed HV & LV Mixed Circuits eg 1 Ckt of 95mm² 3x1c (bundled) + 3 Ckts of 300mm² 3x1c + 1 LV parallel Ckt {1 Ckt 2x(4x240mm² LV AL XLPE/HDPE UBC) or 1 Ckt 2x(4x150mm² LV AL XLPE/HDPE UBC)} + 1 LV Ckt (4x240mm² LV AL XLPE/HDPE UBC or 4x150mm² LV AL XLPE/HDPE UBC) + SCADA/Comms	10	3	6 (Note 1)	2 (Note 3)	1 (Note 2)	1

Notes:

1. Install minimum 1 spare conduit per HV circuit and follow that HV cable circuit route. When 3 or more circuits of HV large cables circuits (eg 300mm² 3x1c or 630mm² 3x1c) exist, the total number of spares required is reduced to maximum number of 6, however, the designer in consultation with the relevant SA Power Networks' Project Manager may specify the need for 'additional conduits' if there is a logical need ie. high road traffic or congested utilities within the ground location where future earthworks should be avoided.

2. Where project specify that SCADA/Comms is NOT required, then LV conduit for supply to SCADA/Comms (Orange) and SCADA/Comms conduit (White) is not required to be installed.
3. Where LV parallel cable is installed in 2 separate conduits, provide 1 spare conduit following that LV parallel cable route. However, for each LV individual circuit, provide 1 spare conduit for each LV circuit and shall follow their individual cable route.

10. Civil Works

10.1 General

Before commencing works, refer to NICC404: Working in the vicinity of SA Power Networks' Infrastructure - Network Access Permit Process.

Civil works shall ensure that the area around the equipment vaults and or footings are kept clean, tidy and have finished surfaces, which will assist the electrical works to be carried out in a safe environment.

All excavation sites which are required to be left open and or unattended (eg left unsupervised) over-night shall be effectively covered for public safety, eliminating potential hazard, theft control and or any accidental damage to SA Power Networks' asset. In some cases, site security personnel may also be required.

Any trench with a depth 1500mm and over, below the finished ground level, shall comply with the specific requirements stipulated in Work Health & Safety Regulations 2012.

For DPTI roads, trenching standards are different to this standards eg DPTI maintains 1000mm depth of cover as minimum. Refer to http://www.dpti.sa.gov.au/, for more details.

SA Power Networks will undertake audits to ensure that the work complies with the design and reserves the right not to accept any materials or workmanship that it deems substandard.

Any deviation from the design, will require approval from the relevant SA Power Networks' Project Manager.

Where the soil is identified from a site associated with 'Potentially Contaminating Activities' (PCA) such as a substation, petrol station or industrial facility, please refer to **Section 10.4** and **Appendix K**, for more details.

10.2 Trenching Requirements

The following are the minimum trenching requirements (but not limited to):

1. SA Power Networks' installation maintain 750mm minimum depth of cover to the top of conduits/spares conduits, and directly buried cables are installed below spares conduits at 1000mm minimum. For DPTI roads, maintain 1000mm minimum depth of cover. This is measured from the ground level to the top of conduits.
2. Public lighting cable in conduit that is to be vested to SA Power Networks can be installed with a cover of 600mm when installed as a 'one off' in a non URD location. Public lighting cable in conduit requires a min cover of 1000mm only when crossing a DPTI road. Refer to E1726 sheet 2.1 for more details.
3. Maintain a minimum separation of 25mm in all directions (or as otherwise specified) between conduits.
4. Maintain a minimum separation of 50mm between directly buried cables and the trench wall. Refer to **Figure 8**, for typical spacing requirements.
5. Refer to **Appendices C** to **J**, in this document, for various typical trench and conduits arrangements and refer to **Section 10.6.6** for Installation requirements.

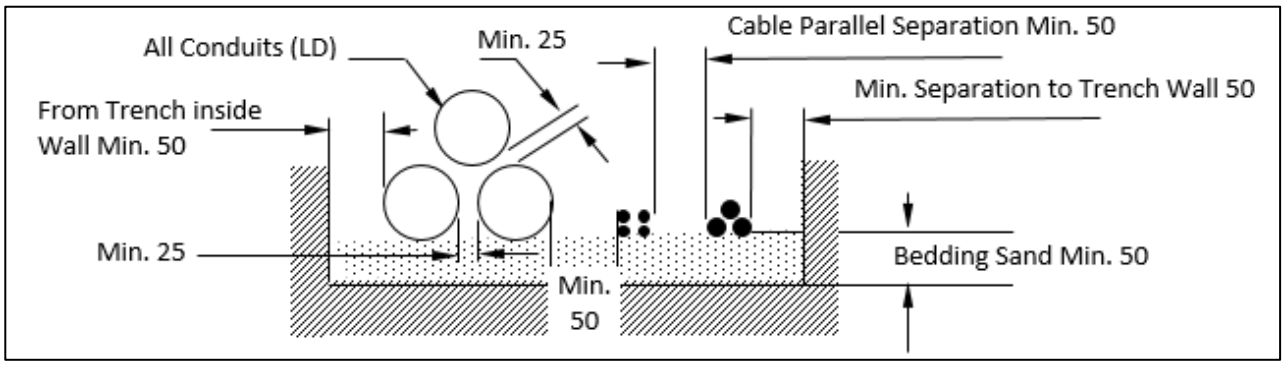


Figure 8: Typical Spacing in a Trench (not to scale), All Dimensions in 'mm'

10.2.1 Road Reserve and Road Crossing Trenching

For road reserves and road crossings, the following are the minimum trenching requirements (but not limited to):

1. The Road crossing trench alignment shall be at 90 degrees to the kerb. Any variation to this will require council approval. Find more details in **Figure 9**.
2. For fully conduited road crossing arrangement, all conduits and spare conduits, shall enter pits by 25mm minimum. Refer to **Figure 13**, E1921 series and **Appendix I**, for more details.

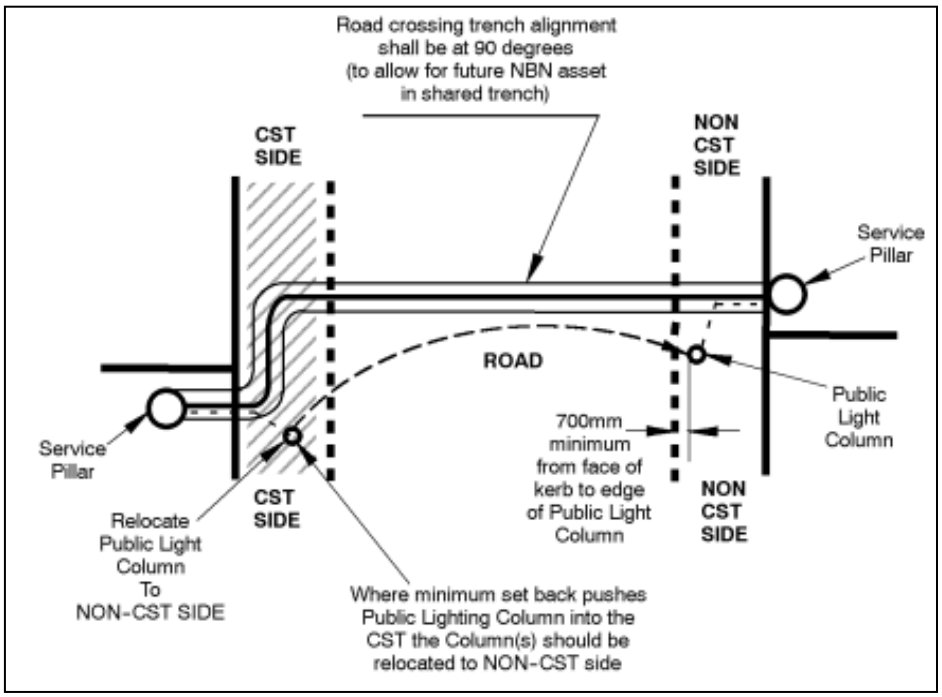


Figure 9: Typical Road Crossing Trench Alignment

10.2.2 Private Property

In a private property, except, where cables are direct buried, the installation of polymeric cover slab (RN0202) is not mandatory, unless otherwise specified. Refer to **Appendix F**, for more details.

10.2.3 Service / Junction Pit Arrangement

Further details can be found in the **Appendices**.

Service and junction arrangements are to meet the following requirements:

1. Where, the LV circuits are for 'Loop In/Loop Out', then the conduits and spare conduits shall be installed on the property side, for entering directly into the ends of pits. Refer to E1923 series, for more details.
2. Where the LV circuits by-passes the pits, then conduits and spare conduits for that circuits shall also by-pass the pits. The third parties' asset (eg Telstra, Optus etc.) including associated spares, shall by-pass SA Power Networks' pits. Refer to **Appendices C** and **D**, for more details.
3. Service and or Junction pits position within the trench may be adjusted for neat installation of conduits and spare conduits. Refer to E1921 series.

10.2.4 Reduced Depth of Cover Arrangement

In some instances, installing conduits at minimum depth of cover at 750mm is unachievable, due to various reasons, eg rocky area, heritage landmark, hard digging, unknown obstacles, conflict with third parties' authorities' assets and so on.

Refer to **Appendix J**, for reduced depth of cover arrangement and the requirements are as stated below:

1. Install surface marker discs (KS3722), at the start and finish at spacing of 30m (where practical) for the full length of the reduced depth of cover trench.
2. Display standard warning sign on the site stating, 'Contact SA Power Networks before trenching in this reduced depth of cover area'. Such information shall also be highlighted on the 'As Constructed' drawings.
3. The SA Power Networks' reduced depth of cover trench may or may not have enough space to accommodate all other services; therefore, other services may need to be installed in a separate trench alongside of the SA Power Networks' trench, for achieving enough clearances.
4. From finished ground level, gradual transition, from standard depth of cover (ie 750mm) to reduced depth of cover (ie 450mm), shall occur in minimum 3m length of transition route or greater.
5. 100mm thick, poured concrete strength at 28 days be minimum 20MPa (Reinforcement not required) installed 50mm minimum above spare conduits shall be extended to envelop the gradual transition area.
6. Marker tape (KS3765) installed above concrete shall also be extended to envelop the gradual transition area.
7. Use 100mm diameter conduits HD class 12.

10.2.5 Reinstatement of Trenches

Reinstatement of trenches in public roadways, footpaths and easement areas shall be in accordance with the requirements of the appropriate controlling authority or to the condition in which it existed, prior to the commencement of works.

10.2.6 Safe Edge Shovel

A shovel which has fiberglass long handle, special mouth and a safe edge (blunt nosed), to avoid damaging cables. These are also available from the SA Power Networks' Material Sales on (08) 8404 9632.

10.3 Trenchless Boring

For typical underground boring arrangement, refer to **Appendix H**. For more information on DPTI's trenchless boring requirements, visit their website.

The directional bore log details must be supplied for the entire length of the bore, for inclusion, on the 'As Constructed' design drawing. The bore log shall be neat and legible, presented in tabular form. Information provided shall comply with TS099: Distribution and Sub-Transmission CAD Drafting Standards.

For trenchless boring works, the following the minimum requirements (but not limited to):

1. The minimum depth of cover of a trenchless bore will be 1500mm. For multiple bores, a minimum spacing of 10D is required between bores, where D is the largest diameter of the conduit. Refer to **Figure 10**.
2. Multiple conduits are permitted to be installed through a single bore.
3. When installing more than one conduit in the bored hole and or the hole exceeds the outer diameter of the conduit by more than 25mm, then fill the resulting voids with a suitable slurry and or grouting, to prevent washout, subsidence and to maintain required cable ratings.
4. Maintain the conduits' configuration through the bore, so that their orientation, at the entry is same at the exit.
5. Install a polypropylene draw rope thru each conduit and or spare conduit, for cable pulling. For more details, refer to **Section 8.12**.
6. Slurry (such as bluey) shall be pumped in until it fills the bore and overflows out at both ends of the bore. The slurry shall have a low TR Rating (ie minimum of TR ≤ 0.9 ^{o}Km/W to improve on the overall cable rating).
7. A pilot conduit of at least 63mm OD to be attached to the bore pipe for pumping slurry. This pilot conduit shall extend to the deepest point of the bore.
8. The electrofusion jointing of HDPE pipes and fittings procedure shall comply with ISO 21307: 2011 and meet the manufacturer's recommendations. For more information, visit PIPA website at www.pipa.com.au.
9. To hold the conduits thru bore, at suitable intervals, use Polypropylene (PP) straps as stated in **Section 8.13**. Metal strapping is not permitted.

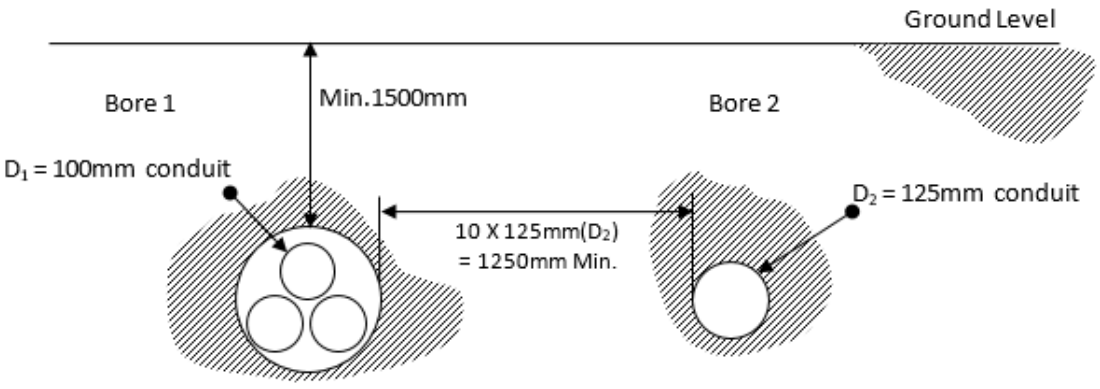


Figure 10: Specific DPTI Requirements for Trenchless Boring

10.4 Hydro Vacuum Excavation

The soil extracted using the hydro vacuum excavation process can be contaminated. If the soil extracted is from a 'Potentially Contaminated Activities' (PCA) site, then it shall be flagged by the licensed transporter (ie the hydrovac contractor) and included in the waste transport certificate and other documentation, that accompanies the liquid waste. This documentation will be provided at the gate of the EPA licensed receiving facility and a copy shall be submitted to the relevant SA Power Networks' Project Manager. For more information, refer to **Appendix K**.

At higher water excavator pressures, there is a possibility of damaging SA Power Networks' cables (eg Paper Lead, Paper Insulated Lead Covered and Fibre-Optic).

To avoid damage to SA Power Networks' cables and conduits, the following are the minimum requirements for hydro vacuum excavation works:

1. The hydro vacuum excavation jet nozzle shall be maintained at 100mm minimum clearance above the ground surface;
2. The working water excavator pressure shall not exceed 2000 psi (ie 13,790 kilopascals);
3. Networks Access Permit is required, refer to NICC404 for detailed requirements.

10.5 Retaining Wall

Any cut or fill greater than 300mm, in the area up to 2m, from SA Power Networks' electrical infrastructure (eg padmount transformer, switching cubicle, service pit, pillar and lighting column) easement boundary, will require a retaining wall.

Where the retaining wall is placed beyond the standard easement, the easement shall be extended to include the area occupied by the retaining wall, ie retaining wall width + standard easement = full easement. Refer to TS100 and TS102 for more details.

For any filled retaining wall, there shall be maximum buffer zone width up to 1m. The total easement shall be extended to include this buffer zone.

The buffer zone is equal to height of retaining wall up to 1m, eg for a 500mm retaining wall, the easement shall be increased by 500mm, for a 1m retaining wall, the easement shall be increased by 1m.

Where the retaining wall are more than 1m, the easement shall be increased up to maximum 1m only, and will require:

1. design verification from a certified structural/civil engineer;
2. engineering calculations; and
3. council's approval, if the manufacturer's specification cannot be verified.

SA Power Networks reserves the rights to refuse energisation, where on inspection, non-compliance is identified, for example:

1. Does not meet specific requirements stipulated in TS100 and TS102 documents.
2. The retaining wall is specified on the design drawing, but not built.
3. For vertical block type retaining wall, a suitable foundation is missing.
4. The site area around the retaining wall and equipment is not properly compacted.

10.6 Conduit Installation

The conduit installation details will be provided in the design drawings. The conduit installation works shall be carried out with the best industry practice. For more information, visit PIPA website at www.pipa.com.au.

Precautions shall be taken to ensure that, all conduit installation works, including conduit ends, joints and alignment etc, does not damage or cause excessive tension on the cables, during cable installation works.

The following are the general requirements:

1. The conduits, couplings and accessories shall be installed as per the manufacturer's instructions.
2. Ensure clearances are maintained all around the conduits. Use of conduit spacers are not mandatory but recommended.
3. Closed metallic loops must not be introduced around power cable conduits, using items such as metallic ducts, metallic strapping, external steelwork or any ferromagnetic material or structures, to avoid current being induced in such materials.
4. All bends shall be pre-formed by the conduit manufacturer prior to arriving at the work site. Conduit bends shall not be made by bending straight conduit sections.
5. All conduits shall be fitted with a draw rope and sealed against the ingress of water and any foreign material.
6. Unused conduit shall be sealed using an appropriately sized conduit end cap.
7. Refer to **Appendices C** to **J**, for conduit spacings and arrangements.
8. Refer to **Sections 10.7, 10.8** and **10.9**, for more details.

10.6.1 Conduit Storage

Degraded conduits are not accepted by SA Power Networks and reserves the right to inspect conduit storage facilities and conduits quality, prior to their installation.

SA Power Networks may request for alternative storage arrangements, where deemed necessary, to minimise damage to stored conduits, due to prolonged exposure to sunlight, heat entrapment, poor ventilation and or inferior storage conditions (eg conduits covered under black sheeting, over stacking, contaminated area etc).

