VICTORIAN ELECTRICITY SUPPLY INDUSTRY

URBAN RESIDENTIAL DEVELOPMENT (URD) DESIGN & CONSTRUCTION STANDARD

Revision History

Version	Date	Description
1	01 May 2021	Initial release.
2	21 June 2021	Updated for minor grammatical and typographical errors
3	27 June 2022	Service pit maximum offset changed from 300mm to 400mm. Concrete collar depth for service pit installation in footpath or driveway changed from 250mm to 200mm. Minor updates through document to add clarity where required.

The Manual has been prepared by the Victorian Electricity Supply Industry (VESI) in consultation with the Urban Development Institute of Australia (Victorian Branch).

Contents

1 INTRODUCTION

The purpose of this standard is to provide a common set of engineering design and construction principles for Urban Residential Development (URD) installation across all Victorian electricity supply industries (VESI) that meet the relevant legislative and Australian Standards requirements.

This common approach ensures installations are of a high standard of safety, quality, reliability and operational performance, ultimately to the benefit of the Victorian community.

While every effort has been made to have a common standard for the majority of URD installation requirement, some requirements are Distribution Business (DB) specific and therefore reference may be required to a DB specific standard. Where this is required it will be outlined within this standard.

For any other design and construction standards related to URD estates not included in this document please refer to the individual DB for their requirements.

For URD estate within the CitiPower network or high density developments in other DBs please refer to the individual DB for their requirements.

For industrial/commercial subdivision refer to the DB specific standards.

This standard has been developed jointly by CitiPower/Powercor Australia Ltd, United Energy, Jemena Electricity Networks and AusNet Services.

2 REFERENCES

2.1 Victorian Legislation:

- Electricity Safety Act 1998
- Electricity Safety (Network Assets) Regulations 1999 – Now superseded
- Electricity Safety (Installations) Regulations 2009
- Electricity Safety (General) Regulations 2019

2.2 Standards Australia Publications:

- AS 2758.1 - Aggregates and rock for engineering purposes-Concrete aggregates
- AS 60038 - Standard Voltages
- AS/NZS 3000 - Electrical Installations (known as the AS/NZ Wiring Rules)
- AS/NZS 1158 - Lighting for Roads and Public Spaces Set
- AS 1289.5.1.1 - Methods of testing soils for engineering purposes - Soil compaction and density tests - Determination of the dry density/moisture content relation of a soil using standard compactive effort
- AS 1289.5.2.1 - Methods of testing soils for engineering purposes - Soil compaction and density tests - Determination of the dry density or moisture content relation of a soil using modified compactive effort
- AS 1289.5.4.1 - Methods of testing soils for engineering purposes - Soil compaction and density tests - Compaction control test - Dry density ratio, moisture variation and moisture ratio
- AS 1289.5.8.1 - Methods of testing soils for engineering purposes - Soil compaction and density tests - Determination of field density and field moisture content of a soil using a nuclear surface moisture–Density gauge - Direct transmission mode
- AS 1345 - Identification of the Contents of Pipes, Conduits and Ducts
- AS/NZS 2032 - Installation of PVC pipe systems
- AS/NZS 2053 - Conduits and Fittings for Electrical Installations – Part 1 & 2 - General Requirements
- AS/NZS 2648.1 - Underground Marking Tape - Non-Detectable Tape
- AS 2885.1 - Pipelines - Gas and Liquid Petroleum - Design and Construction
- AS/NZS 3500 (Set) - Plumbing and Drainage Set
- AS 3798 - Guidelines on earthworks for commercial and residential developments
- AS/NZS 4645.3 - Gas Distribution Networks - Plastics Pipe Systems
- AS/NZS 4130 - Polyethylene (PE) Pipes for Pressure Applications
- AS 4678 - Earth-Retaining Structures
- AS 4799 - Installation of Underground Utility Services and Pipelines within Railway Boundaries
- AS 2419.1 - Fire hydrant installations System design, installation and commissioning
- AS 1141.11.1 - Methods for sampling and testing aggregates Particle size distribution - Sieving method
- AS 4702 - Polymeric cable protection covers

- AS/NZS ISO 31000 - Risk Management - Principles and Guidelines Note: AS/NZS4360 is superseded and replaced by AS/NZS ISO31000
- AS/ACIF S009 - Installation requirements for customer cabling (Telecommunications Wiring Rules)

2.3 WSAA Codes - Water Services Association of Australia:

- WSA 02–2014-3.1 Gravity Sewerage Code of Australia – MRWA Edition – Version 2
- WSA 03–2011-3.1 Water Supply Code of Australia – MRWA Edition – Version 2

2.4 Legacy VESI documents:

- VESI UG Cable Design Manual

3 DEFINITIONS

Asset or equipment - The materials installed in the trench including but not limited to the cables, conduits, backfill and embedment layers.

Burial Depth or Depth of Cover – The distance from the ground level to the top of the cable or conduit being installed.

Cable – A stranded or solid metal conductor (typically Aluminium or Copper) that has been covered with insulating material and depending on the system operating voltage may have additional conductive and protective layers and is used in an underground environment within the electricity network.

Clearance Distance – Either the vertical and/or the horizontal distance, measured edge-to-edge between any asset and/or the Third Party's infrastructure.

CMEN - Common Multiple Earthed Neutral, is a "common" earthing installation in a distribution earthing arrangement where all high voltage and low voltage equipment is connected to a single common earth.

DB – Distribution Business

DB Responsible Officer - Manager/Responsible Officer serving that area of the customer's installation.

DN - Diameter Nominal

DoT – Department of Transport, previously known as VicRoads

DSP – Design Service Provider

Excavation – refers to the activities of digging or trenching and can be by mechanical means or by hand.

Ground Level – is nominally the final level of the ground that equipment is to be installed at.

High Voltage – The voltage designation used for cables with a system voltage that is greater than 1 kV.

Installer - is an individual or organisation authorised by the DB to construct underground cable systems that comply with this standard.

Low Voltage – The voltage designation used for cables with a system voltage of 1 kV or less.

REFCL – Rapid Earth Fault Current Limiter

Re-instatement level – The distance from the top of the ground level to the level required by either DoT or local Municipal Councils for the reinstatement of material excavated from the trench.

Shall or must – Mandatory requirement or obligation.

Should – Non-mandatory, i.e. advisory or recommended.

Trench Depth – The distance from the ground line to the bottom of the excavated trench.

Trench TR Critical – A trench where the thermal properties of the material/s to be placed in the trench must meet specific design criteria (as determined by the DB) to ensure the system requirements of the cables to be installed can be met.

Trench TR Non-critical – A trench where the thermal properties of the material/s placed in the trench will not compromise the system performance of the cables to be installed.

Thermal Resistivity (TR) – The term used to describe the thermal properties of the material/s to be placed in the trench and indicates the extent a material will resist heat flow. For the purpose of this standard the unit of measure for thermal resistivity shall be K.m/W (Kelvin.metres per Watt).

Underground Service – The electricity distributor's supply network to the point of supply.

4 Detail Design Requirements

The detailed design refers to the preparation of a cable proposal plan for a particular subdivision stage(s) and is based on the completed overall planning design.

4.1 Overall planning design guidelines

The overall system planning design is done by the distribution business or accredited DSP and provided to the developer's contractor to undertake detailed design for the site.

Proper economies and performance can only be achieved for any development by the preparation of overall system planning and design to enable:

- Maximum utilisation of the assets
- Provision for future demand growth
- Integration of the development into the larger electricity network.
- Adherence to standards to ensure reliability and quality of the electricity network

To achieve these objectives it is necessary to undertake an overall system plan and design of a URD that takes account of the total extent of the development and adjacent developments, to the extent that this information is available. It means that in a multi-stage development the overall design should be done for all stages and not an individual stage in isolation.

The overall design should show:

- Location and type of kiosk substations and REFCL isolation substations
- Route and size of HV cable
- LV circuit arrangement
- Route of LV mains cable
- Location of paralleling switches
- Kiosk transformer utilisation
- Calculated % voltage drop at LV circuit ends
- LV fuse reach checks
- Spare (emergency) conduits and/or future use conduits

Once the overall planning design is laid out and approved, the detailed design of each individual stage may be completed based on the overall design. For HV Switching needs including remote control requirements refer to individual Distribution Business's.

The overall planning design might be required to be updated at any point as a result of regulatory requirement or changes within the DB networks.

4.2 HV cable route selection guideline

An important part of any electrical URD detailed design is the route underground cables take. The cable route brings together the system planning (ADMD), electrical design (volt drop and rise) and construction (trench depths, crossings, etc.) requirements.

The HV cable forms part of a much larger integrated and interconnected network and consequently must be planned to coordinate with the already constructed system and to provide for later stages of the subdivision being planned and adjacent developments.

The following provides guidance for determining the route of HV cables within URD systems:

- When selecting routes for HV cables the locations of any planned commercial developments, schools, super lots / high density infill developments, etc., in the vicinity need to be considered and the route selected to locate cables within easy reach of possible substations to supply future loads.
- Feeder routes should be as short as possible. (Cable easements may be used through public space and private allotments to minimise the length of feeders, however the use of HV cable in easements should be restricted.
- Notwithstanding the above, future access to the HV cable needs to be considered. Long lengths of cable in continuous easements, where access is difficult, must be avoided.
- The space required to install joints to extend or repair the HV cables can cause practical difficulties in narrow road reserves and where a reasonable alternative exists the route should follow larger roadways.
- Severe and multiple deviations in the cable route can cause difficulties with the cable installation as every angle of deviation is a multiplier of the pulling load. Consequently due consideration must be given to practicality of the cable installation in route selection and advice from installers should be sought where needed.
- High Voltage straight joints are to be minimized. Consideration should be given to continual HV conduits being installed in previous stages when they are not being constructed at the same time.

4.3 Cable proposal plan

The detailed design must be shown on a cable proposal plan. The cable proposal plan contains the detailed and dimensioned lay out of the electricity reticulation design including installation requirements for cables, conduits, joints, kiosk substations, pillars, service pits and public lighting.

In order to assess design clearances and a “workable” or “constructible” design; trench cross-sections and design details on construction drawings for all projects shall indicate asset depths and designed clearances of all proposed assets within the trench - not typical arrangements, a range of nominal depths or minimum/maximum depths.

The location of all other authority mains assets to be installed on a project (including comms/NBN) shall be drawn to scale in plan view on the cable proposal plan in addition to

being tabulated in the Services Schedule. Tree locations shall also be shown on the drawing - refer to section 5.10.17.

Lighting pole offsets from building line are also to be included in the Services Schedule in addition to a common or specific offset from back of kerb being nominated.

The cable proposal plan must include the following:

- Cable route and offsets to property boundaries
- Cable installation details
- Size and type of cables
- Cable Alignments
- Dimensioned trench cross sections in locations where more detail is necessary
- Dimensioned cable/conduit crossings
- HV and LV joint locations
- Dimensioned location, type and size of all conduits including conduit bending radii
- Location of Service pits;
- Dimensioned paralleling pillars and bollards position
- Dimensioned locations of substation/s and nominated kiosk reserve area
- Dimensioned location of public lighting columns;
- Public lighting lantern and lamp details;
- Location of drains and drainage pits;
- Property crossovers and footpaths;
- Building lines;
- Kerb lines;
- Lot numbers and street names;
- Service offsets;
- Cable easements;
- A schematic drawing of each kiosk with a table showing labels for all cable terminations and HV switch numbers;
- Location of existing underground cables and poles relevant to the construction works; and
- Drawing standard notes and references
- Location of Cable Head Poles and HV phasing (CHP's)
- Location of existing underground cables and poles relevant to the construction works; and
- Labels Schedule - A table showing labels for all cable termination's, substation name and, switch and pole numbers.
- Details of any temporary arrangements to be undertaken where connection to apparatus which is live or capable of being made alive is required. (e.g.; the burying

of cable at the base of an existing in-service pole onto which the cable is to be connected.