10.6.2 Conduit Preparation

The following are the requirements for conduits preparation, prior to their installation:

1. Do not install under any circumstances, any conduit with a kink in its length, if damaged conduits are identified, then it shall be rectified by the installer.
2. All conduits shall be internally clean, free of debris and free of rough edges.
3. Where conduits are required to be cut, they shall be cleanly 'cut square and true' using a rotational pipe cutter, the use of hand saws is not permitted.
4. The internal edge of bore tube shall be smooth, chamfered in the direction of cable pull and deburred (ie sharp edges removed).
5. All bore tube joints shall be internally 'de-beaded'.

10.6.3 Proving of Conduits

Prior to backfilling of the trench, and before installing any cable into a conduit, the conduit's integrity and suitability shall be inspected. Conduit (including spares) proving. This work shall comply with the following:

1. Three stage proving process:
   (a) First all conduits shall first be thoroughly cleaned using a scraper and a cylindrical brush.
   (b) Second an approved solid mandrel of diameter 12mm less than the internal diameter of the conduit and 230mm in length shall be pulled through every conduit.
   (c) Third a suitably sized foam pig supplied by TDW or similar approved shall be pulled through every conduit.
2. Jamming of the mandrel and/or visible damage to the pig shall be investigated by the Contractor and any necessary rectification work required shall be at their expense.
3. SA Power Networks reserves the right to request:
   (a) That a waste length of cable to be installed be passed through the conduits and/or video cameras be used to inspect the conduits where reasonable concern exists.
   (b) That a mandrel of diameter equal to Dc and length L per the following formula:

   $L = 2 \times R_b \times \sin(a/2)$ and $a = 2 \times \cos^{-1}[(R_b - Di + Dc)/R_b]$

   where, L = mandrel length; R_b = minimum bend radius; Di = ID of bore pipe and Dc = diameter of cable

10.6.4 Conduit/Cable Sealing Works for Vermin Control

To protect the SA Power Networks' infrastructure from the impact of vermin, all conduit/cable sealing works, where vermin threat is identified, should comply with the requirements specified in TS303 'Vermin Control', which recommends use of 'FILOseal' product (Stock Item JA7005). Refer to **Figure 11** for use of 'FILOseal'.

Figure 11: An Example for use of 'FILOseal' Product

10.6.5 Changes in Ground Levels and Directional Changes

Where the rate of change of ground levels (gradient rise and or fall, 100mm per 1m), then it is important to establish appropriate ground levels at the time of the installation, to ensure that there are no requirements to alter ground levels, after installation.

Refer to **Figure 12** that indicates incorrect and preferred' installation of conduit, where conduit route needs directional changes and note the inappropriate conduit coupling position, where excessive tension is applied to both the coupling and a straight length of conduit.

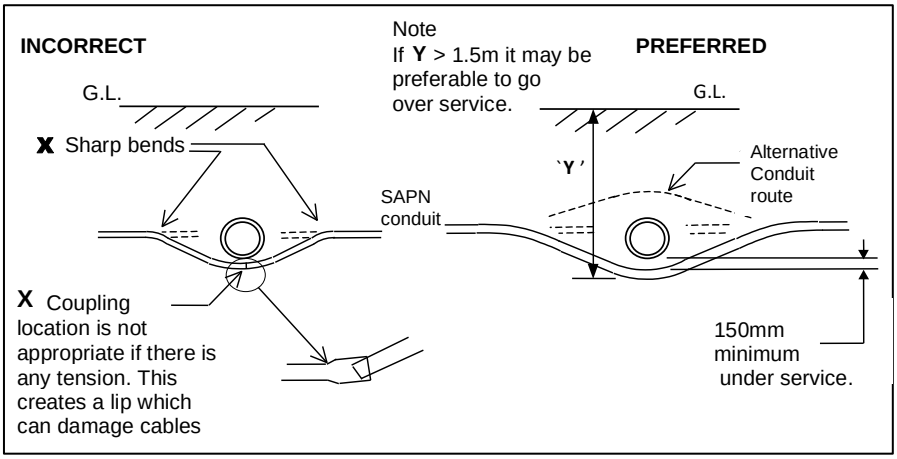


Figure 12: Preferred Option where Conduit Route needs Directional Changes

10.6.6 Installation Requirements

When installing conduits, refer to the conduit arrangements specified in **Appendices** and ensure that the following requirements are met:

1. Install conduits as stated in **Section 10.6**.
2. Maintain spacings as stated **Appendices C** to **J**.
3. Allow minimum of one hour between conduit gluing and the installation a draw rope. The gluing of conduits should be carried out to the manufacturer's recommendations.
4. Conduits between new and existing subdivisions shall be joined together.
5. Where bore tubes are to be butt welded, then the internal surfaces shall be chamfered to reduce the size of internal weld bead.
6. At pole locations, any over to underground conduit at the point of burial shall be installed as stated in **Appendix B**.
7. Cable location markers shall be installed as stated in **Appendix A**.
8. Install spare conduits as stated in **Section 9**.
9. If private conduits of 2 or less, for consumers is required, then they shall be installed as stated in E drawing 1921 series and maintain the alignment and or orientation of junction and or service pit.
10. When the private conduits of 3 to maximum 4 for consumers are required, the location of junction and or service pit is adjusted to avoid interference to driveways, sewer connection points and water meter line. Consumers' services can be installed from any side of junction and or service pits.

11. There are various other factors that shall also be considered during installation works, for examples: Conduit proving, Site safety, Waste soil disposals, Bushfires protection methodology, JSWPs, Induced voltages etc.
12. Ensure that all 'As Constructed' site installation information, is forwarded to the designer and the relevant SA Power Networks' Project Manager, for updating design drawings. Refer to TS099: Distribution and Sub-Transmission CAD Drafting Standards, for details.
13. For open trenches, install only straight lengths of conduits and avoid installing coiled flexible conduits, unless specified. For trenchless boring, coiled flexible conduits are acceptable.

10.6.7 Cable and Conduit Entry into - Service Pillar

The following are the conduit cable entry requirements for service pillar:

1. The bend needed is NC5741 which has a 900mm radius and, while it may require some trimming when joined together, will achieve an entry with a trench at the normal invert.
2. A 1800mm bend, which can still to be utilised for any directional change where there is room, (ie at corners).
3. Details of the arrangements for a conduit entry into a service pillar are stated in E1923 E-drawings series and refer to **Figure 13**.

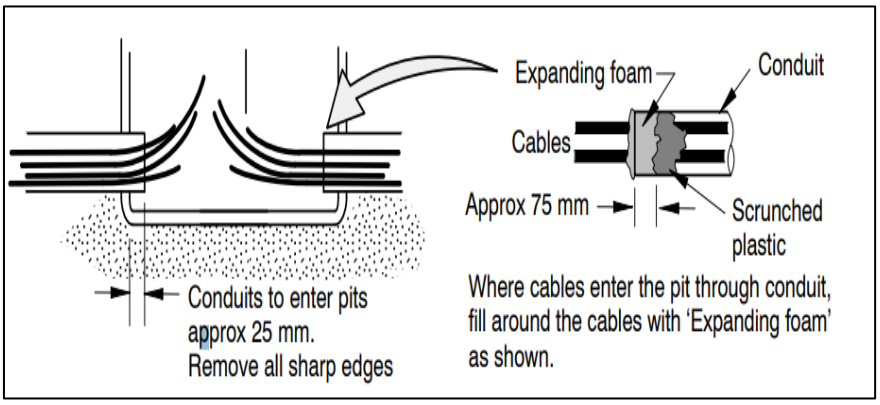


Figure 13: Typical Conduit Cable Entry into Service Pillar

10.6.8 Cable and Conduit Entry into - Service/Junction Pit

The following are the conduit cable entry requirements for Service/Junction Pit:

1. Conduits shall enter 25mm (approx.) from inside wall of pit and all sharp edges shall be chamfered. Refer to E1921 E-drawings series and **Figure 13**.
2. The bottom of conduit shall be between 25mm to 50mm (maxi.) above the inside bottom of the pit.
3. Where cables enter the pit through conduit, fill 75mm (approx.) around the cables inside conduit with non-flammable expanding foam or use appropriate mechanical seals.
4. Cap all conduit entries, to stop the entry of foreign material between the time of the conduit installation and the installation of cables.

5. Non-flammable expanding foam or silicon should be utilised as a sealer around (outside) the conduit entry point into the wall of a service/junction pit, to achieve the conduit tight fit.

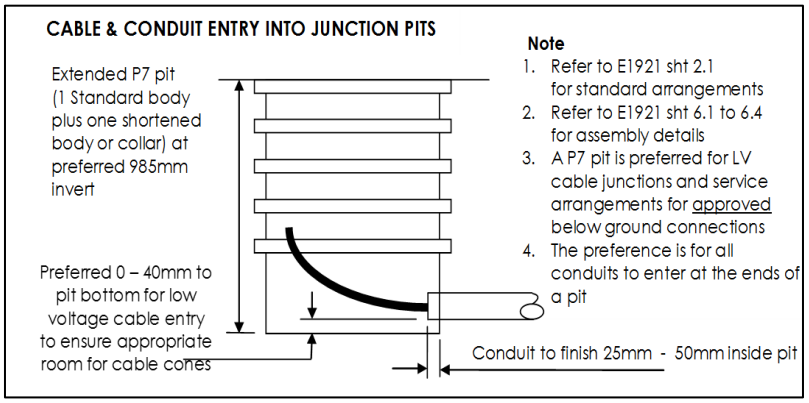


Figure 13: Typical Cable and Conduit Entry into Junction Pits

10.6.9 Typical Over to Under Conduit Entry into Ground

Refer to **Appendix B** for the requirements of conduit entering ground near the pole footing.

10.7 Bedding Sand Specification

The purpose of bedding sand is to protect and identify the underground asset. The sand delivered onsite will be regularly checked and SA Power Networks shall not compromise on bedding sand specifications. If installer is unsure, they shall verify with the sand supplier, prior to using sand.

SA Power Networks reserves rights to ask for bedding sand test compliance certificate, to ensure that the following requirements for standard bedding sand are met:

1. It shall be free of silt, rocks, clay lumps, tree roots, building rubble, metal, glass, sharp objects, organic solvents, slag, harmful substances and or any other deleterious material which has potential to damage cables. Also note that the recycled crushed glass products are not approved as bedding sand.
2. It shall comply with the specification stated in **Table 15**.
3. It shall be layered below and above the cable and conduits to the depths, as indicated in the design drawings. For more details, refer to **Appendices C** to **J**, E-drawings series (E1920 - E1930) and (E1978 - E1985).

Table 15 - Bedding Sand Specification - Permitted Test Values

Test Method	Test	Permitted Test Values
AS 1141.11.1	**Grading Sieve Sizes (mm) AS 1152**	**% Percent Passing**
	4.75	100
	2.36	98 - 100
	1.18	94 - 100
	0.6	85 - 100
	0.425	55 - 100
	0.3	25 -100
	0.15	5 - 40
	0.075	0 - 10
AS 1289.3.3.1	Plasticity Index	(Non – Plastic)

10.8 Backfilling and Consolidation

The following are the backfilling and consolidation requirements:

1. Open trenches shall be backfilled, as soon as practicable, after cable and or conduit laying and or jointing works is completed. If any excavation works cannot be backfilled at the end of the working day, then security provisions shall be required, to protect from vandals and for public safety.
2. Before backfilling any excavation, surplus-jointing materials, any waste materials, all rubbish including timber, foreign material, free water and slurry shall be removed from the trench.
3. Backfill material shall not be placed in any excavation containing free water or slurry and not permitted to be used (or mixed) as bedding sand, around the SA Power Networks' asset.
4. The excavation shall be clean and completely free from all fibrous and vegetable matter and other material, which may attract termites.
5. For a public road that is not under the control of DPTI the authorisation to excavate, backfill and any other specific requirements will be sourced from the relevant council.
6. As a part of compliance requirements, SA Power Networks will require a copy of the approval from the relevant council and or DPTI including details of works.
7. For DPTI and local council roads, the backfilling and compaction shall comply to their specific requirements, however, if no compaction specification found, then as a minimum, comply with the SA Power Networks' requirements, as stated in **Sections 10.8** and **10.9**.
8. SA Power Networks reserves the right to request for backfilling and compaction test compliance certificate.

10.9 Backfilling Compaction

1. Backfilling shall be uniformly compacted in horizontal layers not exceeding 150mm (loose) thickness.
2. Backfilling compaction (over the bedding sand layer) shall not be less than 95% Maximum Dry Density (M.D.D) standard (avoiding any damage to the SA Power Networks' asset) to provide a cohesive uniform layer.
3. If available, then the local council and or DPTI's backfilling compaction specifications are also acceptable.
4. Compaction shall be tested at random depths every 50m or less and a minimum of three compaction tests per trench.

10.10 Civil Works Forms

The TS105A (Forms) series assists in verifying all project works are completed to the standards.

As stated in TS105 Part B 'Index of Forms', the relevant forms shall be completed and submitted to SA Power Networks' representative.

10.10.1 Notification Form

The civil works notification form TS105 C-1 'SA Power Networks' Civil Infrastructure Works Notification Form' is the component of SA Power Networks' asset inspection and vesting process. The civil contractor shall complete and submit form TS105 C-1 to SA Power Networks' representative at least 10 business days prior to commencement of any civil works.

Civil works shall not proceed until the responsible civil contractor have received acknowledgement of receipt and approval of this form from SA Power Networks' representative.

10.10.2 Compliance Form

On completion of civil works, the civil contractor shall complete and submit the form TS105 C-2 'SA Power Networks' Civil Infrastructure Works Compliance Form' to SA Power Networks' representative.

If the civil contractor delays or does not submit these completed forms, then this may result in delays electrical and connection works.

11. Electrical Works

11.1 General Requirements

The following are the general requirements (but not limited to) for electrical works:

1. On request, submit all necessary documentation including instrumentation calibration certificates, used for installation and or testing of the cables, to the relevant SA Power Networks' Project Manager.
2. Prior to the installation of any cable, inspect the civil works, to ensure that the cable installation works can be carried out safely.
3. Examine the cables' integrity prior to their installation (eg identify any cable damage, discolouring, moisture etc). Perform all tests (eg Insulation resistance testing) required to ensure the integrity of the cable installation.
4. Install the cable as per the design, ensure that the cable installation does not damage or exceed the pulling limitations of the cable.
5. Comply with all relevant requirements specified in this standard, design drawings, the SA Power Networks' specifications and the manufacturers' applicable instructions.
6. Develop SWMS for the tasks to be performed and ensure that the overall security and safety of the work area is achievable.
7. Manage the overall program of works during the cable installation phase, including any third-party contractors (eg Jointers and or Terminators) required to complete the works.
8. Where it states on design drawings that 'Network Access Permit (NAP)' will be required, make prior arrangement as stated in NICC404: Working in the Vicinity of SA Power Networks' Infrastructure - Network Access Permit Process.
9. The SA Power Networks' infrastructure shall be treated as live, unless otherwise proven 'Dead' (ie not energised).
10. Ensure that cable pulling and or installation process is very slow, steady and shall be as per 'Cable Pull Tension Chart' as stated on design drawings. Refer to TS100: Electrical Design Standards for Underground Distribution Cable Networks (up to and including 33kV) for more information. Where such 'Chart' is not available, contact Designer and the relevant SA Power Networks' Project Manager immediately. In any case, over tensioning on cables is not permitted.
11. When working on cables near other energised cables, ensure to avoid the possibility of any personnel being exposed to danger from the induced cable sheath voltages which may arise from abnormal system operation.

12. Enough quantity of Polywater® Lubricant 'J' (OC8051) and Polywater® Lubricant Pump with conduit adaptors (OC8052) or equivalent, shall be used for the easy operation of cable pulling. The cable pulling operations without enough lubrication (ie dry run) is not acceptable.
13. In all cases, do not connect and energise installed cables and or equipment to the SA Power Networks' live infrastructure without receipt of 'Authority to Proceed (ATP) - Connection and Energise' from the relevant SA Power Networks' Project Manager. All cables which are either capped and or terminated shall also not be energised.
14. Install proper visible cable destination labels with phase identification on all cable phases.
15. Submit accurate onsite cable installation information to the designer and the relevant SA Power Networks' Project Manager, within Six (6) weeks of completion of the cable installation.

11.2 Cable Cutting and Sealing Works

All cable cutting and sealing processes shall be in accordance with the manufacturer's instructions including maintaining personal safety, safe operating procedures and shall be conducted only by suitably qualified cable installers. Copies of the cable installer's qualifications and or training may be requested by SA Power Networks.

All cable ends whether located in the trench or on the cable drum are to be suitably sealed as soon as practical after the cable has been cut.

Cables shall not be cut using saws or other such hand tools which may result in metal filings contaminating the insulation layers of the cable. Only approved methods for cutting cables shall be employed.

11.3 Lube Injection Points (LIPs) and Pulling Pits

Install the LIPs and pulling pits, as indicated on the design drawings and consider any other project specifications. Notionally, LIPs and or pulling pits may be required before bends and over long lengths, where heavy cable hauling is expected.

The lubricant used shall be fit for purpose, eg Polywater® Lubricant 'J' (OC8051) and Polywater® Lubricant Pump with conduit adaptors (OC8052) or equivalent, and care shall be taken to ensure that no spillage or site contamination occurs, because of its use.

Copies of Material Safety Data Sheets (MSDS) shall be provided to SA Power Networks for any proposed lubricant as alternative, prior to its use. Copies of the MSDS shall be available on-site during cable pulling.

Lube injection points are needed for long pulls with multiple bends, however, in some situations, lube Injection point are not possible, then 'Front End Lubrication' method is the best alternative.

11.4 Locking Facilities

Padmount transformers and switching cubicles are equipped with locking facilities.

Doors shall be locked when the equipment is not being worked on.

Where the Certificate of Practical Completion has been issued by SA Power Networks, we will return all padlocks.

11.5 Labels on Cable Circuits

At the padmount transformers and switching cubicles, labels are required on all HV and LV cable ends to indicate circuit names and or destinations. This is a mandatory requirement.

Labels shall be durable, permanent and weatherproof.

The labels should be checked to determine whether they are in the correct position and all cable ends are correctly designated.

Refer to TS100: section titled - Cable Destination and Numbering System, for more details.

11.6 HV Fusing

Certain transformers and switching cubicles require high voltage fusing.

Where HV fuses are required, they shall be provided by SA Power Networks.

Fuses will be installed by SA Power Networks at commissioning. Fuses shall be safely stored within the transformer or switching cubicle.

Refer to TS100: section titled - Fusing Requirements, for more details.

11.7 Access Permits and Connection to Existing Equipment

Where cables are required to be terminated in the existing SA Power Networks' equipment (eg transformers, switching cubicles and on poles), SA Power Networks will be responsible for all connection works including de-energising and isolation of all relevant points of the feed.

Where it states on design drawings that 'Network Access Permit (NAP)' will be required, make prior arrangement to obtain all access permits for the project. Before commencing works, please refer to NICC404, for the specific requirements.

11.8 Cable Installation

The following are the cable installation requirements (but not limited to) for electrical works:

1. Do not install 11kV (HV) cables in the same conduit as low voltage (LV) cables.
2. In all cases, avoid walking or standing over the cables, as this may cut and damage the cables.
3. Prior to cable installation works, inspect the civil works, ie check that suitable 'bell mouths' are available at the cable entry ends of conduits to prevent soil ingress.
4. Check the cable for cleanliness, integrity and defects. The dirty and defective cable shall not be installed until all affected cable is dealt appropriately.
5. Cable drums shall not be transported in any other position than vertical. The cable ends on cable drums shall be effectively sealed and apparent. The cable drum operations shall be carried out in a safe environment using appropriate Job Safe Work Procedures (JSWPs) and in accordance to relevant E-drawings E1900 to E1910 series.
6. Where cables are to be installed in conduits, care shall be taken that stones or other injurious particles are not drawn into conduits by the cables either by adherence to surface of the cable or by the motion of the cable to the conduit entry.
7. If any part of the works is sealed in an enclosure, covered up or buried prior to being inspected, the SA Power Networks' compliance coordinator can request that the works be uncovered to enable inspection and testing to be undertaken. This requirement is specified in the terms and conditions document.

8. On completion of all the electrical works, installed equipment and or components are capped and or terminated and, in any case, shall not be energised and or connected at the live source point, without 'Authority to Proceed (ATP) - Connect and Energise' received from the relevant SA Power Networks' Project Manager.
9. Installation details and techniques for cable pulling through conduits are also stated in E drawing E1906.
10. The cable pulling, and pipe jacking works shall be as per SA Power Networks' approved methodology and as per specified on the design drawings. The relevant SA Power Networks' Project Manager shall be notified a minimum of four (4) weeks before commencing such works.
11. For a long cable pull, where there are number of corners and or slopes, be vigilant and apply the appropriate cable pulling tension and ensure that enough lubrication injection points are made available.
12. In addition to monitoring equipment, the cable pulling plant shall use tension limiting devices that physically prevent tensions being applied which are more than the cable's maximum pulling tension for the cables being installed.
13. Refer to the SA Power Networks' E-Drawing E 1906 series for 'Cable Installation Guidelines'.

11.8.1 Cable Jointing and Future Connection

All cable jointing and termination works shall comply with appropriate JSWPs. Refer to TS100: section titled - 'LV Capped Cable Pillar - For Future Connection' and E-drawing E1926 for more details.

Cables shall be examined for signs of moisture on conductors or discolouring of copper screen wires etc. If moisture contamination is discovered, the affected cable shall be removed, and new cable shall be installed. A report shall be submitted to the relevant SA Power Networks' Project Manager prior to joining.

Network access permit (NAP) requirements are stipulated in NICC404. NAP shall be arranged prior to de-energising the cable for creating open point at last energised pillar.

Ensure that when joining future cables, pillar is to be removed and joints made in common trench.

11.8.2 Typical Securing LV Cables

Customer's mains terminated in padmount transformers shall be secured. Support rails etc. will be supplied by SA Power Networks. All cable vaults are pre-assembled with a centre cross member.

Customer to supply cable clamps (Unistrut P2024 series or equivalent) and shall ensure the clamps do not allow a continuous magnetic loop around the cable by using a brass screw, nut and spacer washer.

Refer to **Figure 14** for more details.

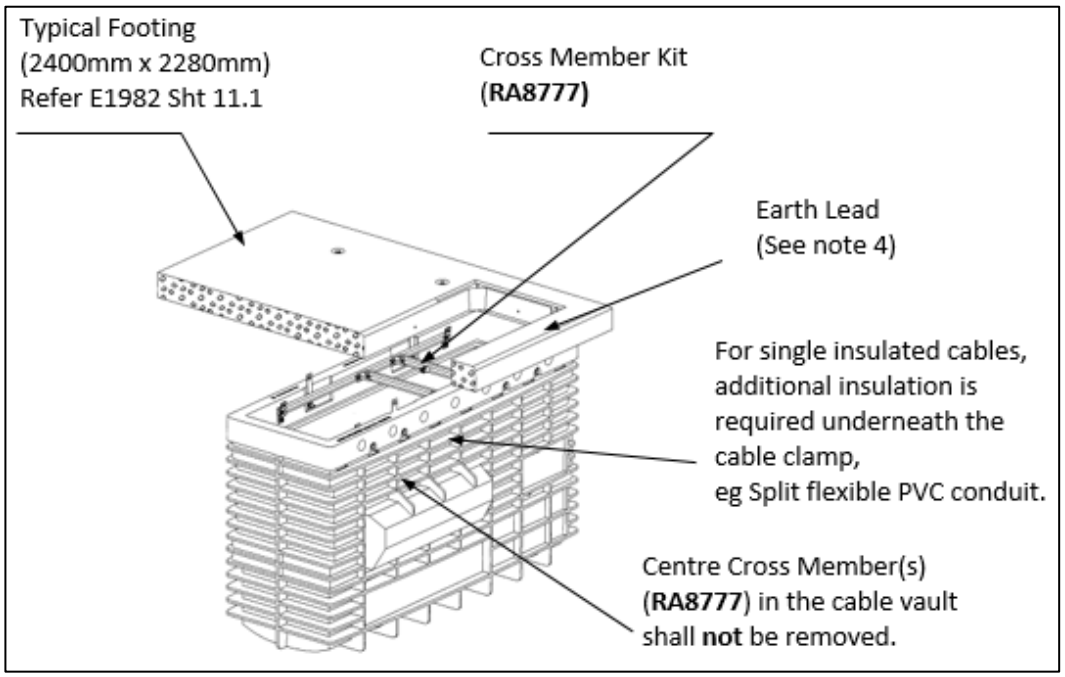


Figure 14: Typical Securing LV Cables

Notes:

1. Where more than one cross member kit is used for securing cables, one steel angle bracket and one copper angle bracket (as supplied in the kit) shall be used to avoid magnetic loops around single core cables.
2. Channels, brackets, spring nuts and setscrews are Unistrut components or equivalent.
3. In CMEN areas bond framework to transformer LV earth bar using earth lead and in MEN areas bond framework to transformer case using an earth lead.
4. Regarding Network Access Permit, sealing of conduits and other standard footing specific requirements, refer to TS100, section titled – Standard Footing.

11.8.3 Cable Traceability

All LV and HV cables information, shall be recorded on 'TS105 F-44' form and be included with other information, before SA Power Networks accepts the certificate of practical completion.

11.8.4 Cable Testing

Cable testing shall be in accordance with the TS105: Testing Standard for Underground and Overhead Networks.

11.8.5 Cable Phasing Identification and Colour Coding

Underground LV and HV cables shall be marked at each end with coloured PVC tape for phase identification as per the following **Table 16.**

Table 16
Cable Phase Identification and Coloring

Voltages	Cable Phase Identification (Colour Coding) ie Phase (Colour of PVC Tape)			
230V/400V	R (Red)	W (White)	B (Blue)	N (Neutral) (Do not disconnect tape)
7.6kV	A (Red)	B (White)	C (Blue)	--
11kV	G (Red)	H (White)	J (Blue)	See Note
33kV	1 (Red)	2 (White)	3 (Blue)	--

Note: HV 95mm^2 3x1c (bundled) cables are marked with numbers for phase identification, such as 1 = Red, 2 = White and 3 = Blue.

11.8.6 Public Street Lighting

Public street lighting installation works shall be in accordance with TS101: Public Lighting – Design and Installation and NICC402: Public Lighting – Ownership & Approval Process.

11.8.7 Earthing

The top of the earth rod shall be a minimum of 300mm below ground level in built up areas, and 450mm below ground level in rural areas, refer to E1011 for more details. For cable pits and pillars, refer to E1905 for more details. Earthing installation works shall be in accordance with TS109: Earthing of the Distribution Network.

11.8.8 Drawings Issuing Process

Drawings issuing process shall be in accordance with TS099: Distribution and Sub-Transmission CAD Drafting Standards.

11.9 Electrical Works Forms

The TS105A (Forms) series assists in verifying all project works are completed to the standards.

As stated in TS105 Part B 'Index of Forms', the relevant electrical works construction forms shall be completed and submitted to SA Power Networks' representative.

11.9.1 Notification Form

The electrical contractor shall complete and submit form TS105 F-1 'Authority to Proceed Request (ATP)' and TS105 F-2 'Documentation - Check List' to SA Power Networks' representative at least 10 business days prior to commencement of any electrical works.

Electrical works shall not proceed until the responsible electrical contractor have received acknowledgement of receipt and approval of these forms from SA Power Networks' representative.

11.9.2 Compliance Form

For all projects with the electrical installation component, the form TS105 F-3 'SA Power Networks' Electrical Infrastructure Works Compliance Form', or TS105 F-4 'SA Power Networks' Partial Electrical Infrastructure Works Compliance Form' shall be completed and submitted to SA Power Networks' representative .

If the electrical contractor delays or does not submit these completed forms, then this may result in delays with energisation works.

12. Who should you talk to?

For all General Enquiries:

In the first instance, please contact Builders and Electrical Contractors Service on 1300 650 014 (8am to 5pm, Mon to Fri) or Email: appointments@sapowernetworks.com.au

Dial Before You Dig Enquiries:

Call '1100' during business hours, and / or visit their internet website at www.1100.com.au

Customer Connections Information and Customer Solutions Managers:

SA Power Networks' Customer Connections Information and Customer Solutions Managers contact details are available on internet, click here: https://www.sapowernetworks.com.au/public/download/?id=221664

For Documentation Access or For Approval of Non-Standard Special Purpose E Drawings:

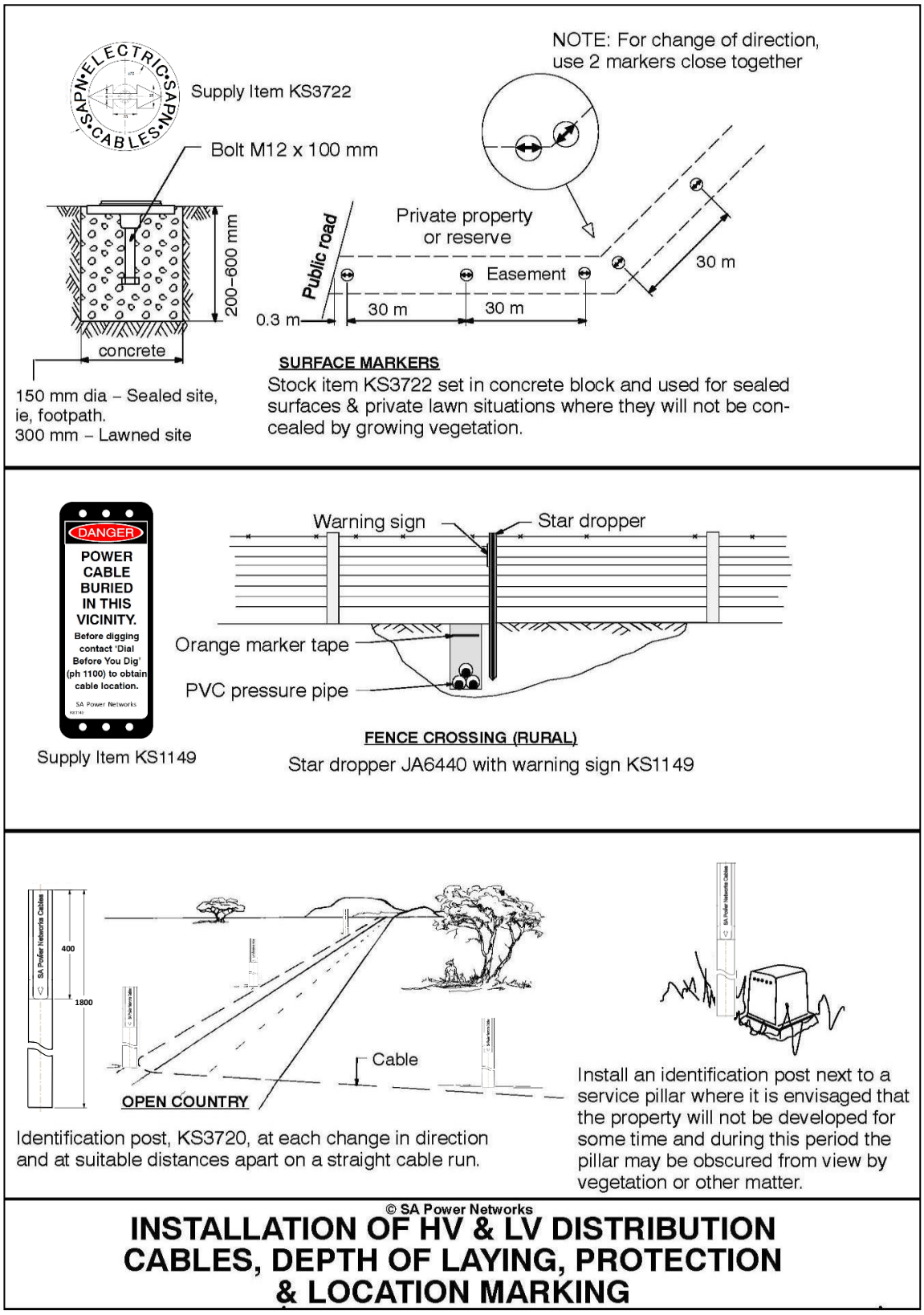
For E-Drawings, Non-Standard Special Purpose E Drawings (E SP), AutoCAD standard templates and Instructional manuals, please contact 'Standards and Equipment Team' via Hotline on (08) 8404 4200 or send an email to: networkstandards@sapowernetworks.com.au.

For 'Service & Installation Rules':

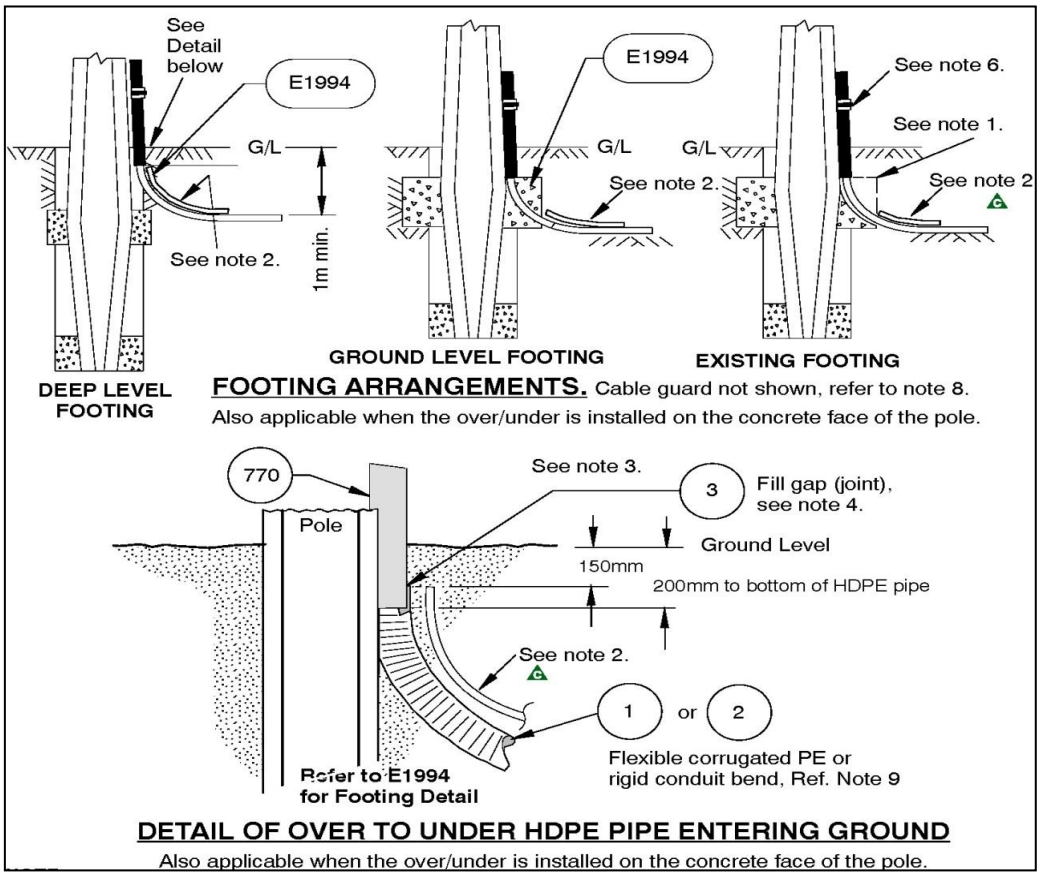
If your question relates to our 'Service & Installation Rules', you should contact our Network Connections Manager on (08) 8404 4898 or send an email to: appointments@sapowernetworks.com.au