- Attention Note
- Legend
- Scale Bar
- North Point
- Drawing standard notes including adjoining drawing reference numbers
- DBYD block
- Cable pulling tension calculations / Cable pulling directions / any requirements to add lubricants during cable pulling
- Any other items required to facilitate the design

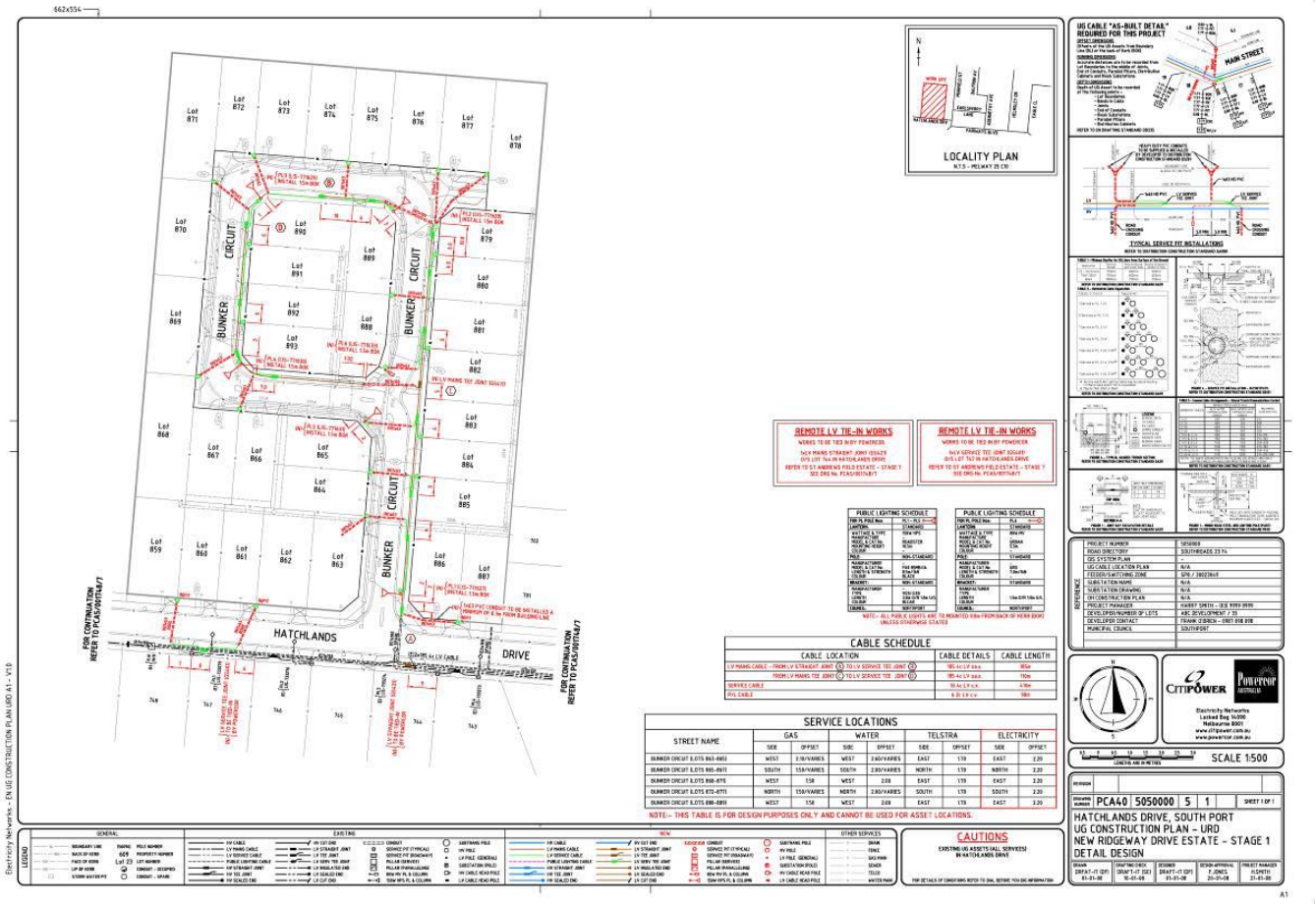


Figure 1 - Typical cable proposal plan

4.4 HV/LV Cables and conduit layout

4.4.1 General requirements

The following requirements need to be taken into account with the placement of conduits and cables:

- Power cables should be direct buried in the ground and protected with slab covers except where a cable:
    - Crosses a roadway or other paved surface;
    - Passes through an easement or crosses the easement of another authority (other than on roadways); or
    - Is in the close proximity of other assets. Refer to section 5.10.1.2

  In these cases the cable shall be installed in "heavy duty" solid wall, electrical conduit. See section 4.4.2 for details.
- The placement of cable and conduit must be designed to facilitate ease of installation and minimise the risk of damage to cables;
- The cable route must be designed to avoid severe changes in direction (radius bends approaching 90^0 angles will need to be softened for HV and LV mains cable to aid cable pulling, see below)
- Account must be taken of the minimum bending radii of cables in determining the cable layout. See section 5.8.3 cable bedding radii and Figure 2.
- Conduit bend dimensions are to be shown for each conduit on multiple runs
- Road crossing conduits for service cables should be placed such that they cross the road as near as practicable to right angles;
- HV and LV cable running parallel to the property boundary shall be a minimum 300mm away. This is for both a fenced or unfenced situation to cater for future changes
- Conduit ends must not be located under proposed driveways, in addition to this for lots with 16m frontages and greater conduits ends must not be within 5 metres of a property boundary to avoid any conflict with future driveways
- Conduit ends must not be located under paved surfaces
- Conduit ends should be clear of drainage pits;
- Conduit crossing the easement of another authority (other than on roadways) the conduit shall be further protected with cable covers;
- Conduit ends of future use conduits must not be installed more than 1200mm depth from surface level.
- Underground cables and conduits must have an orange marker tape installed, refer to section 5.5.2 for details.
- A schedule of services offsets including cable alignments shall be included on the cable proposal drawing (cable offsets will be subject to Municipal Council approval).

- Full cross section to electrical plans with all assets from back of kerb to building line
- Avoid service pit at last lot of each stage

4.4.2 Conduit requirements

Conduits used within the VESI networks shall be heavy duty, solid wall, electrical conduit to AS/NZS 2053. Sandwich Conduit is not to be used due to safety and cable hauling concerns A 150mm or 125mm conduit size must be used for HV cable and 100mm for LV mains, 63mm or 80mm (Jemena only) for all LV service cables and 32mm for public lighting cables. Refer to section 5.8 for conduit selection details. Polyethylene (PE) conduit manufactured to

- AS/NZS 4130 may be used with restrictions (increased depth) for direct bore applications. Refer to Section 5.10.1.5 and Table 1 for details.

Conduit must be installed as per section 5.8.

4.4.3 Clearance requirements

Cables shall maintain clearance to each other and other assets as per requirements stated in section 5.10.

The configuration of cables in trenches including minimum burial depths and protection are specified in sections 5.3 and 5.5.

4.4.4 Cable and conduit bending radius requirements

Power cables have limitations with respect to the radii around which they can be pulled. Radii vary with the type of cable, diameter of the cable and how the cable is being installed. Refer to sections 5.8.3 and 5.8.2 for cable and associated conduit bending radii.

Where cables need to cross to another roadway there is a need to offset the crossing conduit from the perpendicular to avoid:

- Excessive infringement of the space allocation of other services;
- Digging around other services on the roadway splay;
- Excessive excavations to accommodate the roller sets necessary for 90° bends;
- The larger mechanical loads to be managed during installations on 90° bends.

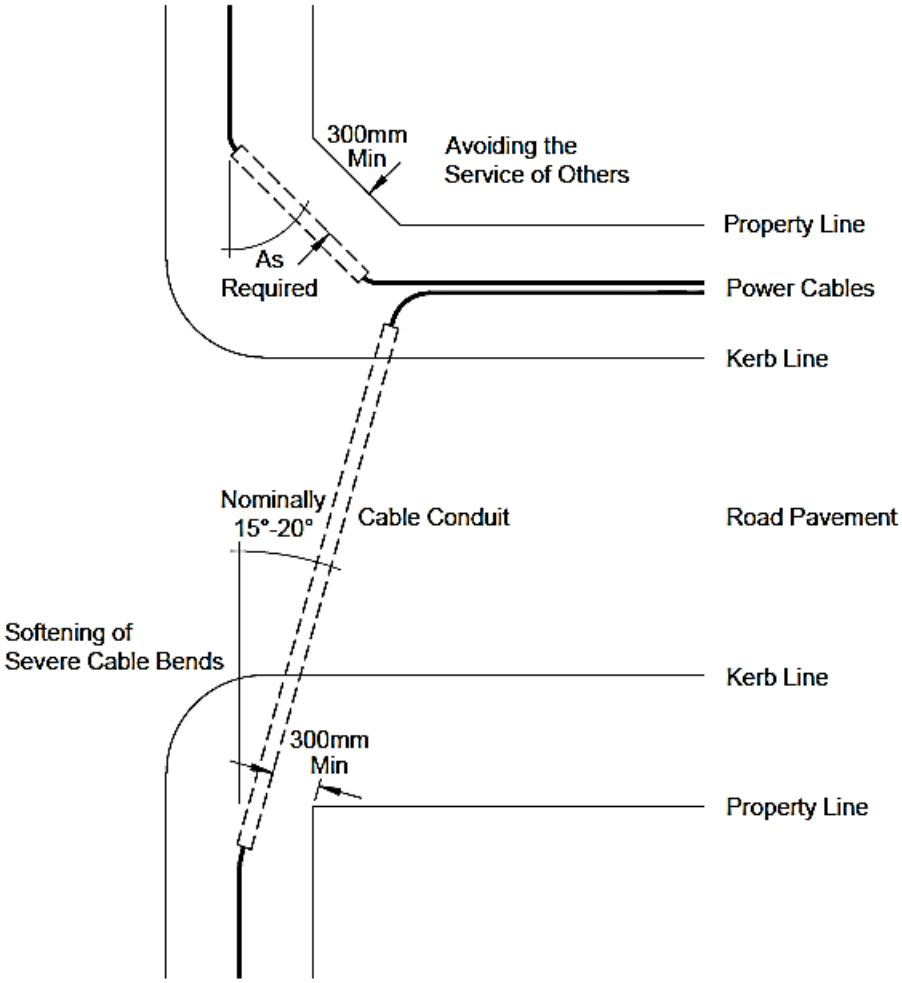


Figure 2 - Cable layout example

4.5 Substations

4.5.1 Distribution Business specific requirements

The size, construction, conduit arrangement and earthing details for kiosk substation reserves shall be designed and constructed as per individual DB requirements. Please refer to the kiosk substation standards of the specific distribution company within the network where the substation is being installed.

Each substation must be named on the cable proposal drawing. Naming convention is to be as per each DBs requirement. Please refer to the labelling standards of the specific distribution company within the network where the substation is being installed.

All HV and LV cables emanating from a substation must be designated with the names, suitably abbreviated if necessary, of the streets in which the LV cable has service cable connections to service pits. The names given must be sufficient to allow the identification of the LV cable which provides supply to each service pit. Please refer to the labelling standards of the specific distribution company within the network where the substation is being installed.

In some area REFCL installation program mandated by Victorian government to reduce fire start. In these areas REFCL isolating kiosk substation maybe required to be installed to maintain REFCL requirement. Please refer to the planning guideline of the specific distribution company within the network where the installation is.

4.5.2 Common VESI requirements

The substation installation must have the least impact upon a subdivision as far as practical and the site should be chosen in the following order of preference:

- In a Municipal Council reserve fronting the road reserve;
- In a corner lot at the rear of the property fronting the road reserve;
- In a lot with the largest frontage; or
- Should be located away from street corners and areas of high vehicular traffic

Notwithstanding these preferences, achieving the best practicable transformer utilisation remains the prime objective and this must not be compromised seeking to facilitate the above.

The substation reserve must:

- Be level, as far as practical (1 in 40 maximum)
- Not to be installed in the areas subject to declared 1 in100 year (or less) floods
- Have no other authority drainage outlets/grates located within the reserves, as this will have an impact on the site earthing, except drainage designed for substation site as per Figure 3
- Where necessary, construction of retaining walls may be required. Refer to section 4.5.4.

- Have no plants or vegetation located within the reserve, as plants and vegetation can become over grown, impeding access and also causing damage to the equipment
- Be shown on the cable proposal plans, including detailed cross sections from the trench to kiosk. Separate substation drawing showing all required construction details associated with the substation (e.g. levels, foundation, drainage, fencing, retaining walls, cable cross sections, all other assets, etc.) be produced for clarity.

Substation installation involves:

- Preparation of foundation
- Installation of conduits,
- Installation of high voltage and low voltage earthing systems,
- Placement of the substation on the foundation and termination of the installed high voltage and low voltage cables.

4.5.3 Kiosk Substation to Fire Hydrant Clearances

As per AS2419.1 (2017) – Clause 3.5.3.1, external fire hydrants must be greater than 10 metres away from any high voltage electrical distribution equipment such as transformers (kiosks).

4.5.4 Substations site preparation, retaining walls & Fences

4.5.4.1 General:

- It is preferable for land adjacent to the substation reserve area to be levelled such that there is no batter at the edge of the site. However, if the slopes are too great to allow this to be done, then the slopes must be battered to achieve slopes of no stepper than 1 in 5 from the substation reserve boundary onto adjacent properties.
- Where the difference in levels at any substation site boundary is between 0.3m & 1.5m, retaining wall should be installed. Other method may be approved for differences up to 0.3m. Where fill or cut exceeds 1.8m on any reserve boundary, an indoor substation shall be installed in lieu.
- Where fill is required and is greater than 200mm deep within the substation area, the filling material shall be, approved by the DB Responsible Officer and compacted in 150mm loose thickness layers to final density of not less than 90% of Australian Modified Maximum Density.
- Substation reserve area must be free of all obstruction above and below ground. This includes any customer owned infrastructure and service pipes or easements of other statutory authorities. Any metallic pipes buried direct in ground within 5 meters of substation HV earth grid to be insulated to 1.0kV minimum insulation level, in non CMEN area.
- Shrubs and trees must not be planted within substation reserve or on the road frontage outside the kiosk reserve

- Access to a kiosk with doors fully open is critical for safety and operational purposes. With doors fully open there must be a clear direct path for a person to exit in emergency conditions. For maximum personal safety a kiosk should always be installed with the doors facing to the most open point of the reserve area to the most accessible and unobstructed side of the reserve, Warning signage must be clearly visible when approaching the kiosk.
- Consideration for kiosk placement must include adjacent buildings, switchboards and vegetation. A kiosk should not be located with access doors directly in front of these objects.
- Final surface of the kiosk substation reserves shall be designed and constructed as per individual DB requirements.
- A concrete open invert drain should be installed, after cable installation, on any substation site boundary where the surface runoff from surrounding land would cause a flow of water onto the substation site, or where Municipal Council requires the site to be drained. Any invert or retaining wall drains shall be lead into a suitable pit (as shown) and be piped to the drainage system of the estate.
- Final kiosk foundations and kiosk installations shall not lean by an angle greater than 1.5° in any direction. This is to ensure adequate level of insulating oil in transformer.
- See below figures for general layout and site requirement:

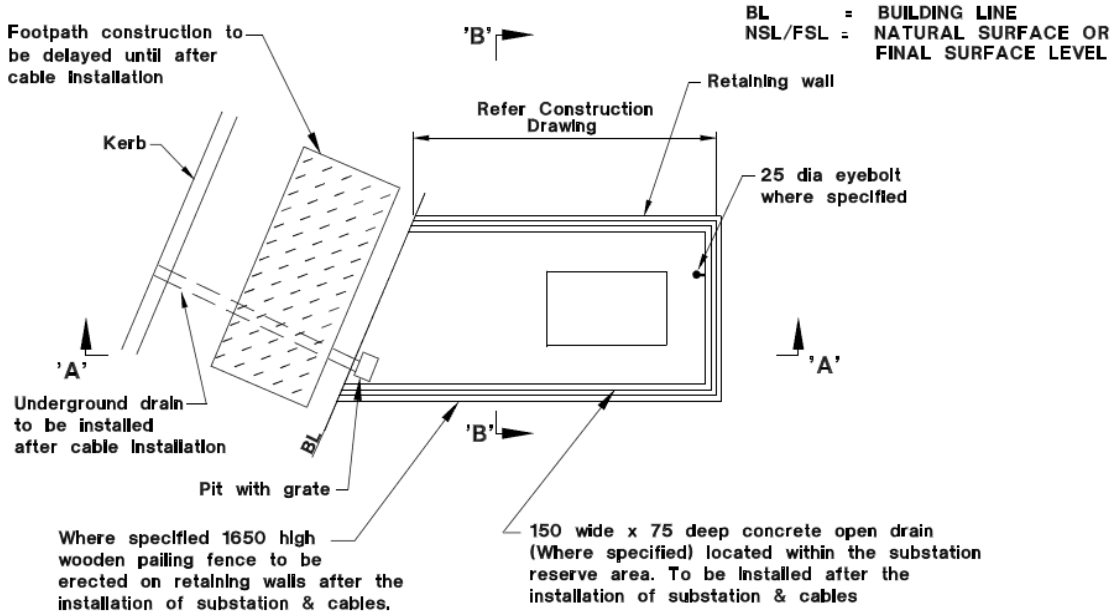


Figure 3 – Substation retaining walls & fences, Plan view

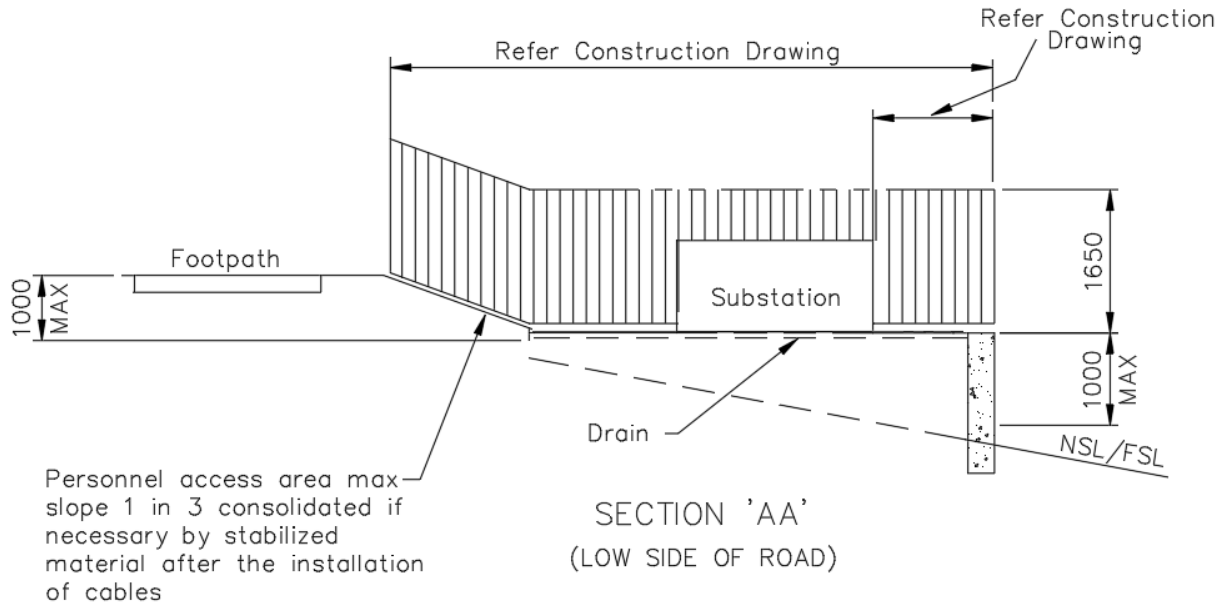


Figure 4 – Substation retaining walls & fences, low side of road

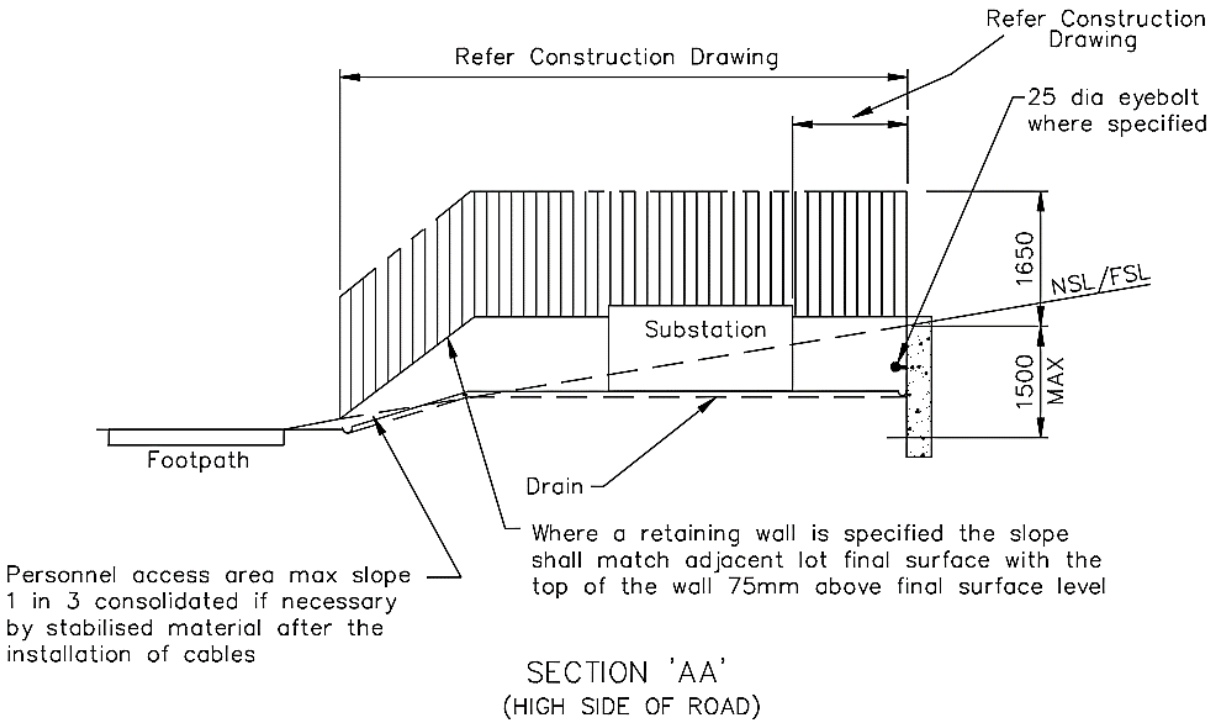


Figure 5 – Substation retaining walls & fences, high side of road

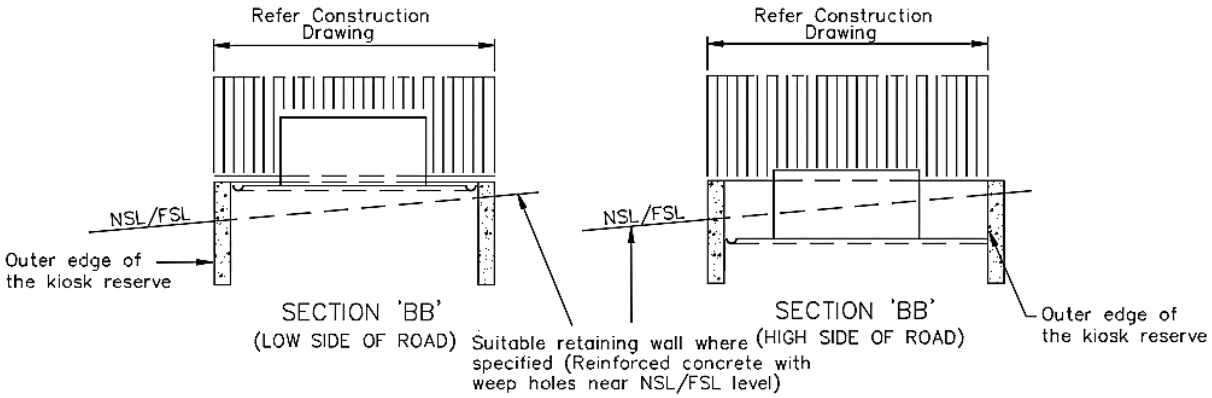


Figure 6 - Substation retaining walls & fences, Section 'BB'

4.5.4.2 Retaining Walls:

- Place the outer edge of the wall with the outer edge of the Kiosk reserve in the low side of road. Refer to Figure 6.
- Place the inner edge of the wall with the outer edge of the kiosk reserve in the high side of road. Refer to Figure 6.
- Wall footings to be 250mm below the Kiosk reserve level.
- Walls shall be no thicker than 300mm and shall finish at least 75mm above finished level of the outside land outside the boundary. Suitable weep holes shall be provided.
- 25mm diameter eyebolts rated to withstand 31kN tension are required in retaining walls where cable offset is on the opposite side of the road to substation. This is to be shown on the retaining wall engineering drawings.
- Cable conduits may be required to extend through retaining walls into substation site in some instances. Details will be supplied by the DB Responsible Officer.
- Complete engineering details of natural and finish levels, cut or fill, gradients, drainage, fencing or retaining walls and materials, as well as longitudinal and transverse cross-sections to at least 5m beyond the substation site boundaries shall be submitted to the DB Responsible Officer for approval.

4.5.4.3 Fences:

- Fences are mandatory around the perimeter of the substation site where retaining walls are erected and/or are situated on its own parcel of land abutting private property, such as reserve in a housing estate.
- Fences are optional when the substation site is located entirely on private property except where retaining walls are required.
- Fences are not required on boundaries with Municipal Council reserves except where retaining walls are required.

- Non-conductive fence (Minimum 1.65m high) to be placed around the Kiosk reserve where the wall is present; any post and rails shall be facing substation site. Palings on the inside are not preferred but can be considered on a case by case basis.
- Any fencing materials which are in contact with the ground shall be non-conductive. With the exception of nails and screws supporting the plinth, no metallic objects are permitted within 100mm of the finished surface level.
- If a fence is built on the retaining wall in non CMEN areas, the fence posts must be non-conductive but all other fence materials may be non-conductive or metal.
- Alternative non-conductive fencing will be considered in the rural environment with council approval
- Complete details of the proposed retaining walls and fence design shall be submitted to the DB Responsible Officer for approval prior to commencing any works.
- See below figures for retaining walls and fences requirement:

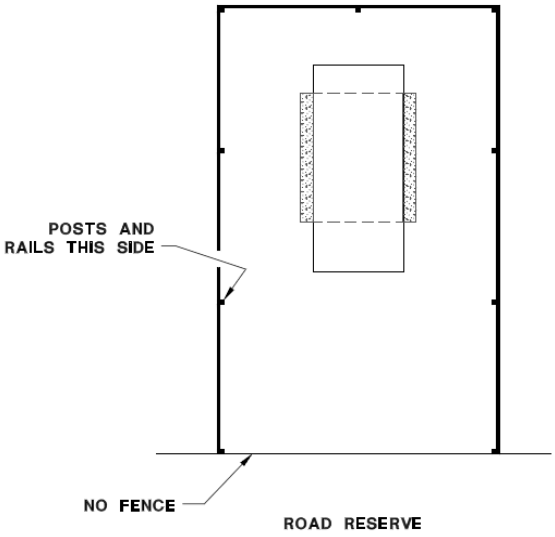


Figure 7 – Typical fence construction

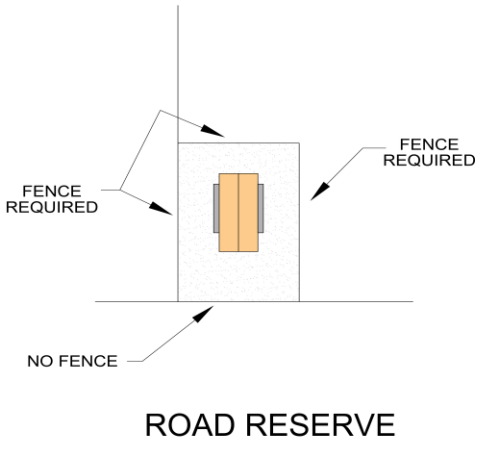


Figure 8 – Substation on private property & abutting adjacent title boundary

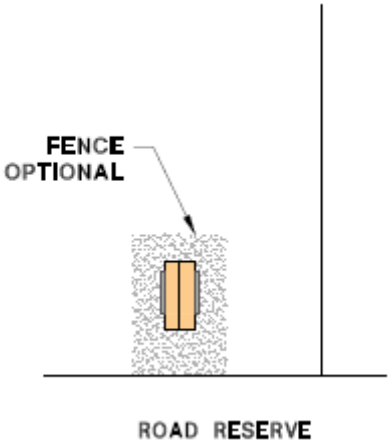


Figure 9 – Substation on private property

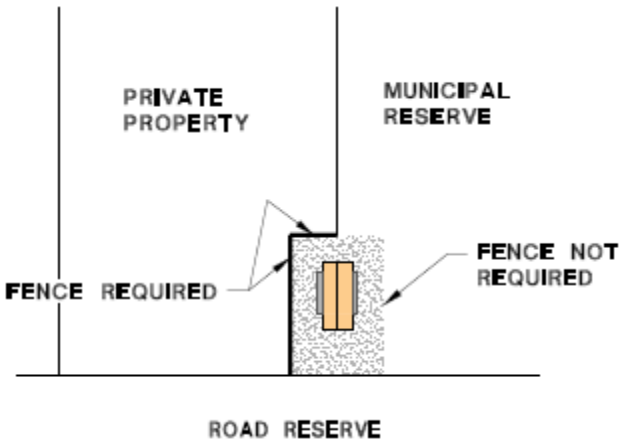


Figure 10 – Substation on its own parcel of land (kiosk reserve)