Appendices

A Cable Location Marking Drawings



B Over to Under Pipe Entering Detail - Typical

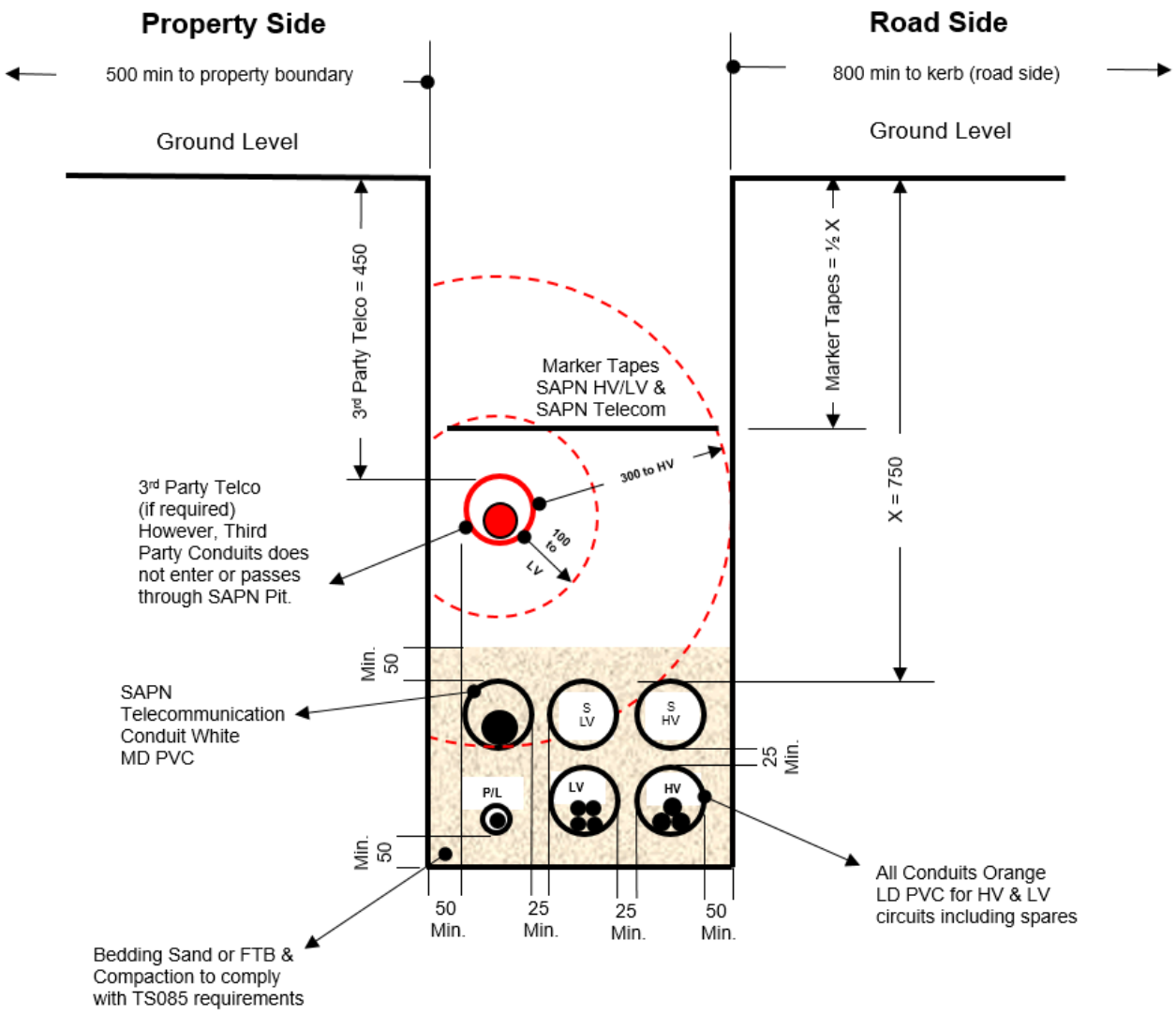


Notes:

1. Where existing pole and footing is used, it will be necessary to break out the footing. The criteria of non-traffic side of pole and opposite side to strain direction as to not compromise the integrity of the footing. After the cable has been installed, reinstate the footing.
2. If the cable is not mechanically protected by the concrete footing to a depth of 1m, use polymeric cover slabs (supply item no. RN0202, 15m roll).
3. Measurements are the same whether flexible corrugated conduit or rigid conduit bend is used. Internal sharp edges at the bottom of the pipe shall be removed to prevent cutting of cable insulation.
4. After installing HDPE pipe into conduit and conduct sealing work - Vermin Control as stated in TS303.
5. Spray paint strap and buckle with black paint (supply item no. JB 2905) after installation.
6. Normal maximum spacing of straps, 1m nominal ± 200mm.
7. Pipe may be mounted on pole face or pole edge, but preferable on the face away from the traffic flow.
8. Cable guards are required only in bushfire risk areas and where flammable material is at the pole base. Refer to E1993 series for installation details. Cable guards to be bonded to the pole in accordance with E1009.
9. Cable warning labels (supply item no. KS1149) are mandatory at all Over/Under arrangements, and Extracts from E-Drawings E1996 series are included.

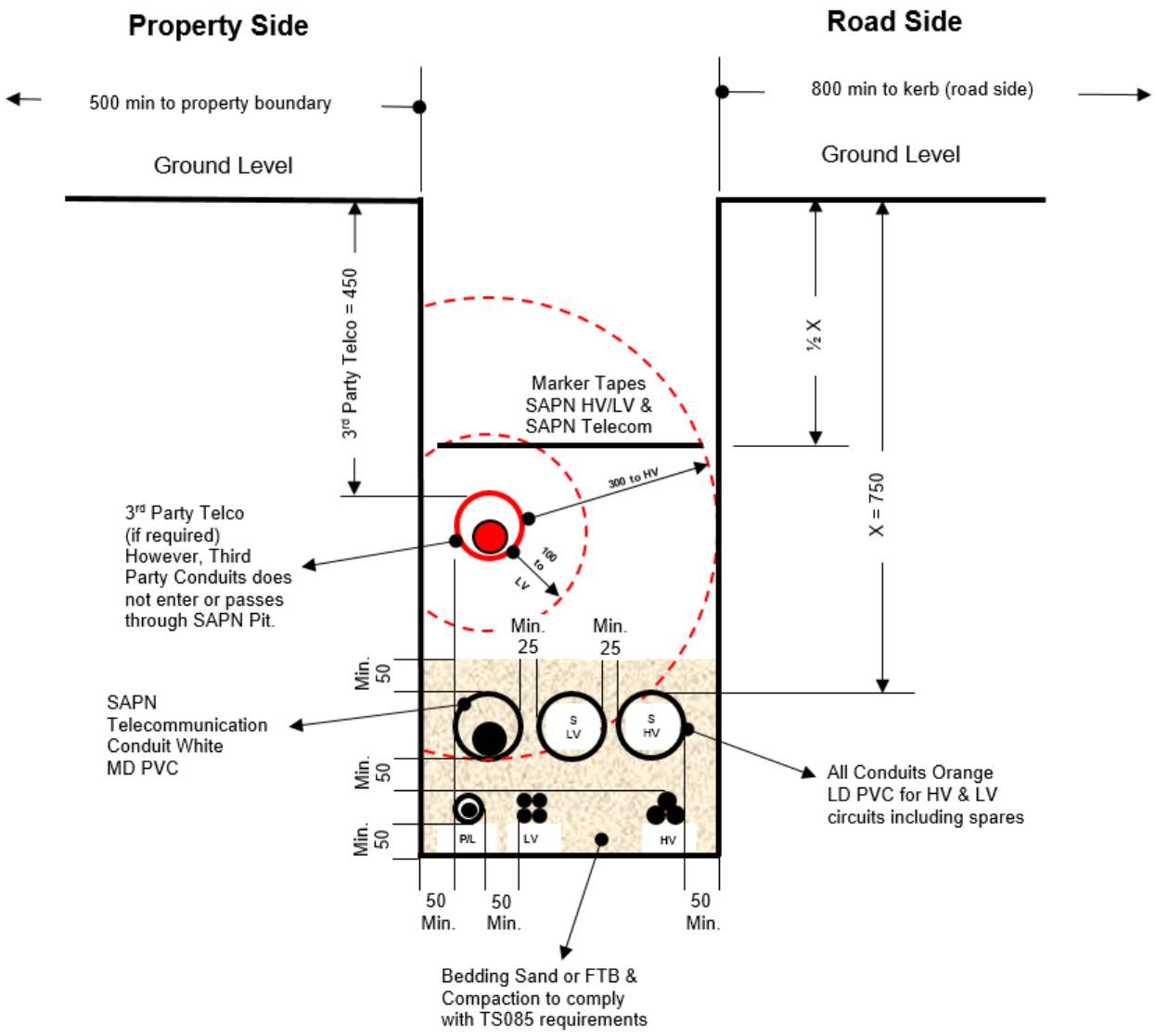
C Typical Trenching for PLEC Projects

C.1 Example 1 - Cables in Conduits



C.1 Example - Cable in Conduits

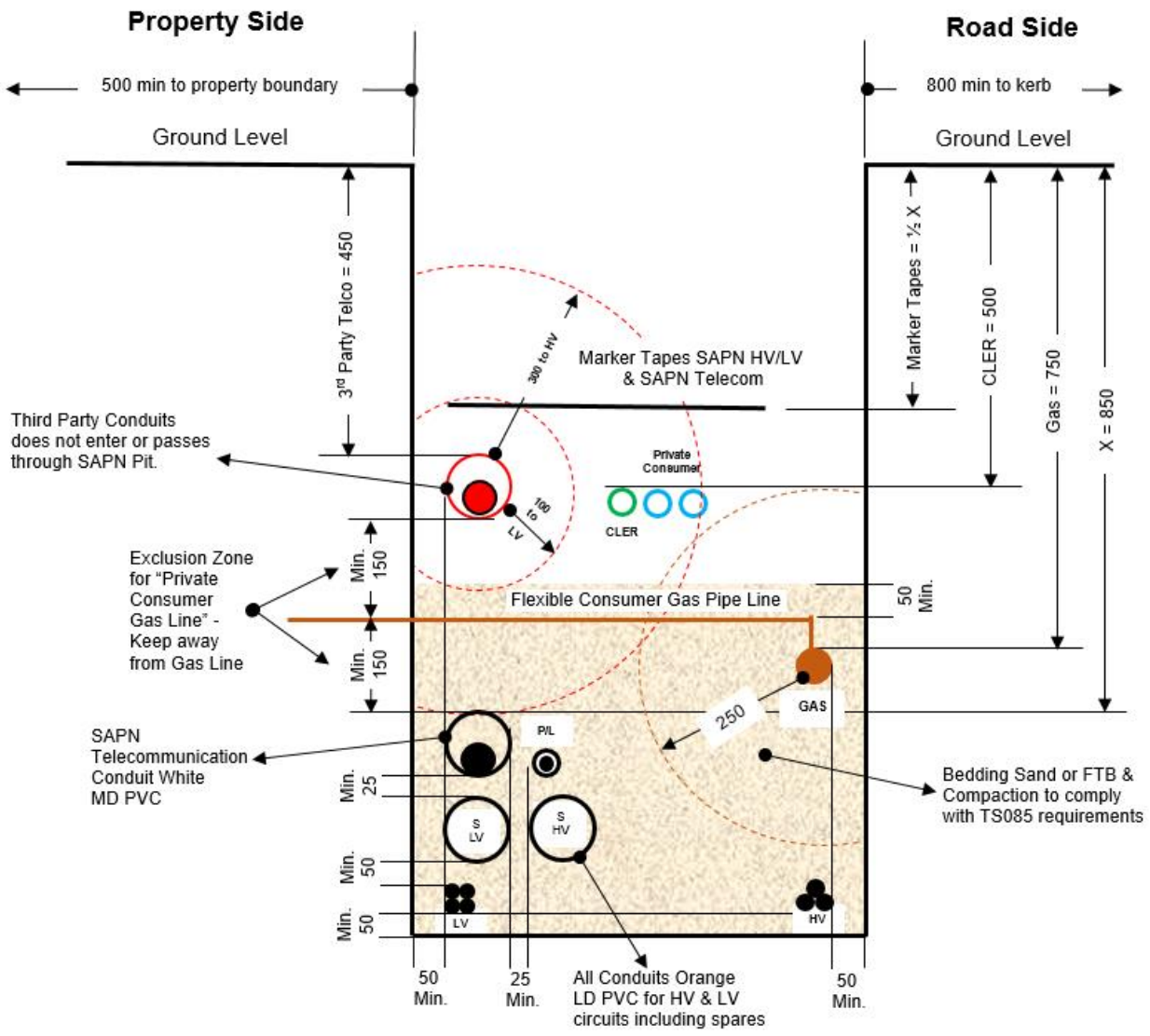
C.2 Example 2 - Cables Buried Direct



C.2 Example 2 - Cables Buried Direct

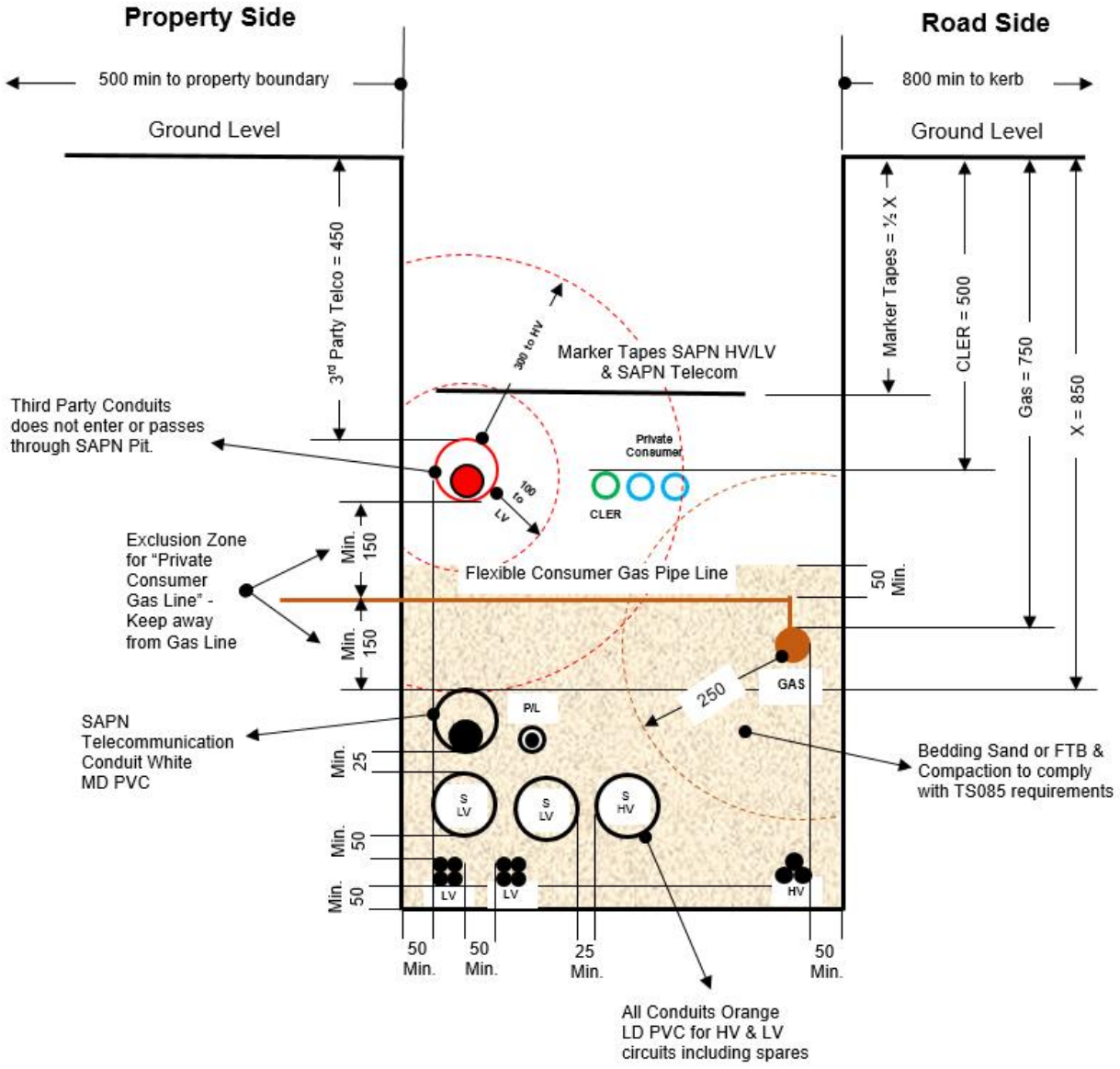
D Typical Shared Trench Arrangement

D.1 Example 1 - Cables Buried Direct (in Footpath)



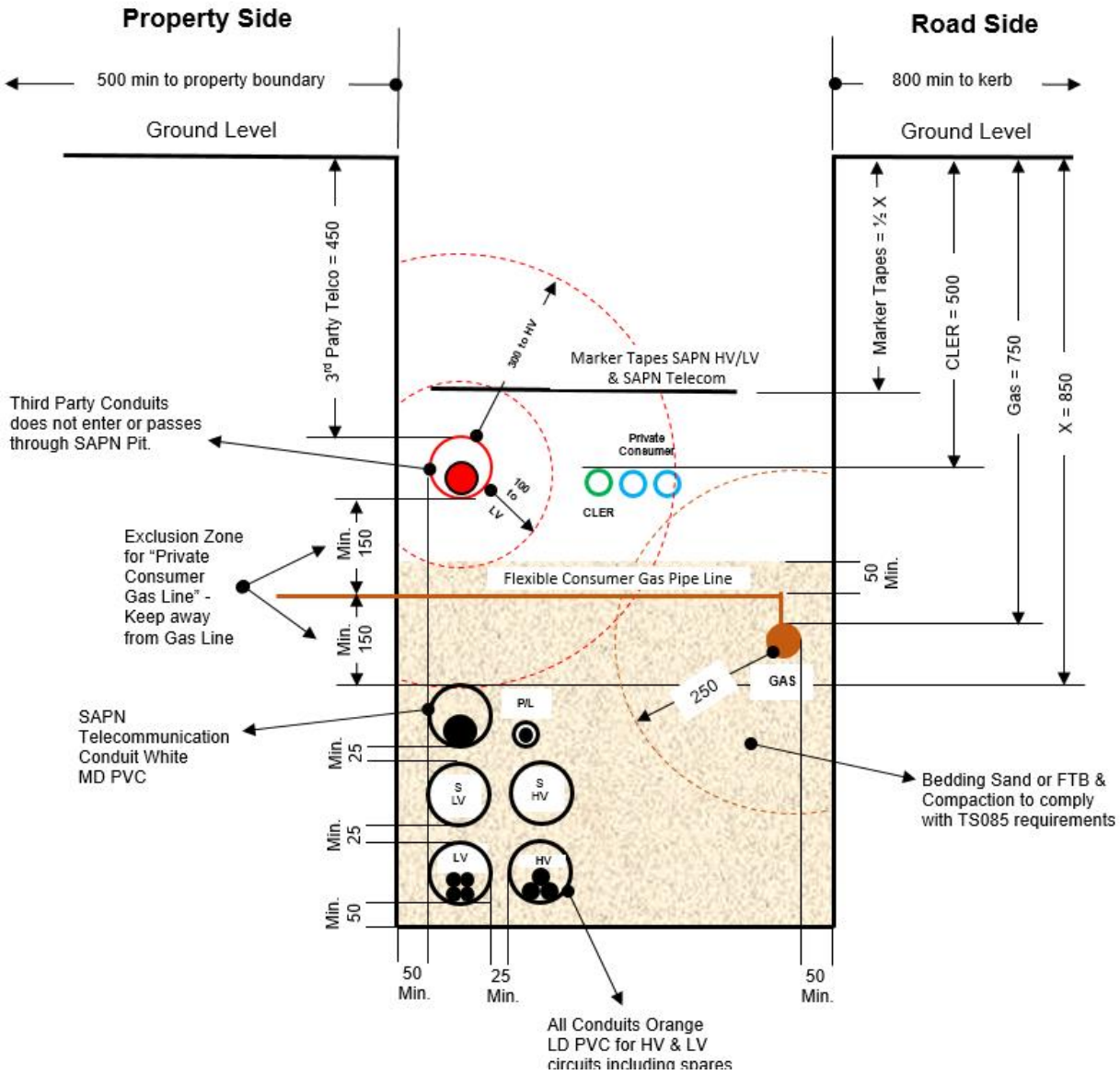
D.1 Example 1 - Cables Buried Direct (in Footpath)

D.2 Example 2 - Cables Buried Direct (in Footpath)



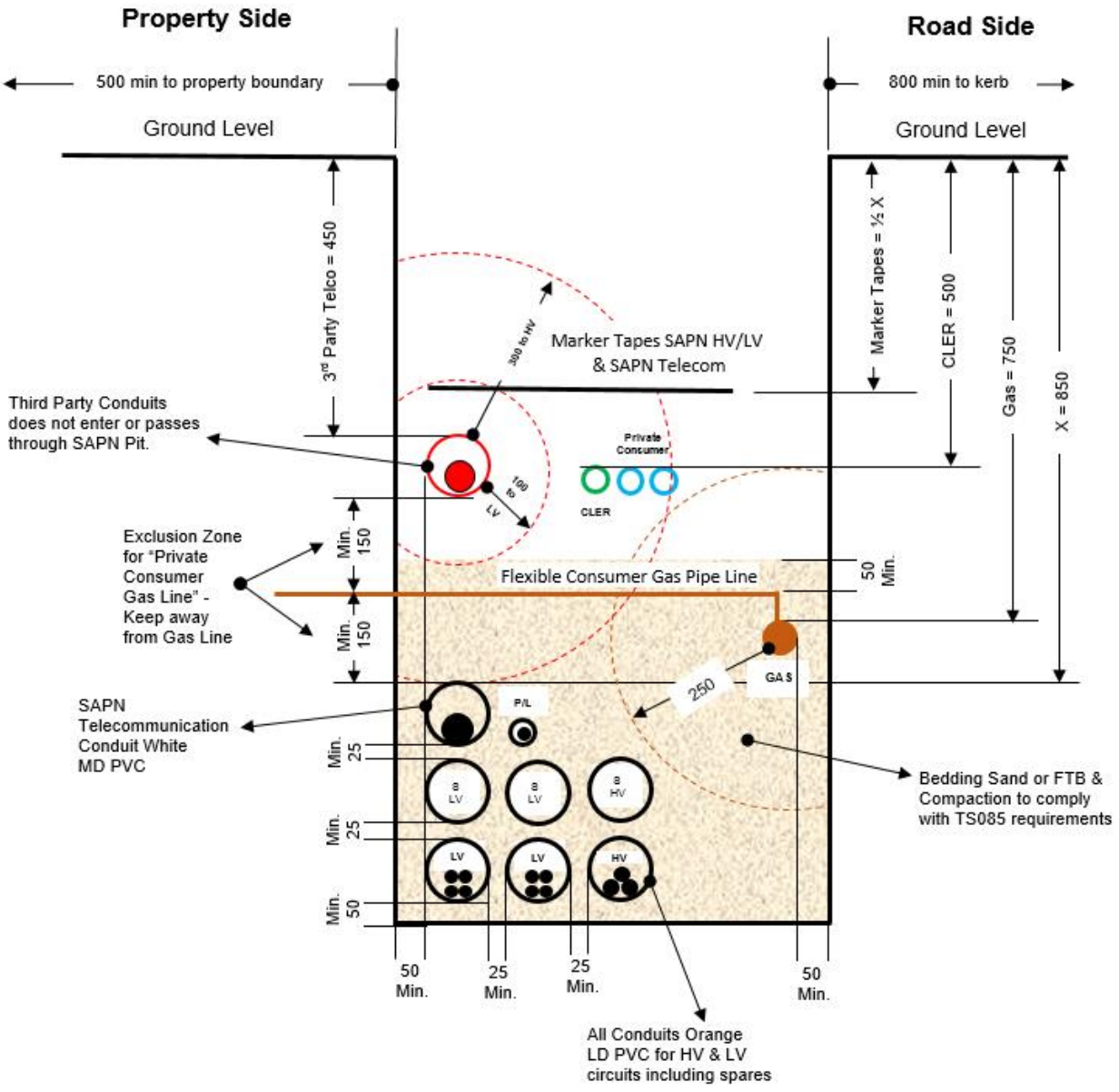
D.2 Example 2 - Cables Buried Direct (in Footpath)

D.3 Example 3 - Cables in Conduits (in Footpath)



D.3 Example 3 - Cables in Conduit (in Footpath)

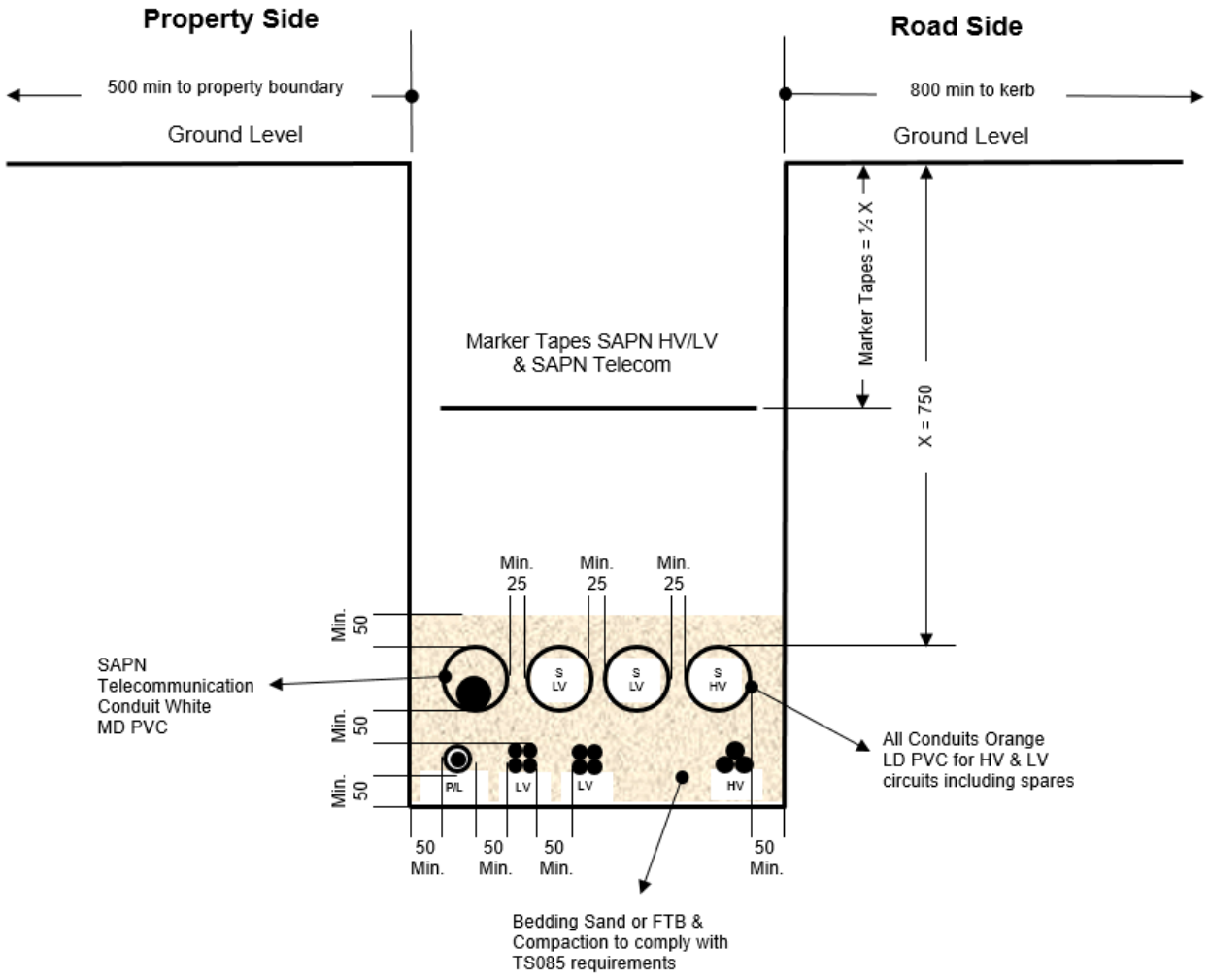
D.4 Example 4 - Cables in Conduits (in Footpath)



D.4 Example 4 - Cables in Conduits (in Footpath)

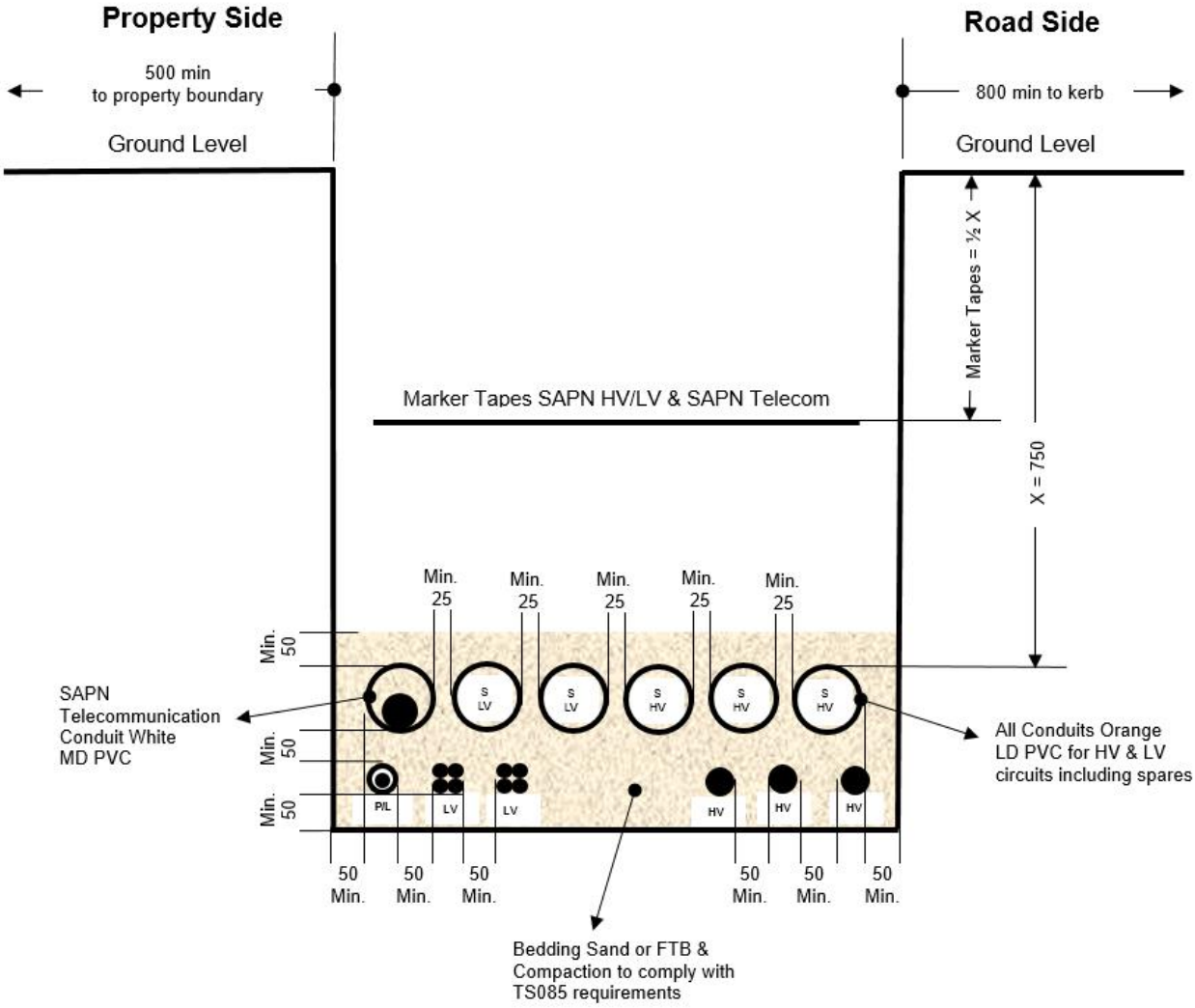
E Typical SA Power Networks Trench (Non-Shared Trench)

E.1 Example 1 - Cables Buried Direct (in Footpath)



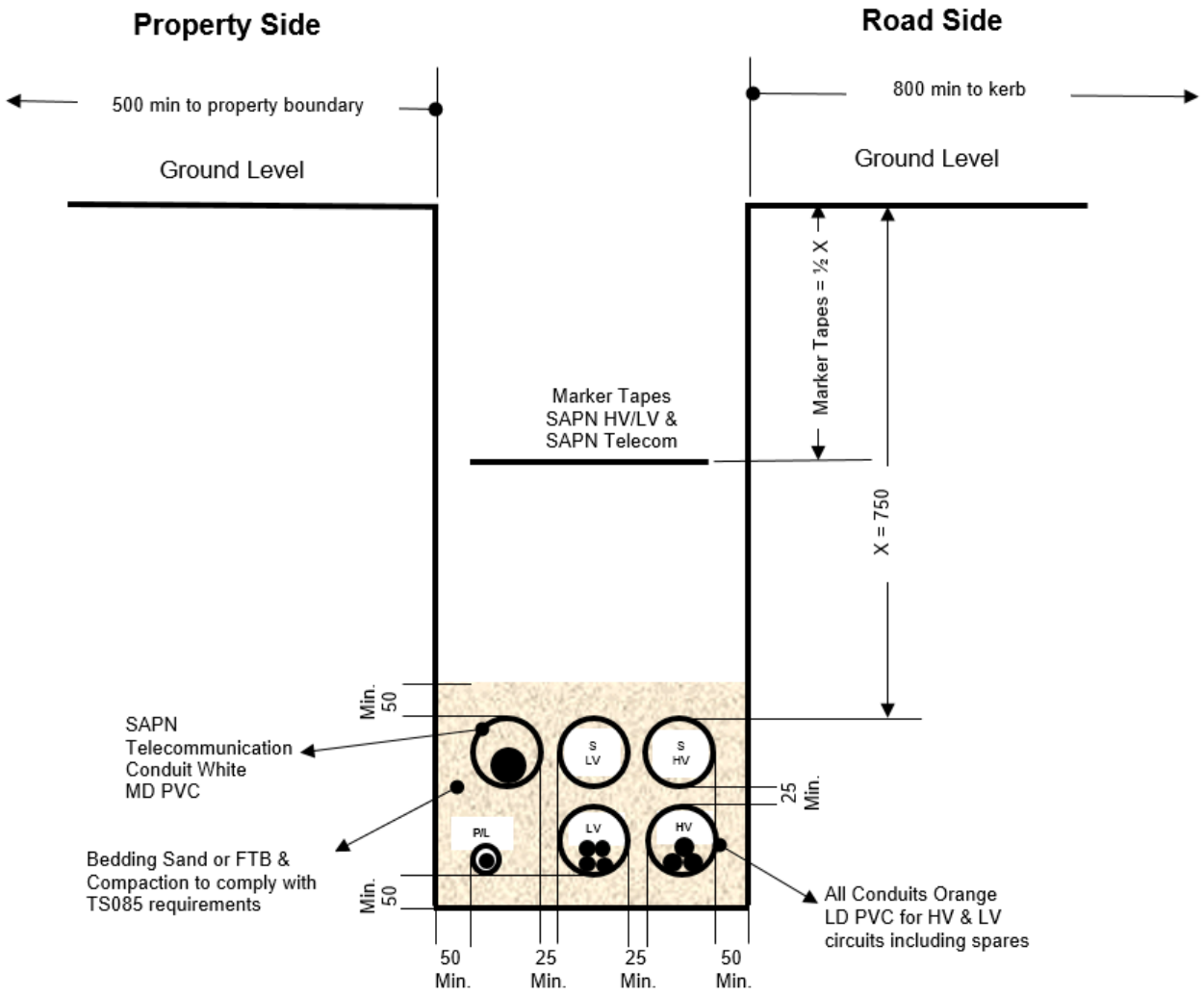
E.1 Example 1 - Cables Buried Direct (in Footpath)

E.2 Example 2 - Cables Buried Direct (in Footpath)