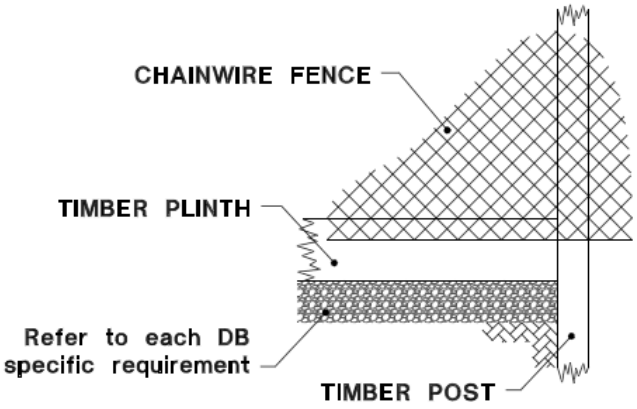


Figure 11 – Chain wire fence construction acceptable arrangement

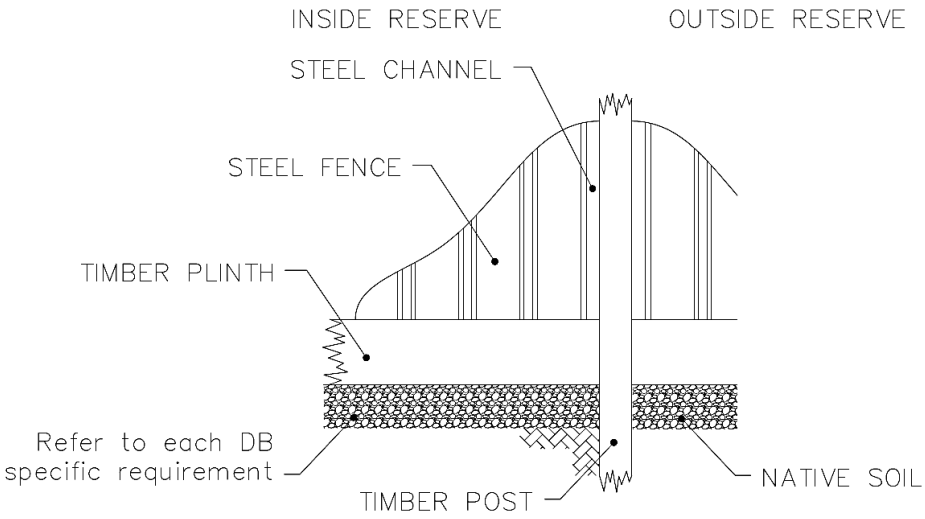


Figure 12 - Steel fence construction acceptable arrangement

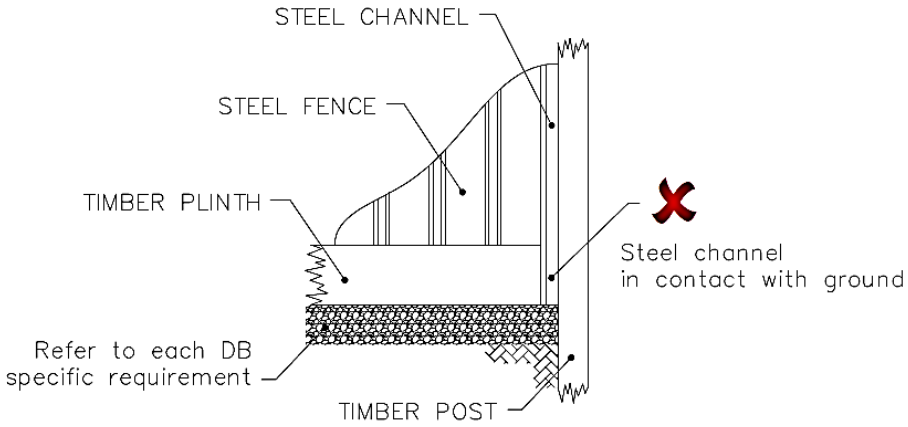


Figure 13 – Metal fence construction unacceptable arrangement

4.6 Pole Structures

Where subdivisions take HV supply from an overhead line, the type of CHP's structure must be specified. Details of pole structure are to be obtained from each DB specific to the area.

Cable bending radii must be considered at CHP's to ensure there is adequate space. Refer to Figure 25.

4.7 HV Cable Joints

Planned joint positions must be shown on the cable proposal plan. The selection of joint positions should optimise the utilisation of cable drum lengths and minimise the number of cable joints. The following provides guidance in this regard:

- The length of HV cable supplied on a full single drum will be approximately 500m and this length will enable the majority of runs from substation to substation to be in continuous lengths without the need for a joint.
- Where a substation is in close proximity to the edge of a subdivision stage, consideration should be given to installing conduit between the substation and the edge of the subdivision to "pull in" the cable at a future date and avoid a joint. As a general rule when the cost of a HV joint exceeds the cost of the conduit then conduit should be installed.
- Consideration must be given to the complexity of the HV cable run to and from the substation. If the cable, although installed over a very short distance has to pass through multiple bends it may be better to install the cable now, as pulling though conduit and many sharp bends at a later date may not be achievable.
- For HV joint bay dimensions, please refer to section 5.3.4.
- For clearance from trees, please refer to section 5.10.17.

4.8 LV Cable Joints

The selection of service tee joint positions should minimise the lengths of service cable required and be placed clear of obstructions to enable an excavated space sufficient to permit jointing.

Mains tee joints are used to make a solid connection to the through mains power cable to extend a mains cable into other streets. The joint position should be selected to minimise the length of the tee cable. Joint bay sizes are similar to those of a service tee joint.

Service tee joints and mains tee joints should be placed so that the joint is clear of any future driveways and conduit ends by at least 1.5m to provide sufficient space for a replacement joint if ever required.

For LV joint bay dimensions, please refer to section 5.3.4.

For clearance from trees please refer to section 5.10.17.

4.9 Low Voltage Paralleling Pillars

A low voltage (LV) paralleling pillar is an above ground pillar which houses a switch or link which connects and disconnects two low voltage cables. The pillar is installed on the cable alignment, generally between adjacent substations to provide flexibility of the network.

In general sufficient paralleling facilities are provided to enable a substation to be out of service and for about one third of its design load to be carried from peripheral substations ignoring voltage regulation. It is not expected that paralleling arrangements should be able to cope with peak load conditions. Generally where 185/240 mm^2 mains are used a minimum of two parallels should be provided for each substation, which means that some low voltage circuits may not have direct parallels but must be kept alive by feeding through the substation bus.

The paralleling pillar is normally left in the open position unless otherwise shown on the construction plan.

Due to the fact that paralleling pillars are installed above the LV distribution mains cable they are generally located on the nature strip and should be centrally placed in the front of an allotment between the driveway and the property boundary.

While the location mentioned above satisfies the electrical connection requirements, it does make the pillars readily accessible to the public and vulnerable to vehicle damage and vandalism. They can also be a potential tripping hazard to pedestrians. For these reasons the following applies to the installation of paralleling pillars:

- They should be located away from street corners and areas of high pedestrian and vehicular traffic.
- They shall be protected by either being located beside public light columns (where possible) and/or shall have protective bollards installed. Refer to Figure 14, Figure 15 &

  Figure 16 protective bollard installation requirements.
- They shall not be located within the tree zone as specified in section 5.10.17.

- Supplied with a reflective tape around the top of the pillar to increase their visibility

All paralleling pillars must be shown on the cable proposal plan and their location dimensioned.

Low voltage cable, service cable or public lighting cable supplied from a substation circuit must not extend past the location of any paralleling pillar. This is to ensure that customers and lighting associated with a substation circuit can be clearly identified.

LV service and public lighting cables are not to be connected to paralleling pillars. Labelling of pillar and circuits is to be as per individual DB requirements.

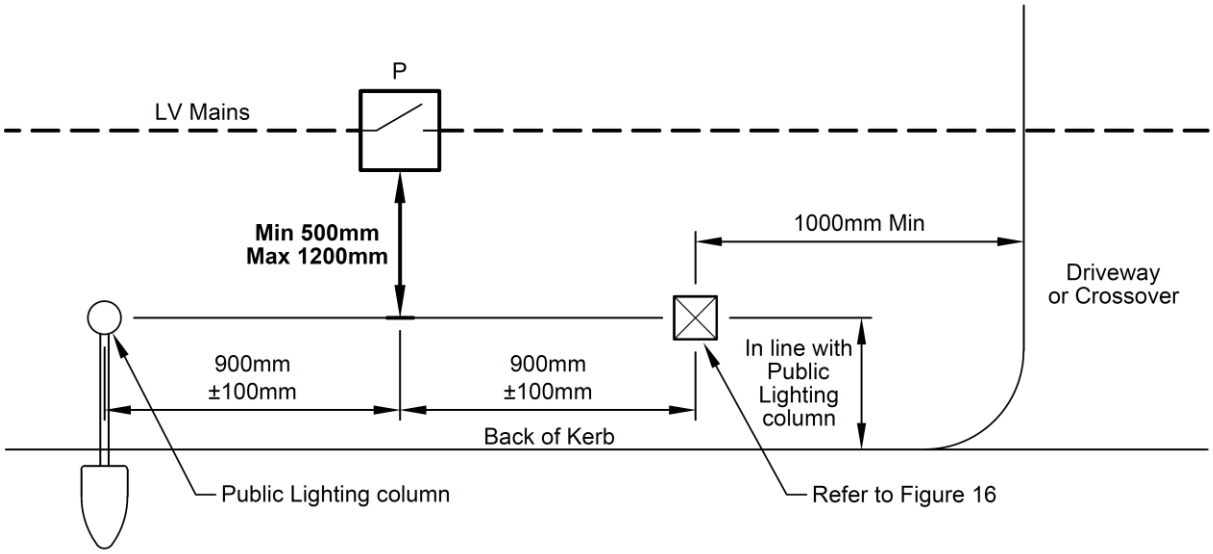


Figure 14 - With Public Lighting Present

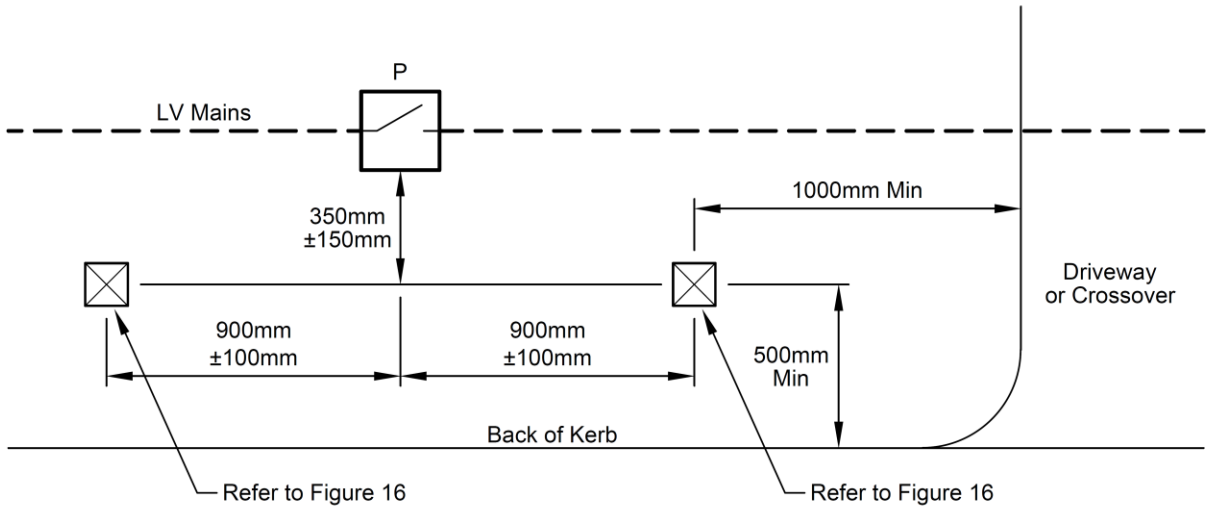


Figure 15 - Without Public Lighting Present

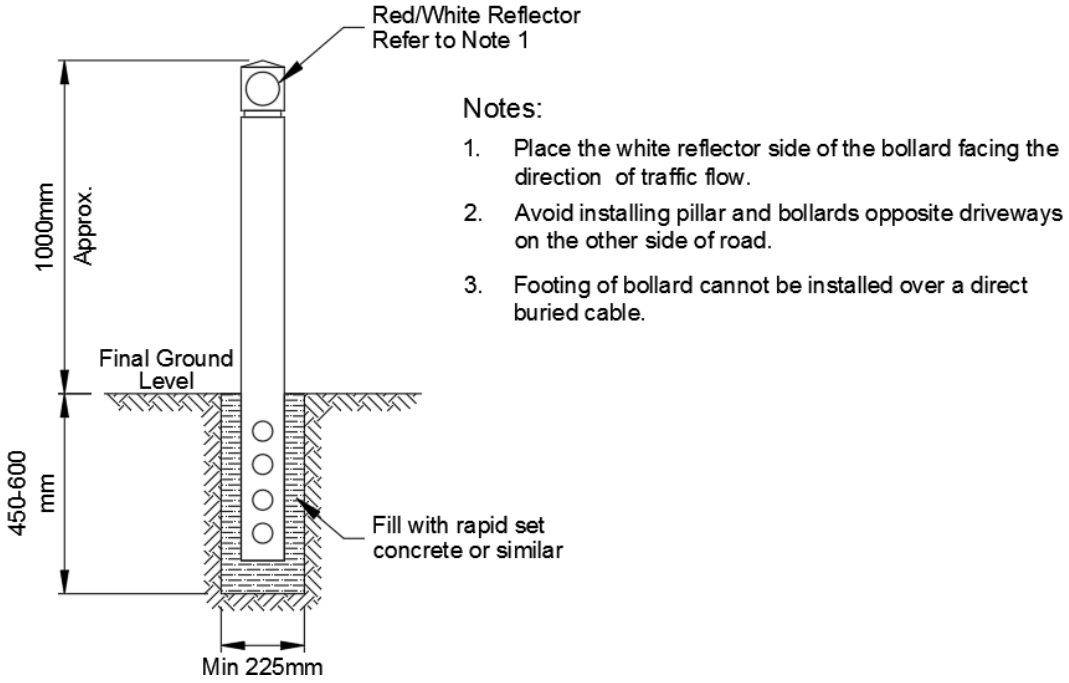


Figure 16 - Protective bollard installation requirements

4.10 Service Pits

Service pits are the standard method of providing an underground service for LV supplies up to170A per phase as per the Service Installation Rules (SIRs).

A typical underground servicing arrangement from underground LV mains is illustrated in Figure 17.

4.10.1 Service pit location

The service pit is generally located on the road reserve abutting the property boundary, and where practicable, located to serve two adjoining properties to minimise the number of pits and length of service cable to be used.

Service pits are to be located in non-trafficable locations (i.e. footpath) wherever possible. In situations where this is not possible and the service pit is located in a trafficable location (i.e. driveway), please refer to the specific distribution network business where the pit is being installed for trafficable pit options.

Consideration should also be given to installing pits at both boundaries of allotments that may be suitable for subdivision in the future i.e. larger than normal and/or corner blocks. However, a second pit cannot be installed on a lot if that pit is supplied from a separate LV circuit to that of the first pit.

Where electrical service pits are installed near a paralleling pillar, the service pit shall be supplied from a cable joint located on the same side of the pillar. The service pit shall not be

supplied from a cable joint located on the opposite side of the paralleling pillar as shown in Figure 18. Service pits must be shown on the cable proposal plan.

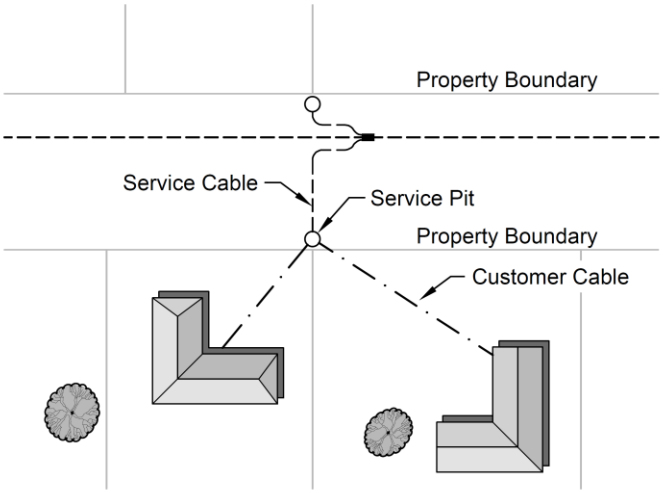


Figure 17 - Typical service pit arrangement

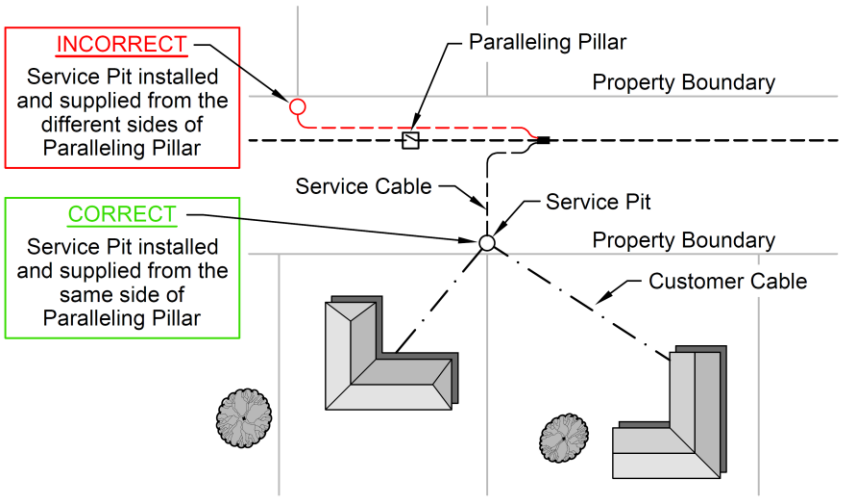


Figure 18 – Service pit & paralleling pillar installation & supply

4.10.2 Pit Maximum Offsets

4.10.2.1 Property Line Offset

Service pits shall be located as defined in sections 4.10.1 above and should be placed close as possible to the front title boundary but to allow for obstructions and offset footpaths, the following tolerances are allowed:

The maximum pit offset from the property line to the edge of pit where a concrete footpath is installed, is 400mm including a minimum of 150mm concrete encasement from the pit to the footpath edge. Where no footpath is installed the maximum offset from the property line to edge

of pit is 400mm. Refer to Figure 19 and Figure 20 below. Service pit with bottom entry must be installed with concrete encasement, Refer to Figure 21.

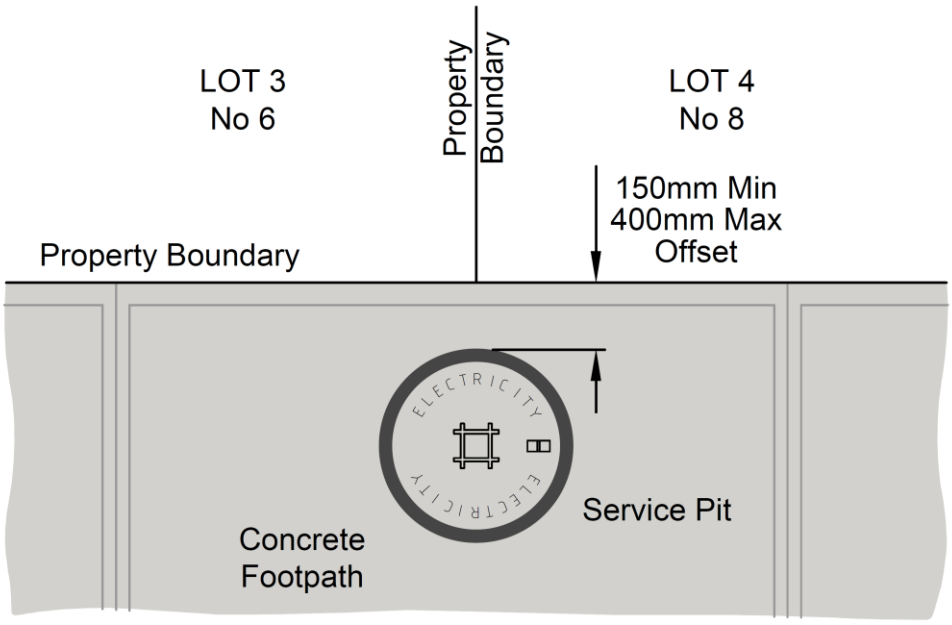


Figure 19 - Maximum service pit building line offset

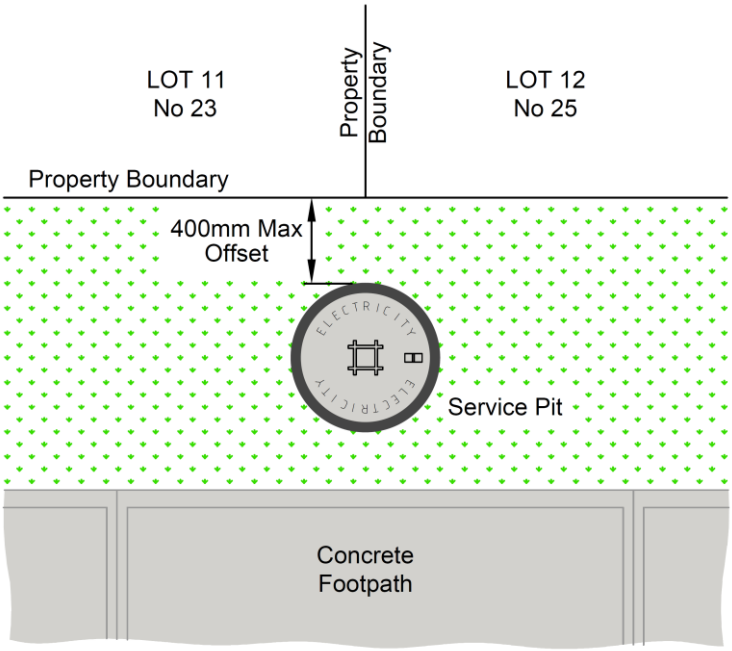


Figure 20 - Maximum service pit building line offset – no footpath

See below other acceptable arrangements for service pit installation.

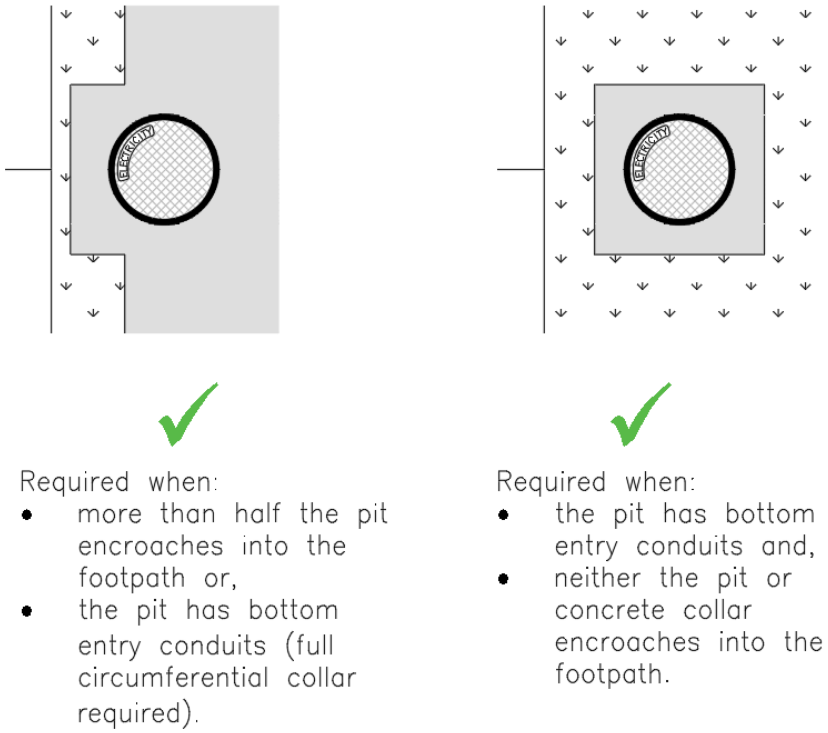


Figure 21 – Acceptable service pit installation

4.10.2.2 Lateral Deviation.

Service pits should be located as close as possible to common property boundaries (where applicable), but to allow for a maximum lateral deviation of 200mm is allowed from a common property boundary to the pit centre. Orientate the pit to ensure lead-in conduits do not cross neighbouring property boundary.

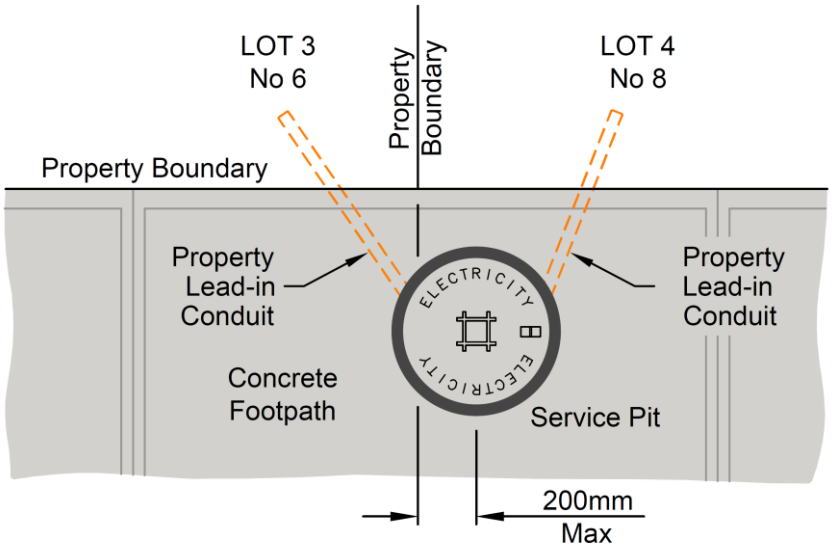


Figure 22 - Maximum service pit lateral offset

Installation On Sloping Ground

Where pits are installed on sloping ground they shall be installed on an angle to match the ground conditions. Level installation where sloping ground exists can result in a “cut and fill” situation with a portion of the pit exposed which may affect the depth of cover over the conduit(s). No part of the pit shall be in private property.