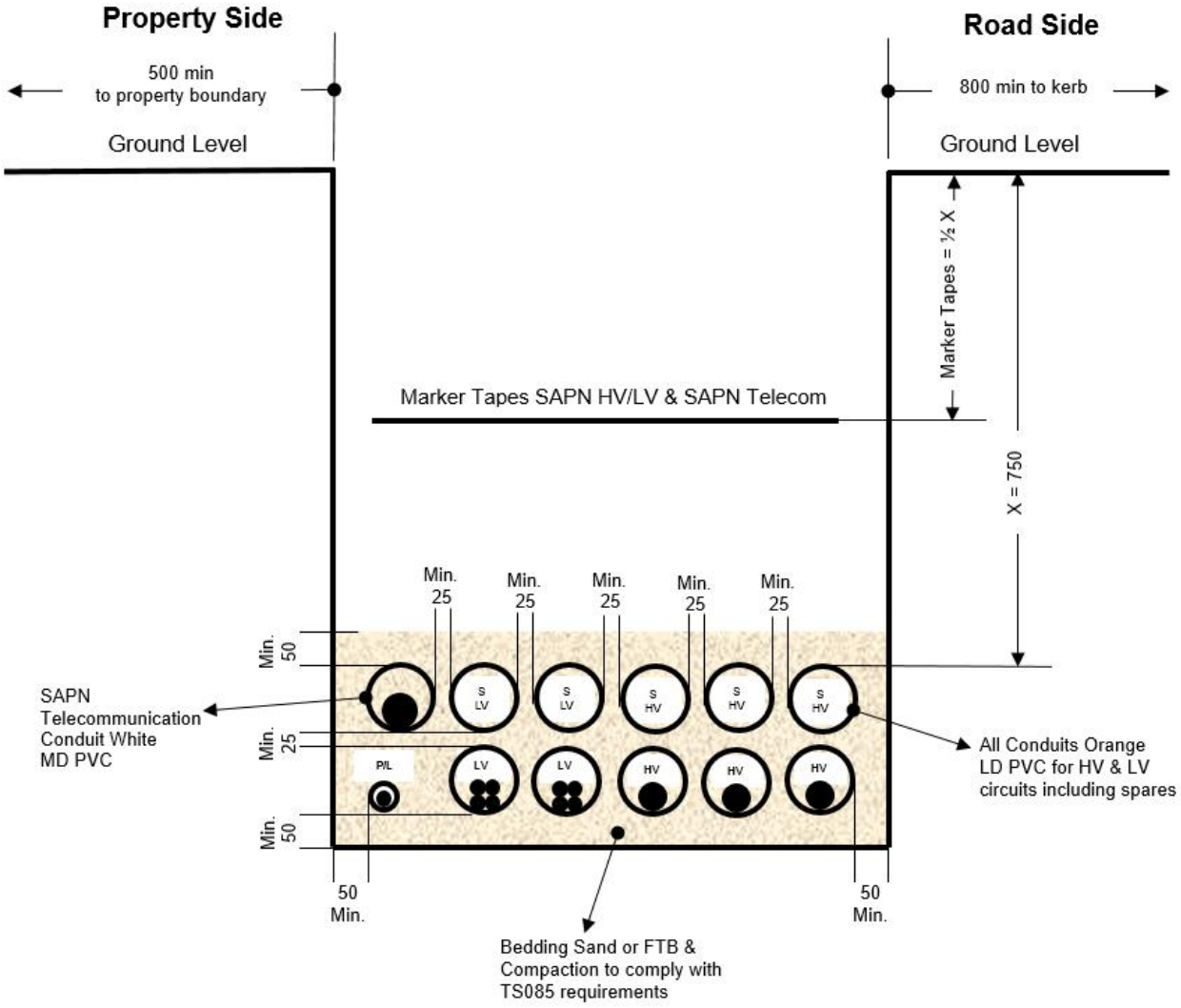
E.2 Example 2 - Cables Buried Direct (in Footpath)

E.3 Example 3 - Cables Buried Direct (in Footpath)



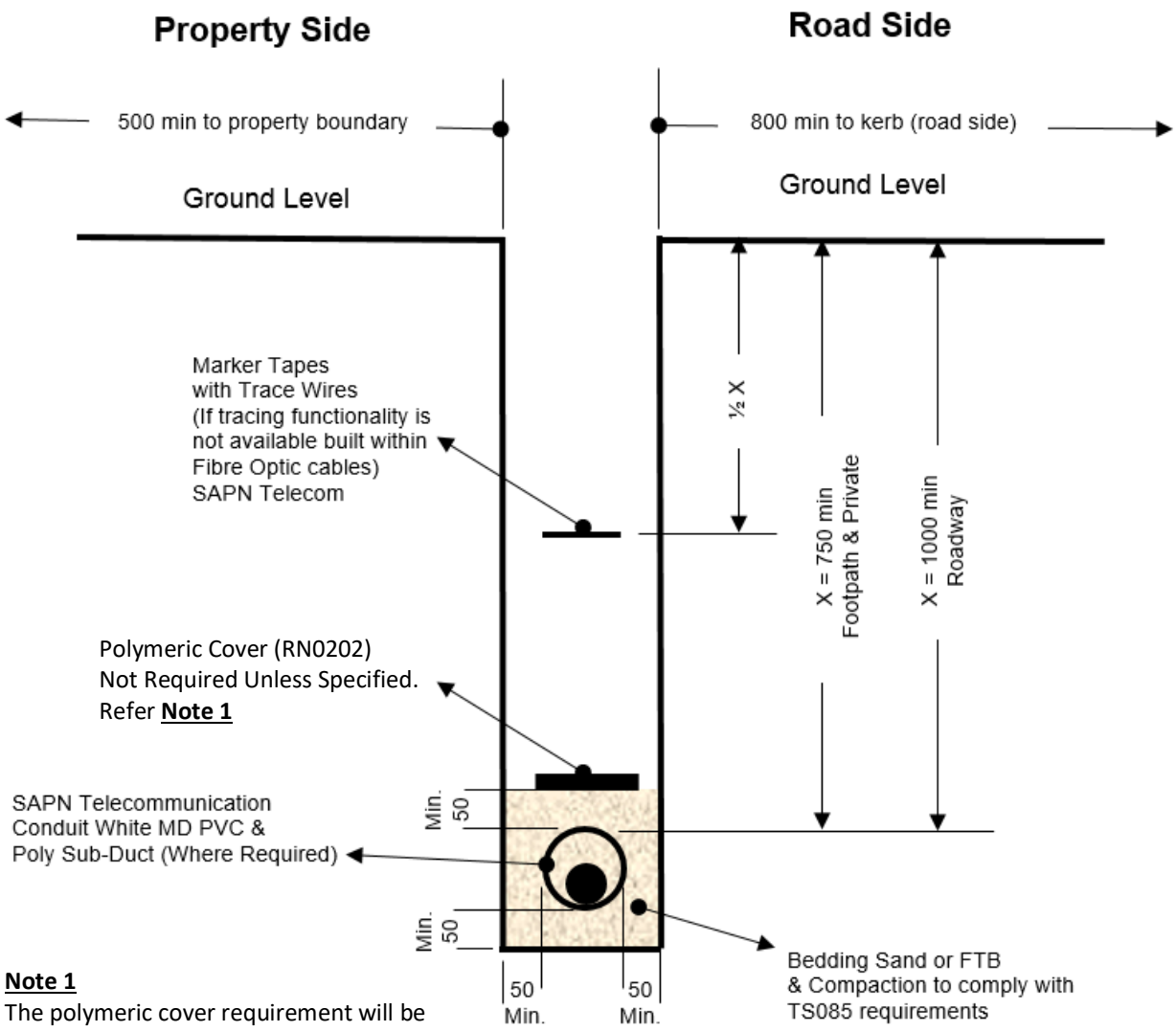
E.3 Example 3 - Cable Buried Direct (in Footpath)

E.4 Example 4 - Cables in Conduits (in Footpath)



E.4 Example 4 - Cables in Conduits (in Footpath)

E.5 Example 5 - Typical Telecom Trench (Non-Shared Trench)

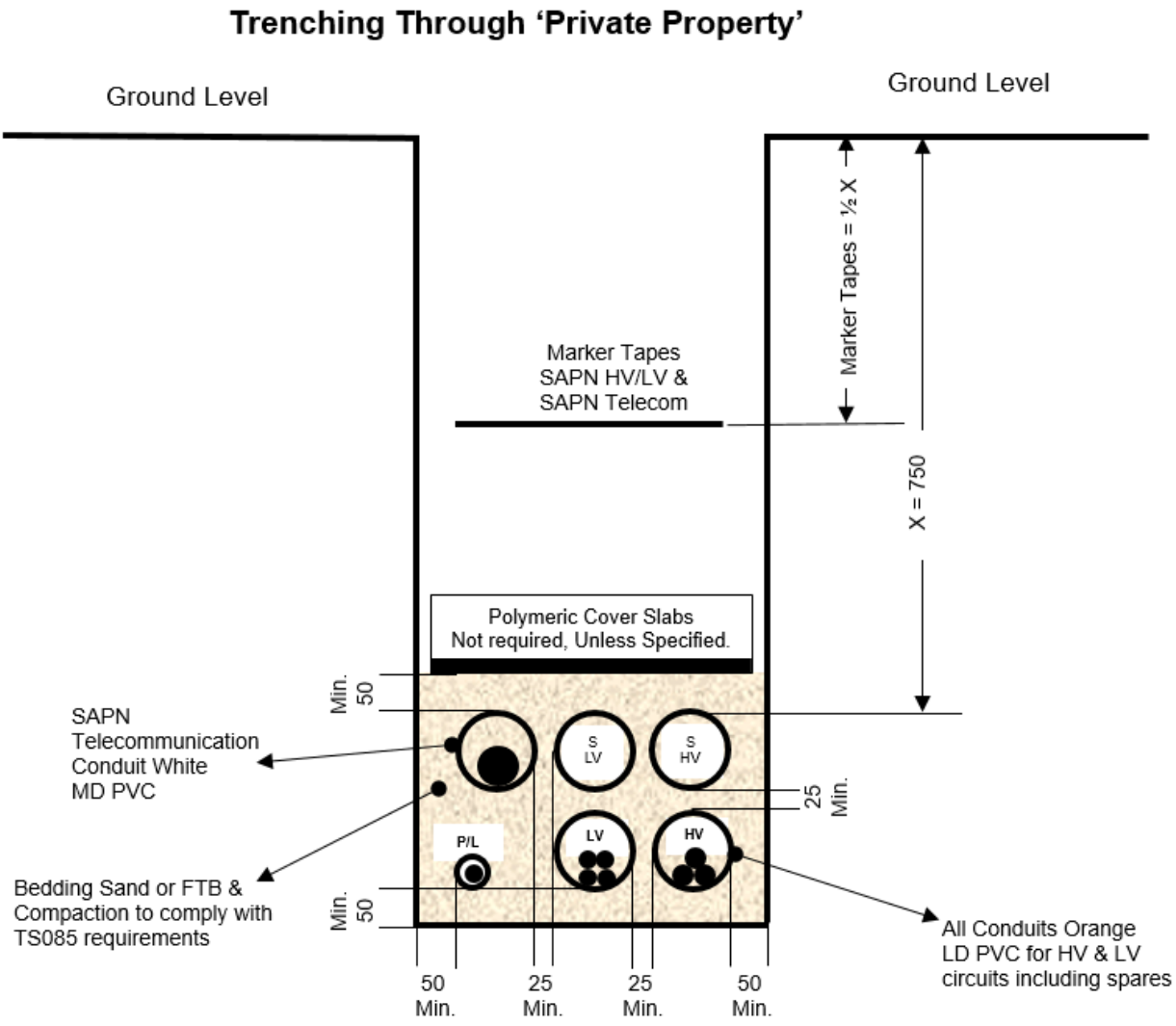


Note 1
The polymeric cover requirement will be assessed depending on the vulnerability of the SAPN Telecommunication asset.

E.5 Example 5 - Typical Telecom Trench (Non-Shared Trench)