For gradients greater than 15 degrees a special design or ground treatment may be required (e.g. the ground levelled or stepped), including consideration for conduit cover depth.

Approval of engineering drawings must be obtained prior to installation, contact the DB Responsible Officer for further details.

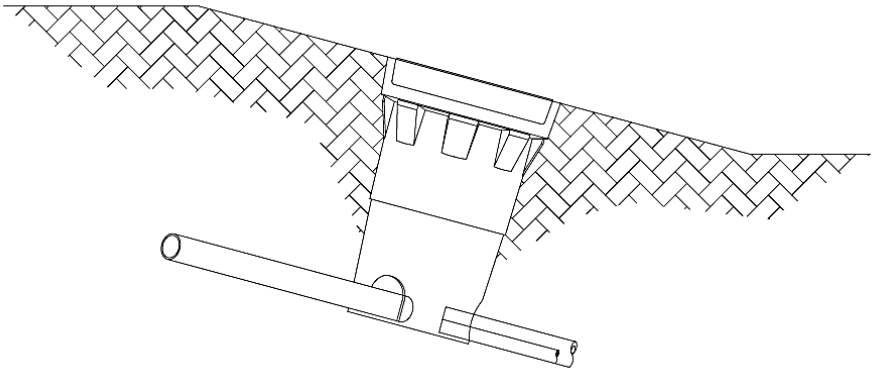


Figure 23 – Pit installation on sloping ground

4.11 Public Lighting

The Public Lighting scheme for the development will be shown on the cable proposal plan and must be in accordance with the Public Lighting Technical Standard of the relevant DB.

Should major road lighting be required as part of the development this must also be designed and incorporated in the cable proposal drawing.

All public lighting proposals must be submitted to the local Municipal Council or DoT for approval. With regard to installation of columns:

- Columns should not be placed within 6 metres of adjoining property boundaries, to be approved as part of public lighting approval, for lots 16m frontage or greater.
- Edge of columns shall not be placed within 300mm from the edge of storm water pits;
- Columns should not be placed within 1.0 metre from the edge of pram/pedestrian crossings and driveways;
- Columns shall be installed a minimum 0.8m from back of kerb (as per Municipal Council requirements) or unless otherwise specified
- Columns must be supplied from the nearest service pit unless:
    - The service pit already supplies a public lighting column; or
    - The pit is located physically past a paralleling pillar.

- The service pit is congested with the cables

Where a suitable service pit is not present and a number of public lighting columns require supply, looping between poles is not allowed. Each pole is to have a service pit adjacent or nearest to the pole with public lighting cable looped from pit to pit. Supply to column will be from within the adjacent pit.

4.12 Non-Standard Public Lighting Columns

Approved non-standard public lighting columns may be used with the agreement of the Municipal Council.

The installation would be subject to a formal agreement between the DB and the Council. It is the developer's responsibility to determine the willingness of the distribution company and the Council to enter into such an agreement.

The developer should seek the advice of the DB and the Council in this regard.

5 CONSTRUCTION REQUIREMENTS

5.1 Construction planning requirements

Construction of an underground electricity distribution system in a medium density residential subdivision generally consists of:

- trenching;
- laying of high voltage, low voltage, service and public lighting cables;
- laying of conduits;
- laying of bedding sand and protective cover slabs;
- preparation of substation foundations;
- substation installation and earthing works;
- installation of public lighting columns;
- installation of pillars and service pits;
- jointing and terminating cables;
- backfilling and site cleanup;
- testing;
- detailed recording of cable location and other associated works as detailed on the construction plan.

5.2 Construction Plan

The cable proposal plan when approved by the DB will form the construction plan.

The construction plan must show trench cross-sections and design details for all projects indicating actual asset depths and designed clearances - not typical arrangements, a range of nominal depths or minimum/maximum depths.

The location of all other authority mains assets to be installed on a project (including comms/NBN) shall be drawn to scale in plan view on the proposed construction drawing in addition to being tabulated in the Services Schedule. Tree locations shall also be shown on the drawing - refer to section 5.10.17.

Lighting pole offsets from Building Line are also to be included in the Services Schedule in addition to a common or specific offset from Back of Kerb being nominated.

The construction plan must include:

- Cable route and offsets to property boundaries
- Cable installation details
- Size and type of cables
- Cable Alignments
- Dimensioned trench cross sections in locations where more detail is necessary
- Dimensioned cable/conduit crossings

- HV and LV joint locations
- Dimensioned location, type and size of all conduits including conduit bending radii
- Location of Service pits;
- Dimensioned paralleling pillars and bollards position
- Dimensioned locations of substation/s;
- Dimensioned location of public lighting columns;
- Public lighting lantern and lamp details;
- Location of drains and drainage pits;
- Property crossovers and footpaths;
- Building lines;
- Kerb lines;
- Lot numbers and street names;
- Service offsets;
- Cable easements;
- A schematic drawing of each kiosk with a table showing labels for all cable terminations and HV switch numbers;
- Location of existing underground cables and poles relevant to the construction works; and
- Drawing standard notes and references
- Location of CHP's and HV phasing
- Location of existing underground cables and poles relevant to the construction works; and
- Labels Schedule - A table showing labels for all cable termination's, substation name and, switch and pole numbers.
- Details of any temporary arrangements to be undertaken where connection to apparatus which is live or capable of being made alive is required. (e.g.; the burying of cable at the base of an existing in-service pole onto which the cable is to be connected.
- Attention Note
- Legend
- Scale Bar
- North Point
- DBYD block
- Cable pulling directions (if required)

5.3 Cable Trenches

Typical trench details contained in this standard apply to road reserves, private property and road crossings.

HV cables shall be installed on the road side of LV cables.

Trenches must be constructed along the alignments shown on the construction plan and must be kept as straight as possible.

The bottom of the trench must be free of all sharp projections and provide uniform support for the cable or conduit.

For embedment and backfill of trenches please refer to section 5.4.

5.3.1 Depths of cover/Burial Depths

The minimum burial depths referred to in Table 1 apply to all underground low voltage, high voltage and sub-transmission cables installed. Minimum burial depths are defined as the minimum depth of the line from the uppermost surface of the cable or conduit enclosing the cable, i.e. the ground cover over the top of the cable or conduit.

Application	Directly Buried with Cover Slab	Buried Enclosed in HDPVC Conduit	Bored installations enclosed conduit*
LV - multi-core	600mm	600mm	750mm
11kV - 22kV	600mm	600mm	750mm
66kV	750mm	750mm	1000mm

Table 1 - Minimum Depths for U/G Cables from the Surface of the Ground

*Marker tape not required in bore application, refer section 5.5.2.4. HDPVC or PE conduits may be used however 750mm minimum burial depth is required due to the absence of marker tape.

An underground cable must not be closer to the final surface level of the ground than the relevant minimum depth specified in Table 1. Minimum specified burial depths must also be maintained at entries to vaults, etc.

These depths do not apply to:

- the first 1000mm of a low voltage underground cable system; and
- the first 2000mm of a high voltage underground cable system,

from the point where the underground cable system enters the ground if that initial portion of the cable system is protected by a DB approved mechanical cover or conduit or pipe.

Minimum specified burial depths must also be achieved under all finished surface levels and this includes under the edge of roads and the gutter (channel) where a kerb and channel is constructed. For a typical 150mm invert kerb and channel, to achieve 600mm cover beneath the channel (HD Cat A conduit) a depth of 750mm at the top of Back of Kerb (BOK) is required. Similarly where polyethylene (PE) conduit is utilised for boring installations (750mm cover required) for a 150mm kerb invert the depth required at BOK would be 900mm. Refer to Figure 24.

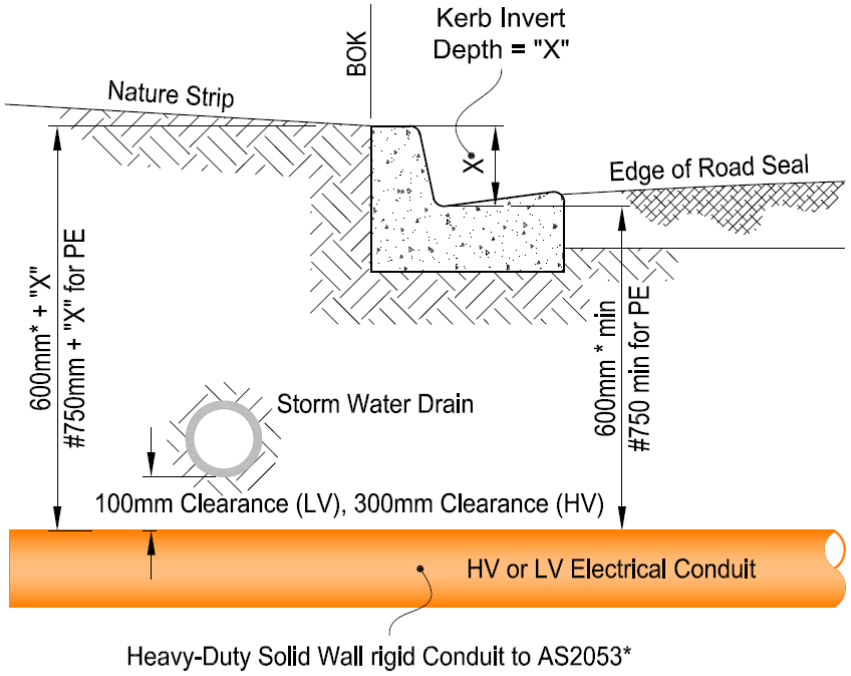


Figure 24 - Depth under Invert kerb and channel

5.3.2 Trench Depths

The minimum trench depth for direct buried cables is generally the sum of, the depth of the cable (from the surface level), the diameter of the cable, plus a minimum100mm of bedding material. Refer to section 5.6.

The minimum trench depth for cable in conduit is generally the sum of, the depth of the conduit (from the surface level) and the diameter of the conduit. Refer to section 5.7.

Trench depths for shared trenches may vary; see sections 5.10.3 & 5.10.4 for typical trench details.

To the extent possible, trench bottoms shall be level and be relatively smooth undisturbed earth without sharp rises and drops in elevation. Rocks or ridges shall not project into the trench. Should a trench be left open for a prolonged period of time (e.g. overnight), it shall be the civil contractor's responsibility to do any trench cleaning prior to cable installation.

Cable current ratings are affected (de-rated) by installations deeper than 600mm cover, the deeper a cable is buried the more mass of earth surrounds it and the more difficult it is for heat to be transferred away from the cable. This causes the cable to heat up, become less efficient at conducting electricity and lowers its current carrying capacity (de-rating the cable) Within the VESI networks, cables shall be buried up to a maximum depth of 1400mm (maximum trench depth of 1500mm). This depth has been chosen to minimise cable derating and also minimise safety risks of people working in deep trenches in the future, where maintenance or repair may be required on the cable. While this maximum depth has been allowed for construction

purposes, the appropriate selection of cable (e.g. 185mm², 240mm² cable) based on the cable depth must still be taken into consideration to ensure required current ratings are achieved. Please refer to the system planning guidelines of the specific distribution company within the network where the cables are being installed.

Note that this maximum depth is effectively considered to be the bottom of the installed asset or embedment material for access and maintenance purposes, not the cover depth. Refer to Figure 26.

Trench or boring depths greater than this shall require prior approval from the DB Project Responsible Officer who shall verify the reasons for the proposed increased installation depth and confirm that no other reasonable engineering solution is available.

The DB Project Responsible Officer will confirm approval together with any additional requirements necessary to mitigate cable rating and future access issues, such as the use of trench thermal backfill material and/or spare conduits.

Furthermore the proposed construction drawings must show the actual arrangement in accordance with section 4 as applicable.

The above trench depth limit of 1500mm does not apply to HV cable head poles for a maximum distance of 2m from the pole, to allow for cable bending radius where required. Where the incoming conduits are from a road crossing, a maximum distance of 5m is allowed. Refer to Figure 25.

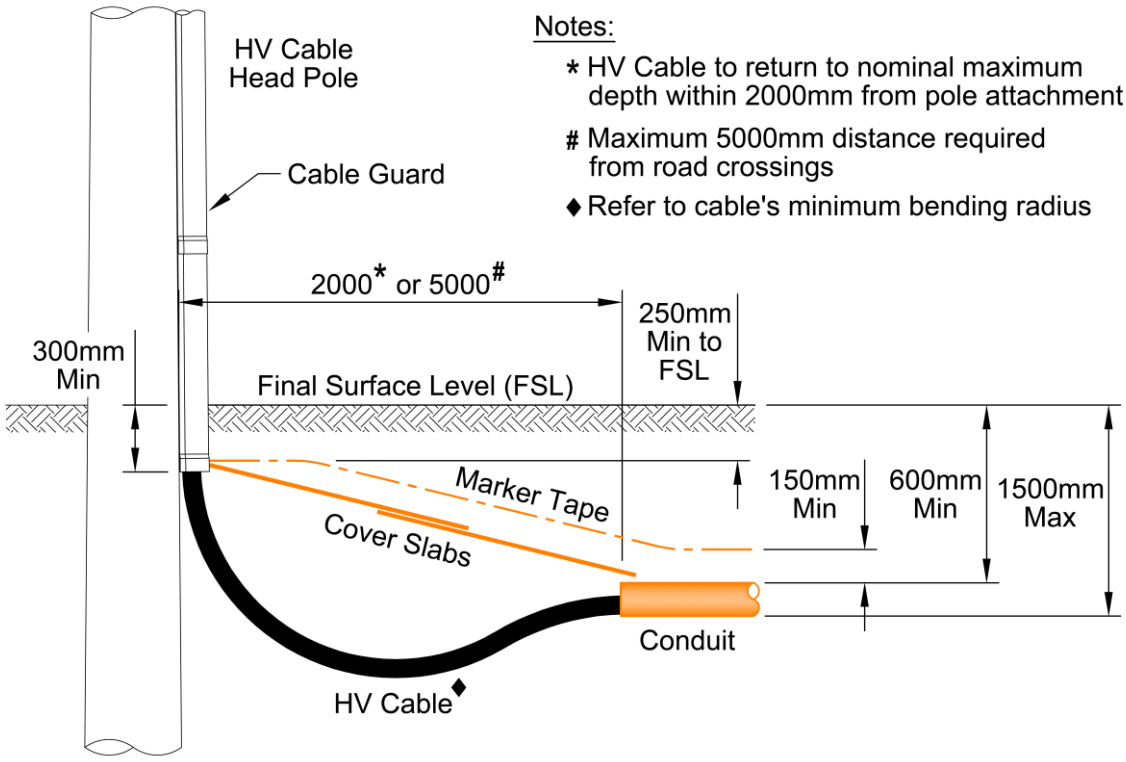


Figure 25 - HV cable bending radius at cable head pole

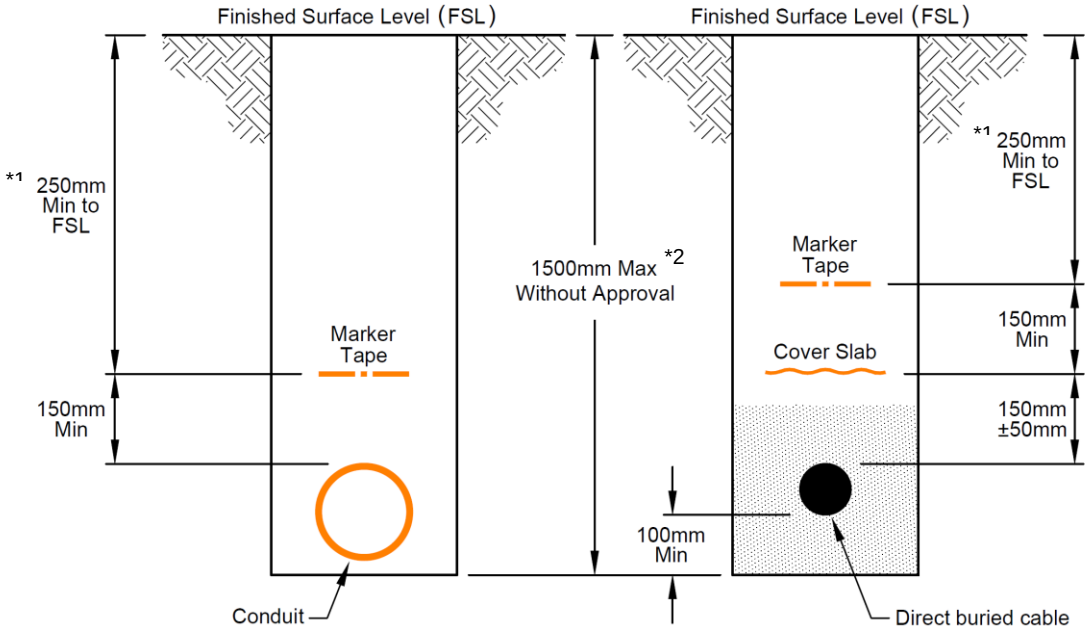


Figure 26 - Maximum trench depths without DB approval

Note: *

1. Marker tape should be located no deeper than 600mm from FSL. If working within AusNet's network and marker tape is required to be located deeper than 600mm please refer to AusNet's policy.
2. Appropriate selection of cable (e.g. 185mm², 240mm² cable) based on the cable depth must still be taken into consideration to ensure required current ratings are achieved

5.3.3 Trench Widths

The width of a trench is determined by the cables to be included, other authorities' assets, and recommended separation between circuits given in section 5.10.3, as well as considering practical working widths. Typical trench widths for common cable arrangements are given in Table 4 and Table 12 to minimise excavation and bedding costs, a trench should not exceed the recommended widths specified in these tables.

5.3.4 Trench Widths for jointing purposes

The following section provides typical dimensions of a trench for jointing purposes. These dimensions allow adequate space for personnel to undertake jointing works safely and efficiently.

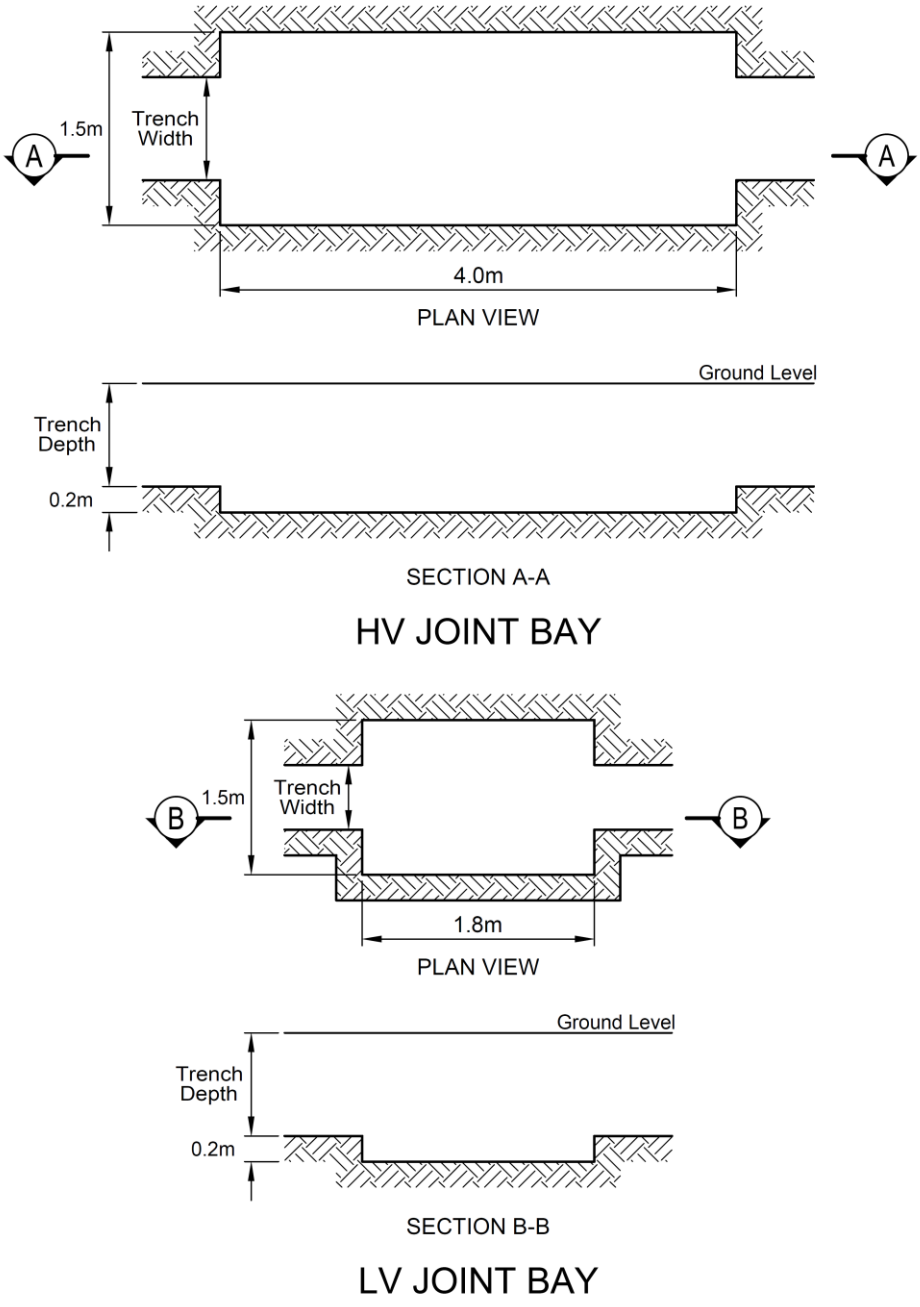


Figure 27 - Joint Bay Excavation Details

5.4 Embedment and Backfill Requirements

Embedment is the material surrounding the cable or conduit that provides screening, bedding and heat dissipation for thermal rating. For direct buried cables, the site excavated soil is generally not suitable for embedment due to rocks, sharp objects and corrosive matter that may damage the cable.

Backfill is the material used to fill the trench from the top of the embedment material to the ground line for non-paved areas or re-instatement level for paved areas. Backfill also affects cable thermal rating.

Both embedment and backfill material may be classified as either Trench Thermal Resistivity (TR) Non-critical or Trench TR Critical where cable thermal current rating must be optimised. The project Network Scope will specify where Trench TR Critical is required. This standard will only discuss TR non critical installation as this is most common in URD installations. For TR critical installation please contact the DB of the specific site.

5.4.1 Embedment

5.4.1.1 Cables Direct Buried

For direct buried cables a “Washed Concrete Sand” to AS2758.1 shall be used.

Sand is used around direct buried cables to provide a soft supporting surface/material for the cable to be installed and pulled through. Without this soft supporting material the cable outer sheath can be damaged allowing water ingress into the cable, eventually causing cable failure.

To ensure the cable is not damaged the sand must:

- Be clean, washed (free of organic material and be between a Ph level of 6 and 8), and be a natural sand (such as river sand). Unwashed or contaminated sand can damage the cable and also corrode earthing conductors near electrical equipment causing safety issues.
- Not have rocks, gravel, building rubble, tree roots, solvents, glass or metal, as these materials may damage the cable outer sheath allowing water ingress, eventually causing cable failure.
- Not have clay, as clay becomes hard when it dries making it difficult to access the cables without damage if maintenance or upgrading of cables is required. Clay can also shrink and swell when exposed to water imposing stress on the cable.
- Not be a manufactured or crushed product.
- Be a distinct colour from the surrounding native soil.
- Have water filtering properties to drain water away from cables, joints and other assets (such as kiosks) to avoid water damage.

Sand used for bedding shall comply with the particle size distribution requirements shown in Table 2 when tested in accordance with the latest edition of AS1141.11.1 (Sieve tests on the installed material shall be made available when requested).

Sieve Size (mm)	Percentage Passing by Mass
4.75	95 to 100
2.36	95 to 100
0.075	0 to 5

Table 2 - Particle Size Distribution Requirements for Bedding and Backfill

Figure 28 - Examples of compliant sand

Figure 29 - Examples of **non-compliant** bedding material - Sand containing clay

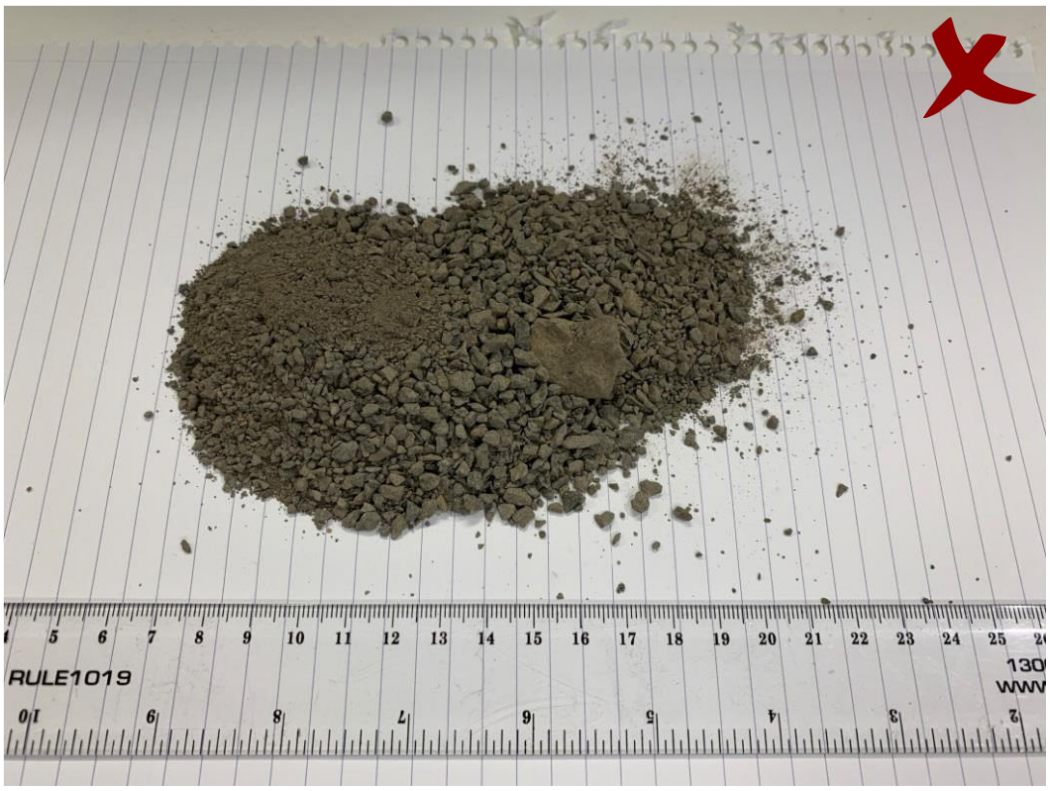


Figure 30 - Examples of **non-compliant** bedding material – Gravel

An embedment layer of 100mm minimum thick (measured after compaction) above and below the cable(s) is required.