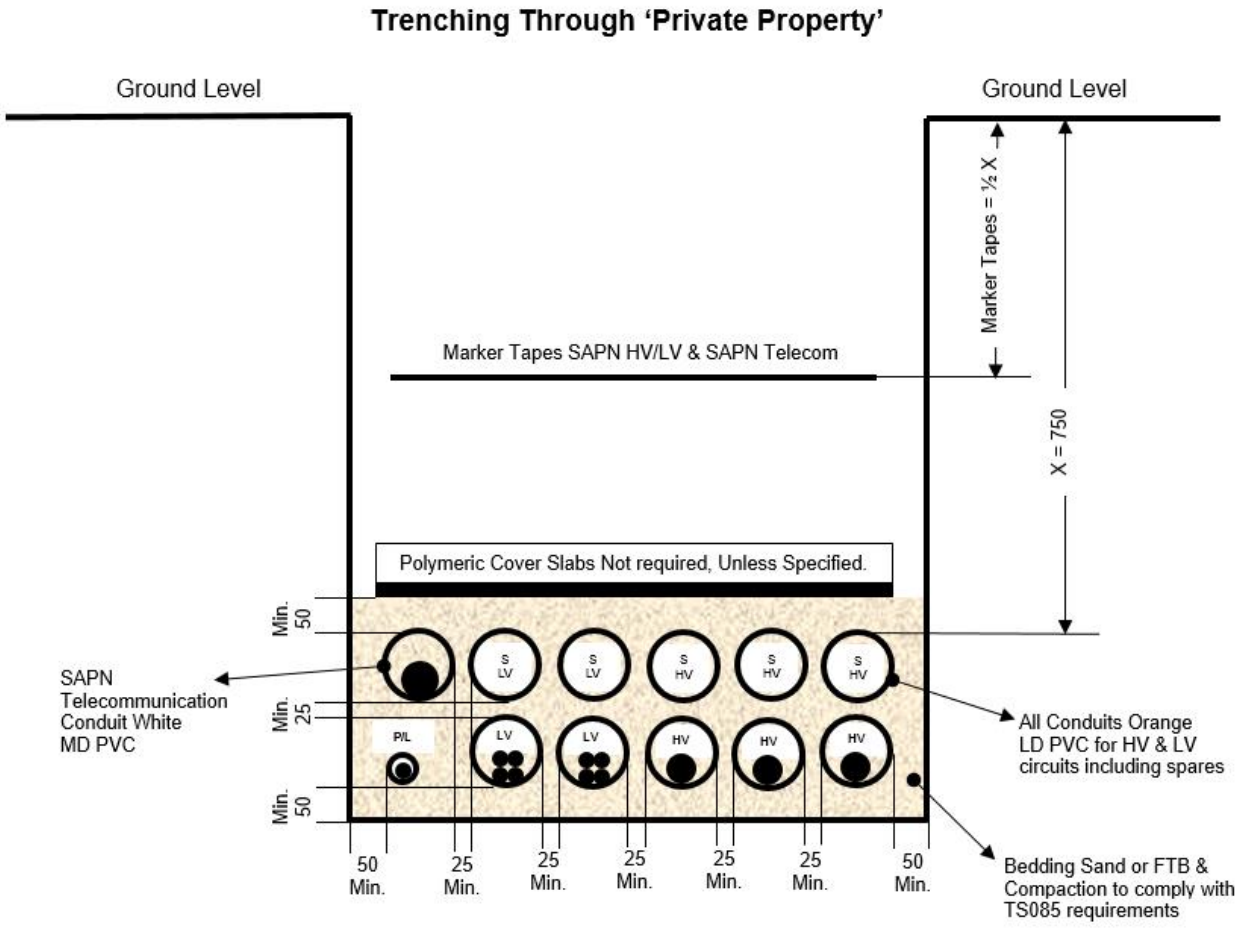
F Typical Trenching on Private Property

F.1 Example 1 - Cables in Conduits



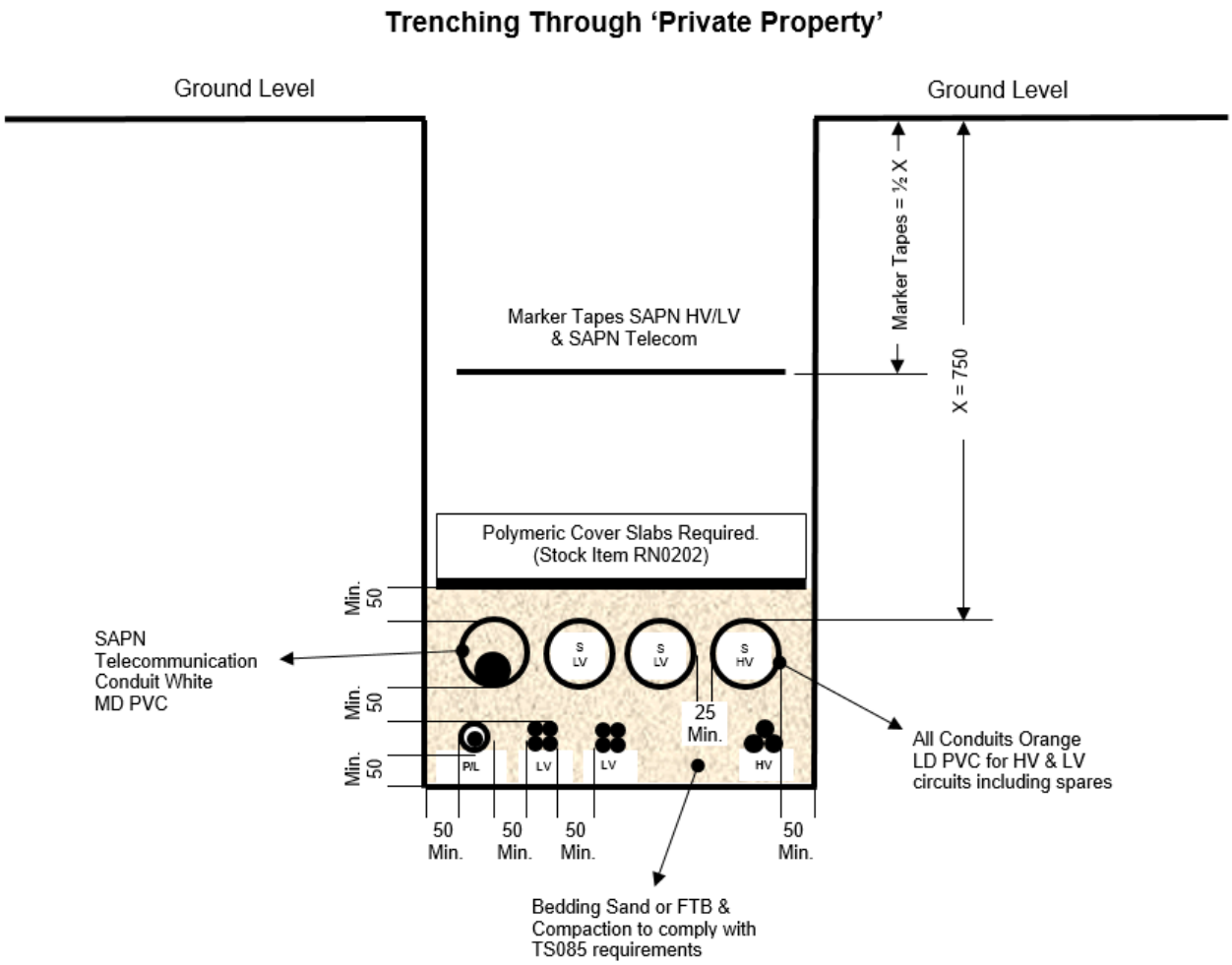
F.1 Example 1 - Cables in Conduits

F.2 Example 2 - Cables in Conduits



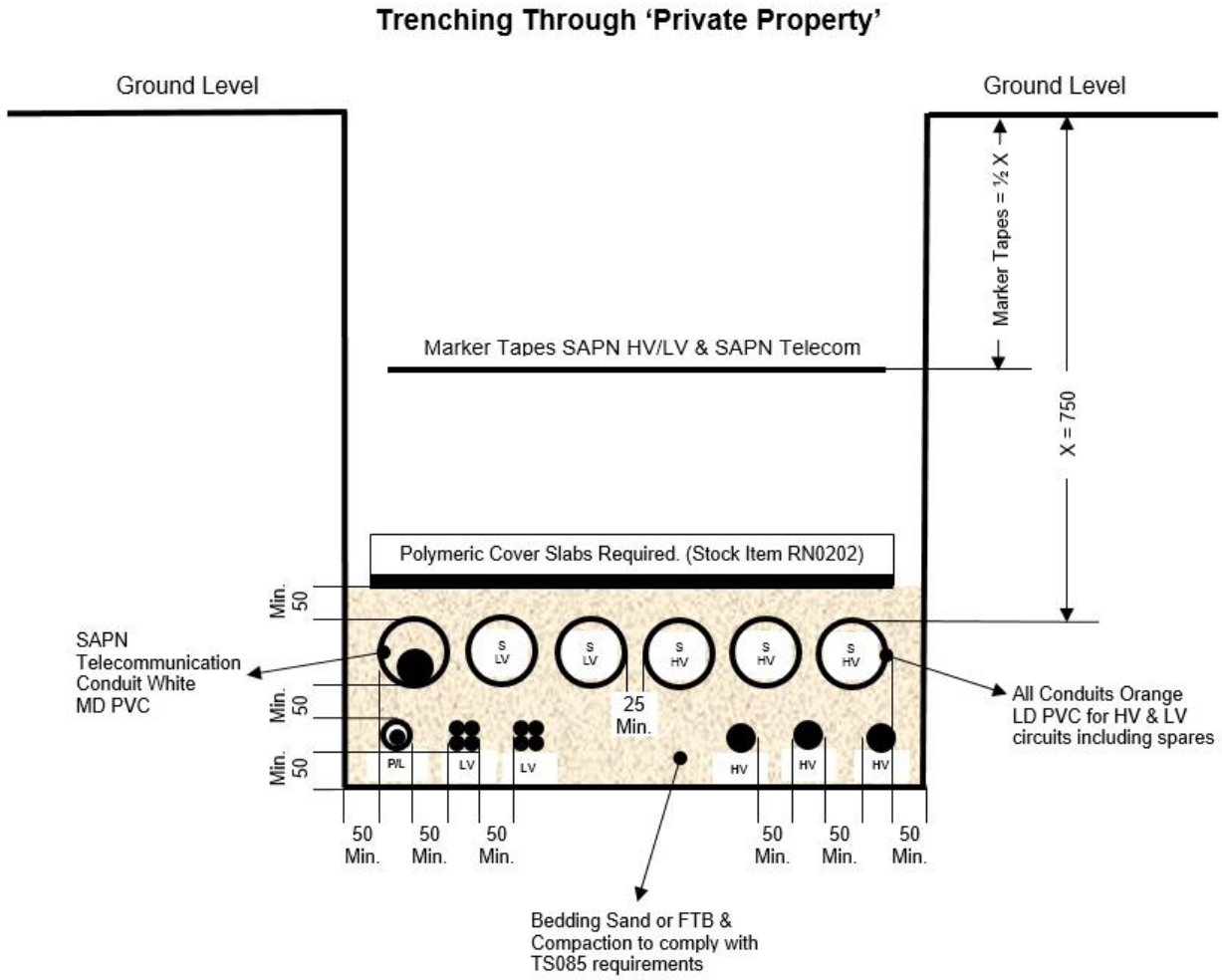
F.2 Example 2 - Cables in Conduits

F.3 Example 3 - Cables Buried Direct



F.3 Example 3 - Cables Buried Direct

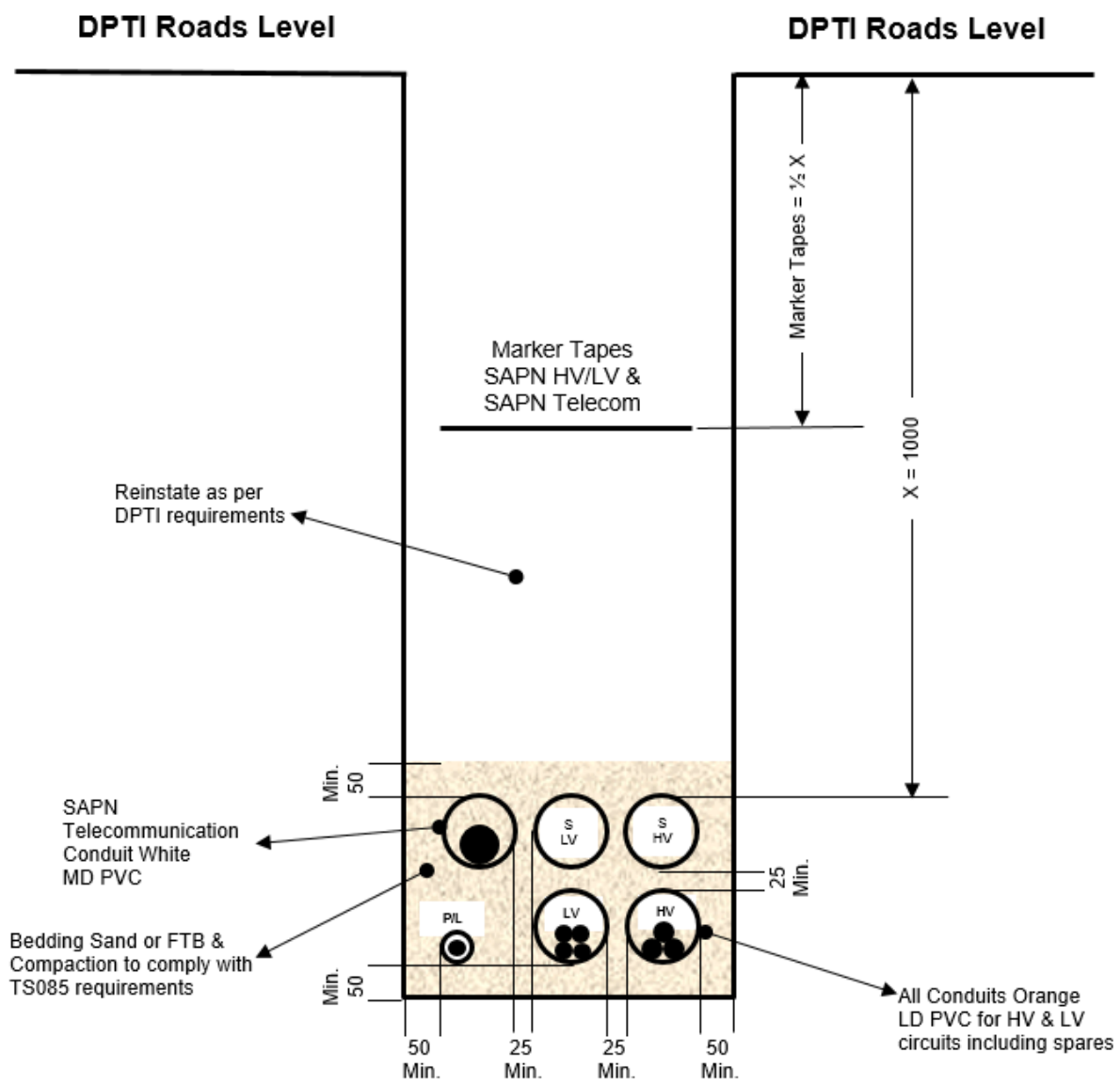
F.4 Example 4 - Cables Buried Direct



F.4 Example 4 - Cables Buried Direct

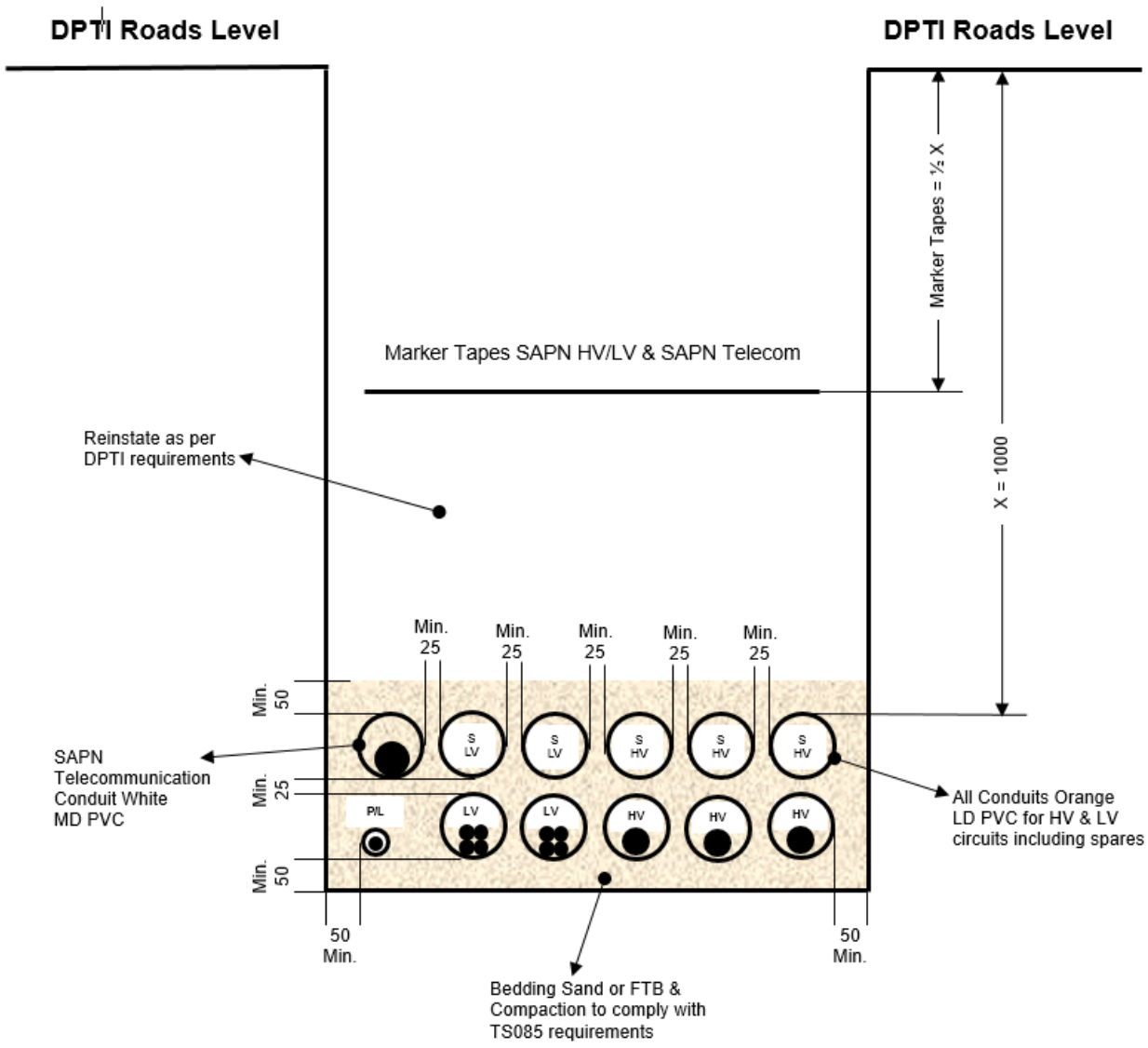
G Typical DPTI Roads - Cables in Conduits

G.1 Example 1 - Cables in Conduits



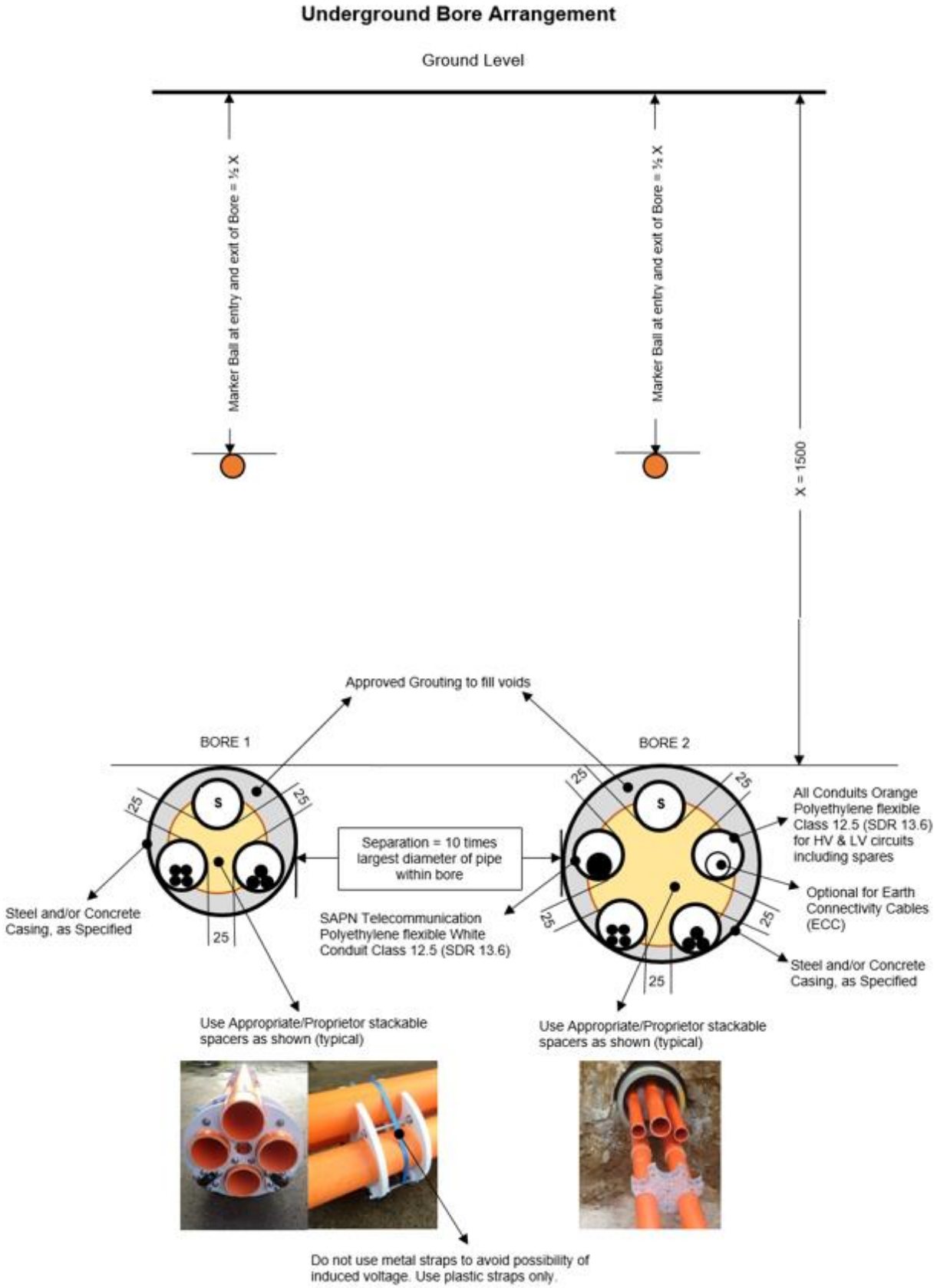
G.1 Example 1 - Cables in Conduits

G.2 Example 2 - Cables in Conduits



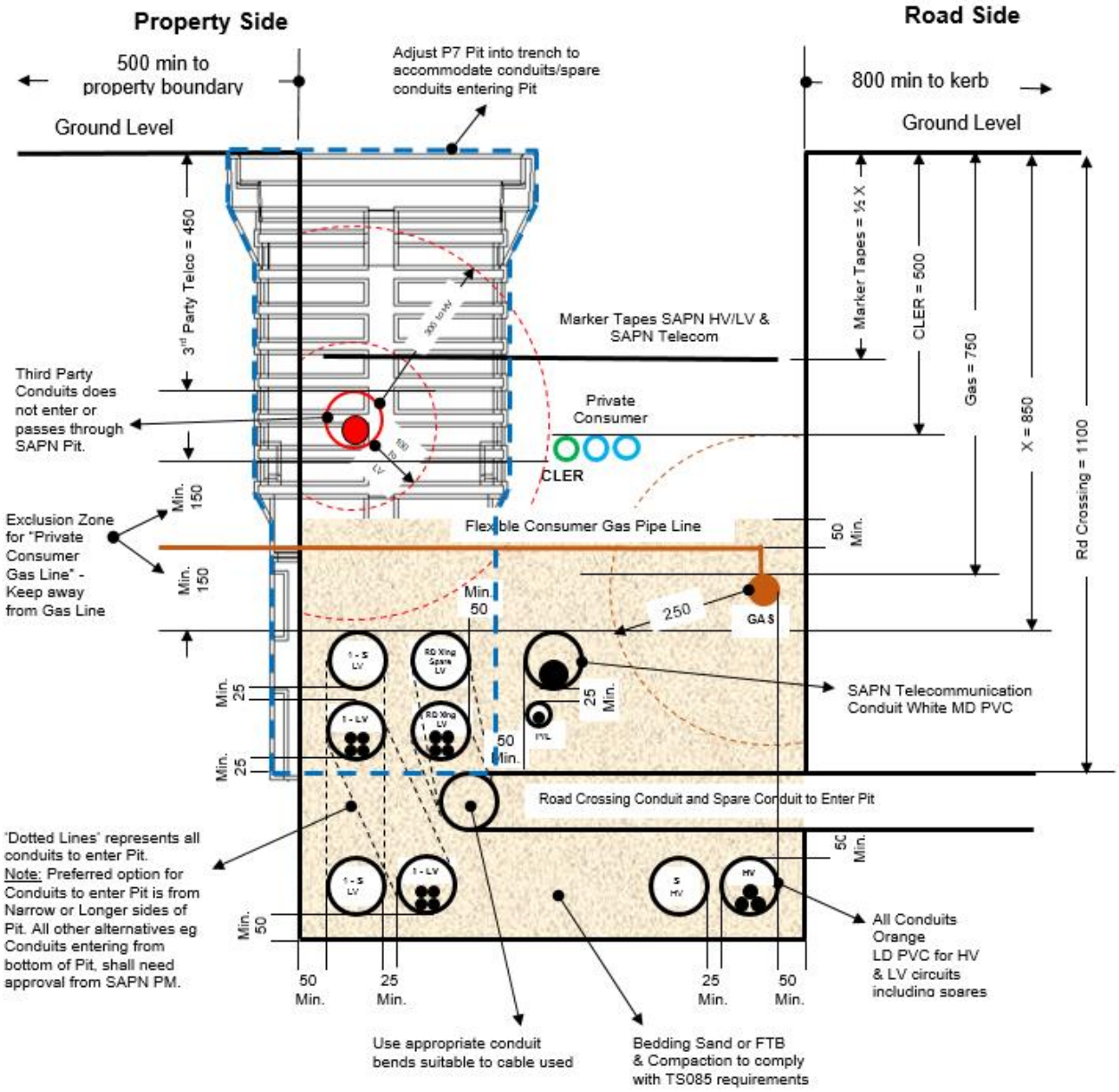
G.2 Example 2 - Cables in Conduits

H Typical Underground Boring Arrangement



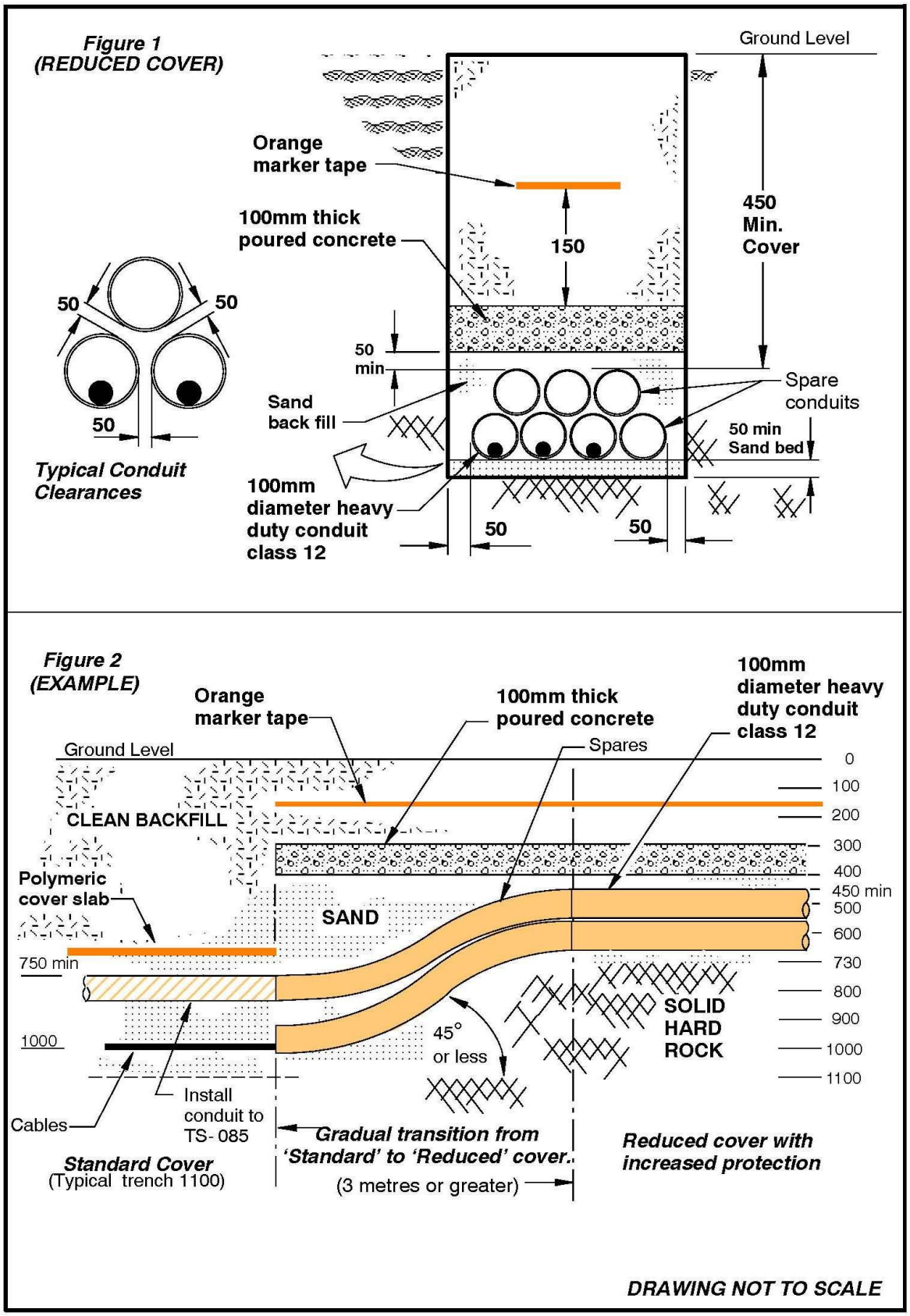
H: Typical Underground Boring Arrangement

I Typical Road Crossing Conduits Arrangement



I: Typical Road Cross Conduits Arrangement

J Typical Reduced Depth of Cover Trenching - Cables in Conduits



J: Reduced Depth of Cover Trenching – Cables in Conduit – Typical

K Waste Soil Management Procedure - Summary

This Appendix is an extract from the SA Power Networks' internal environmental document 'Waste Soil Management Procedure' (ie EMS Procedure 5.3), which is derived from the SA EPA Standard for the production and use of Waste Derived Fill. Please contact the SA Power Networks' Environment Branch on
08 8404 5888, to obtain a copy of these documents and or for any further assistance.

SA Power Networks undertakes a large range of activities which may generate soil that needs to be removed from the location that was excavated. The following **key questions** may provide a starting point in making judgment in dealing with contaminated soil.

1. Is the soil coming from a site associated with a Potentially Contaminating Activities (PCA), for example around a transformer or from a substation?
    a) YES - If the material is coming from a PCA site it shall be tested for its disposal suitability. If testing (refer to Notes) confirms that the material is either Waste Fill or Intermediate Waste Soil, it shall be transported in EPA licensed vehicles, each load will require a transport certificate and be disposed at EPA approved facility for recycling or disposal.
    b) NO - refer to question 2.

2. Is the volume of soil from a project site OVER 100 tonnes?
    a) YES - If the volume is greater than 100 tonnes, the material shall be tested and assessed (refer to Notes) by an EPA approved consultant (eg Enviropacific Services, BlueSphere Environmental, McMahon Services or URS) prior to transportation to an EPA approved recycling or disposal facility.
    b) NO - If the volume of soil is less than 100 tonnes and passes an olfactory and visual inspection the material can be reused onsite or transported to any EPA approved recycling or disposal facility. Refer to 'Standard for the production and use of Waste Derived Fill (WDF)' and 'Site Contamination' for EPA's compliance requirements.

Notes:

1. If after testing, the material is classified as a Low-Level Contaminated soil then it shall be disposed-off at either TPI Inkerman, IWS at Dublin or Southern Waste at Maslin Beach.
2. The reuse at another site of any soil from a PCA site (even if the soil is assessed as Waste Fill) is not recommended until assessed by a suitably qualified auditor/consultant prior to transport for reuse. Soil that passes an olfactory and visual inspection may be reused at the site where the activity is taking place without additional testing.
3. Test results shall accompany any material transported.
4. All soil that is removed from the SA Power Networks' sites or third-party sites shall meet EPA's compliance standards.
5. Organisational and individual penalties may apply for non-compliance under the EPA Act.

L Definitions

Applicant	Person applying for access to the SA Power Networks' network.
AS/NZS	Stands for Australia and New Zealand Standards published by Standards Australia.
Authorised Person	The person in charge of the premises, or the registered electrical worker or the licensed electrical Contractor or other person appointed or selected by the person in charge of the premises, to perform specific duties associated with the electrical installation on the premises.
Boring	Refers to activities of directional drilling (typically horizontal or vertical).
Cable/s	Means an insulated conductor, or two or more such conductors, laid together, whether with or without fillings, reinforcements or protective coverings. (Note: Cable for this manual also means aerial bundled cables).
CLER	Stands for Customer Lighting Equipment Rate.
CST	'Common Service Trench' also known as 'Shared Service Trench'.
Customer	has the meaning given to that term in the Electricity Act 1996, namely a person who has a supply of electricity available from a transmission or distribution network for consumption by that person and includes: The occupier for the time being of a place to which electricity is supplied; and Where the context requires, a person seeking an electricity supply; and A person of a class declared by regulation to be customer. Customer is considered as 'Applicant/Requestor' but may or may not necessarily be the building owner and or the landowner.
Customer Agents	Customer agents are parties representing the customers. Such parties may include the registered electrical workers, the licensed electrical Contractors, consulting engineers, architects, and equipment manufacturers.
Distribution Network	has the meaning given to that term in the Electricity Act 1996, namely the whole or a part of a system for the distribution of electricity but does not include anything declared by regulation not to be a distribution network or part of a distribution network. For the purposes of these rules references to Distribution Network means the network poles, wires, underground cables, transformers, substations etc, operated by SA Power Networks, which transports electricity from the transmission system to a customer/building owner's Connection Point.
Electrical Connection Works	Includes: Those works required for the connection of the proposed extension to the SA Power Networks' distribution network; and Any works (electrical or non-electrical) that involve work on, around, under or above the existing network.
Excavation Depth	Is the vertical distance measured between ground level and the deepest part of the excavation.
Electrical Works	Includes: All cable laying, cable jointing and street lighting required to service the applicant, and any works required to connect the applicant to the SA Power Networks' distribution network but does not include LV electricity reticulation beyond the point of supply; Padmount transformer and switching cubicle installation; and Includes trenching, excavation, backfilling, conduits, pits, footings and restoration.

L.1 Definitions (Continued)

Fire hydrant (external)	As defined in AS 2419.1: 2017, a fitting installed in a fire main with a single valve outlet or two valves outlets for the connection of fire hose(s). They are normally installed outside building.
Fire hydrant (internal)	As defined in AS 2419.1; 2017, an internal attack fire hydrant located to provide fire hose coverage to a floor area not otherwise covered by attack fire hydrant(s) located within a fire- isolated stair or adjacent to a non-fire-isolated stair.
Hazardous Area	An area in which an explosive gas atmosphere is or may be expected to be present, in quantities such as to require special precautions for the construction, installation and use of equipment. Note that the hazardous areas are divided into zones based upon the frequency and duration of the occurrence of explosive gas atmospheres which include flammable vapour (from liquid) and combustible dusts which may include fibre and flying.
High Voltage (HV)	For this document shall mean a voltage exceeding 1,000V A.C. up to and including 33,000V A.C.
Low Voltage or LV	For this document shall mean a nominal voltage exceeding 50V A.C. but not exceeding 1,000V A.C.
Mains Side	The side of the street on which LV distributor cables are installed.
NAP	Means 'Networks Access Permit'.
NICC	Means the SA Power Networks' publications 'Network Information for Contractors and Customers'.
NP	Stands for the SA Power Networks' Network Planning Branch.
PLEC	Stands for Power Line Environment Committee. They are responsible for the selection of sites where SA Power Networks' assets are to be undergrounded for the community benefit.
SCADA	Supervisory Control and Data Acquisition - is a control system architecture that uses computers, networked data communications and graphical user interfaces for high-level process supervisory management.
SA Power Networks' Project Manager	Is the SA Power Networks' Customer Solutions Area Manager or the Authorised Officer serving that area of the customer/building owner's installation.
Separation Distance	It is either the vertical and/or the horizontal distance, measured between any SA Power Networks' plant and the Third Party's infrastructure.
Service Mains	The electricity cable connecting the Customer's first point of supply to SA Power Networks' connection point.
Service Side	Means the non-distributor side of the street.
Shall	Is to be understood as mandatory requirement or obligation.
Underground Service	The electricity distributors supply network to the point of supply.
Ventilation	As defined in AS/NZS 60079.10.1: 2009
Adequate	An open-air situation with natural ventilation, without stagnant areas, and where vapour are rapidly dispersed by wind and natural convection. Air velocities should rarely be less than 0.5 m/sec and should frequently be above 2 m/s.
Inadequate	Natural ventilation limited by topography, nearby structures, weather conditions. Artificial ventilation may be necessary to meet adequate ventilation.
Works	Means the term works as defined in the works agreement.

M References

The following listed documents are for additional information but may not be a conclusive list and other documentation may be required on a project specific basis. Refer to the following SA legislative acts and regulations, SA Electricity Code, the SA Power Networks' publications, relevant AS/NZS and ENA standards for more detail.

Please note: It's your responsibility to ensure you have complied with all relevant standards and you have used the latest version. For civil contractors conducting regular civil works for any the SA Power Networks' installations, there is an E Drawings Group: 40 - Civil Construction available on request, which detail many project specific aspects of civil works that may not be detailed in this standard.

South Australian Legislations

- Electricity Act 1996 and Electricity (General) Regulations 2012
- Electricity (Principles of Vegetation Clearance) Regulations 2010
- Environment Protection Act 1993 and Environment Protection Regulations 2009
- Development Act 1993 and Development Regulations 2008
- Telecommunications Act 1997 and Telecommunications Code of Practice 1997
- Work Health & Safety Act 2012 and Work Health & Safety Regulations 2012

Essential Services Commission of South Australia (ESCOSA) Codes

- SA Electricity Distribution Code (EDC)
- SA Electricity Metering Code (EMTC)

Energy Networks Association (ENA) Publications

- ENA NENS 03: National Guidelines for Safe Access to Electrical and Mechanical Apparatus
- ENA NENS 04: National Guidelines for Safe Approach Distances to Electrical and Mechanical Apparatus

Australian Energy Market Commission (AEMC) Publications: National Electricity Rules (NER)

The Department of Planning Transport and Infrastructure (DPTI) Publications

The Office of Technical Regulator (OTR) Publications

SA Power Networks' Documents:

Manuals (for Examples):	
Manual 14	Safety, Reliability, Maintenance & Technical Management Plan
Manual 18	Network Tariff & Negotiated Services
Manual 32	Service and Installation Rules
E Dwgs Group 40	Civil Construction Manual
Technical Standards & NICC Brochures (for Examples)	
NICC400	Information for an applicant undertaking a contestable extension
NICC401	Information on Network Design and Installation by an External Contractor
NICC404	Working in the Vicinity of SA Power Networks' Infrastructure - Network Access Permit Process
TS100	Electrical Design Standards for Underground Distribution Cable Networks (up to and including 33kV)
TS102	Easement standard for distribution networks
Relevant E Drawing Series	

Standards Australia Publications

AS 1074	1989	Steel tubes and tubulars for ordinary service
AS 1141.11.1/Amdt 2	2016	Methods for sampling and testing aggregates Part 11.1: Particle size distribution sieving method
AS 1289.3.3.1	2009	Methods of testing soils for engineering purposes Part 3.3.1: Soil classification tests - Calculation of the plasticity index of soil
AS 1319	1994	Safety Signs for the Occupational Environment
AS 1345	1995	Identification of the contents of pipes, conduits and ducts
AS 1931.1	1996	High voltage - Test techniques Part 1: General definition and test requirements
AS 2067	2016	Substations and high voltage installations exceeding 1kV AC.
AS 2419.1	2017	Fire Hydrant Installations Part 1: System design, installation and commissioning
AS 3798/Amdt 1	2008	Guidelines on earthworks for commercial and residential developments
AS 4678/Amdt 2	2008	Earth-retaining structures
AS 4799	2000	Installation of underground utility services and pipelines within railway boundaries
AS 60038	2012	Standard voltages
AS 60068.1	2003	Environmental testing Part 1: General and Guidance
AS/CA S009	2013	Installation requirements for customer cabling (Telecommunications Wiring Rules)
AS/NZS 1477	2017	PVC pipes and fittings for pressure applications
AS/NZS 2032	2006	Installation of PVC pipe systems
AS/NZS 2053.1	2016	Conduits and fittings for electrical installations Part 1: General requirements
AS/NZS 2648.1	1995	Underground marking tape Part 1: Non-detectable tape
AS/NZS 3000	2018	Electrical Installations (known as the wiring rules)
AS/NZS 3500 (Set)	2015	Plumbing and Drainage Set (Parts 0-4)
AS/NZS 3845.1	2015	Road safety barrier systems and devices Part 1: Road safety barrier systems
AS/NZS 4026	2008	Electric cables - for underground residential distribution systems
AS/NZS 4130/Amdt 1	2009	Polyethylene (PE) Pipes for Pressure Applications
AS/NZS 4645.3	2018	Gas distribution networks Part 3: Plastic pipe systems
AS/NZS 60079.14	2017	Explosive atmospheres Part 14: Electrical installations design, selection and erection
AS/NZS ISO 14001	2016	Environmental Management Systems - Requirements with guidance for use
AS/NZS ISO 31000 (Set)	2013	Risk Management Set - Principles and Guidelines. (AS/NZS 4360 is superseded in 2004)
G591	2006	Telecommunications in Road Reserves Operational Guidelines for Installations - Industry Guideline

International Standards:

ASTM STP1331	1998	The Design and Application of controlled low-strength materials (Flowable Fill)