The bedding and screening material shall be tamped to ensure there is no air space left, particularly in close vicinity to the cables, which would give rise to an increase in the external thermal resistance. Mechanically operated rammers shall not be used for this purpose.

5.4.1.2 Cables in Conduit

For cables in conduit embedment material is not required around conduits unless specified otherwise on the approved cable construction plan. Soil excavated from site may be used.

5.4.2 Backfill

Backfill is the material used to either partially or completely fill the trench after cable or conduit installation. Soil excavation must comply with state/federal legislative environmental requirements.

5.4.2.1 Cables Direct Buried

Backfill is the material used to fill the trench from the top of the embedment material to the ground line for non-paved areas or re-instatement level for paved areas. (Paved areas are road surfaces and subgrades subject to vehicle use and weight loads.)

5.4.2.1.1 Non-Paved Areas

Subject to soil contamination or specific Municipal Council requirements, where possible the soil (which must be clean and free of impurities and rocks) originally removed from the trench should be used as backfill. The soil shall be compacted during reinstatement to ensure ground subsidence will be negligible. Reinstatement shall be to Council requirements.

5.4.2.2 Cables in Conduit

5.4.2.2.1 Non-Paved Areas

Subject to soil contamination or specific Municipal Council requirements the soil originally removed from the trench or crushed rock is to be used as backfill. The soil shall be compacted during reinstatement to ensure ground subsidence will be negligible. Reinstatement shall be to Council requirements.

5.4.2.2.2 Paved Areas (Roadways)

In paved areas all trenches will be backfilled to Municipal Council or Road Authority requirements.

If there is no specific Council or Road Authority requirement then all trenches will be backfilled with wet mix of Class 3, 20mm crushed rock in 150mm layers. Each layer shall be at optimum moisture content and thoroughly compacted with mechanical rammers to 95% modified relative compaction before the next 150mm is added. Soil must not be used for backfill. Where specified, the final layer of consolidated crush rock shall be surfaced with a 25mm compacted layer of cold mix asphalt consolidated to a level flush with the adjacent pavement surface. The surface shall be even and tidy with all surplus material broomed and removed from street. The content of cold mix shall be to the requirement of local authority.

5.5 Cover Slabs and Marker Tape

5.5.1 Cover Slabs

Cover slabs are used to provide mechanical protection to cables and for the safety of construction workers, during future excavations. Unprotected cables can be damaged and also pose a health and safety risk to construction workers if they are hit during excavation.

Therefore the correct installation of cover slabs on URD estates is an important safety requirement.

As mentioned in section 5.3.1, Table 1, all direct buried cable shall be installed with cover slabs.

5.5.1.1 Permitted Material

- Polymeric cover slabs that comply with AS4702 shall be used
- Allowable cover slab specifications are provided in Table 3 below

Nominal Width (mm)	Profile	Minimum Thickness (mm)	Length (mm)
210	Corrugated	5	1200
300	Corrugated	5	1200
200	Straight	5	1200
300	Straight	5	1200

Table 3 - Polymeric Cover Slab Details

5.5.1.2 Installation Profile

- Corrugated profile cover slabs are designed to interlock with each other to eliminate movement of the slabs, however this corrugated profile also make them very rigid and difficult to bend. This cover slab shall be used to cover direct buried cables for all installations where possible.

- Straight (flat) profile cover slabs do not interlock with each other and therefore are prone to movement; however they are move flexible and can be bent to follow the vertical cable contour. Therefore they are permitted to be used to protect direct buried cables in the following situations only:
    - At cable head poles
    - LV pillars & cabinets
    - Behind public light columns
    - Kiosks & HV switching cabinets
- Straight profile cover slabs shall only extend a maximum distance of 1m past the cable turning point

5.5.1.3 Installation Requirements Typical Trench Section

This requirement shall be used for all typical trench section situations where direct buried cables are installed:

- Cover slabs shall be installed 150mm -50/ +50mm above the cable/s in typical trench situations as shown in Figure 31.
- Cover slabs shall be installed to overhang the cables by a minimum of 40mm
- Where multiple cover slabs are installed they shall overlap each other by no less than 50mm both sideways and lengthways.
- Cover slabs shall overlap conduit end by a minimum of 50mm
- If there are multiple direct buried cables in the same trench at different burial depths the cover slab shall be placed 150mm -50/+50mm from the top most cable. Refer Figure 31.
- Due to construction complexity cover slabs may be installed at an increased distance above the cables in “limited situations” as specified in clause 5.5.1.5.

5.5.1.4 Cable entry/termination points

- Within 1m to an LV asset or 2m to the HV asset cable entry points (e.g. Terminations) the cover slabs shall be placed in such a manner to provide the intended mechanical protection to all the cables in the vicinity. A typical arrangement is shown in the Figure 32 & Figure 33. Multiple slabs shall be used to cover multiple cables. The typical VESI asset as shown could be;
    - Kiosk entry/exit (HV asset)
    - Paralleling pillar entry (LV asset)
    - CHP’s entry (HV or LV asset)
    - Any other similar cable arrangements

5.5.1.5 Installation Requirements limited Situations

- Within 1m to an LV asset or 2m to the HV asset this requirement may be used in the limited situations of the assets described below.
- Cover slabs shall be installed to overhang the cables by a minimum of 40mm
- Cover slabs shall overlap each other by a minimum of 50mm

The cover slab may be installed up to 150mm -50/+50mm from the top most cable at these locations:

- Cable joints
- Cable intersecting points
- Cable / conduit crossings
- Between conduit ends and the mains cable trench

Refer to Figure 34, Figure 35 and Figure 36.

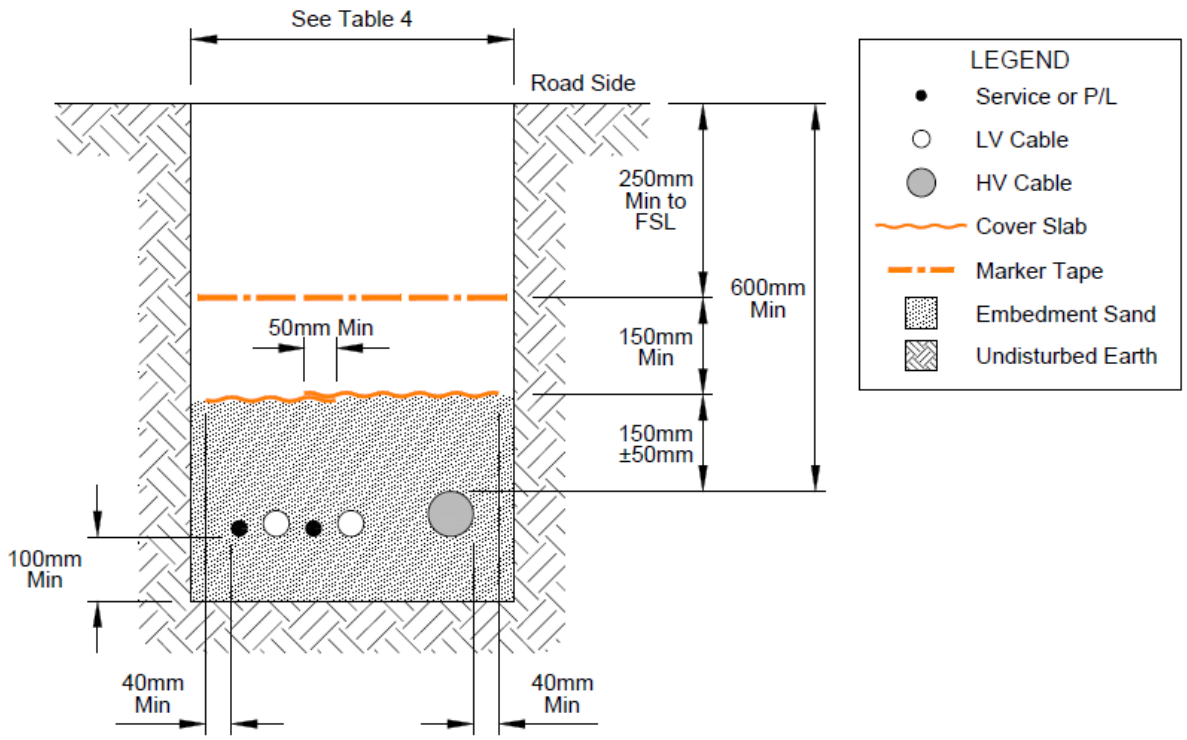


Figure 31 – Typical trench section with cover slab and marker tape

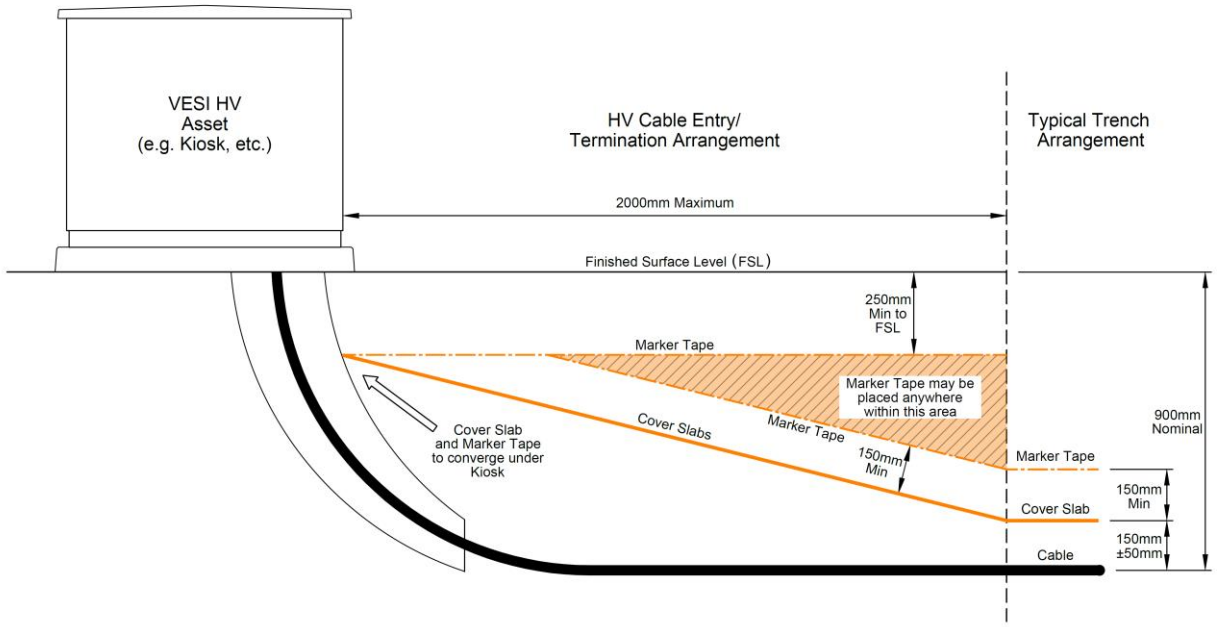


Figure 32 – Typical trench arrangement with cover slabs and marker tape for HV assets

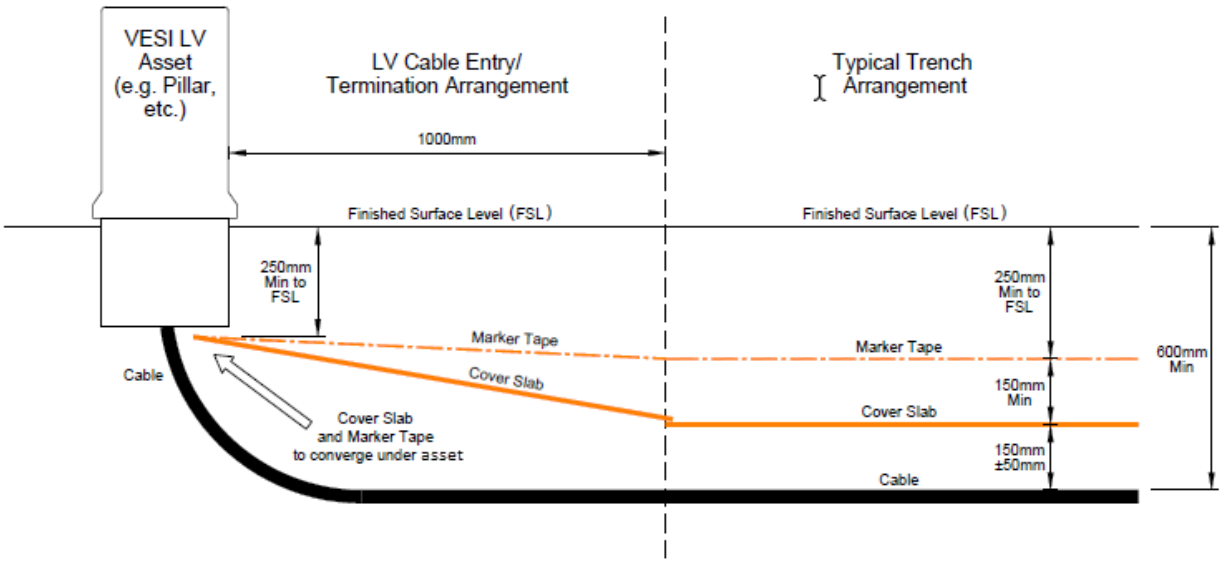


Figure 33 – Typical trench arrangement with cover slabs and marker tape for LV assets

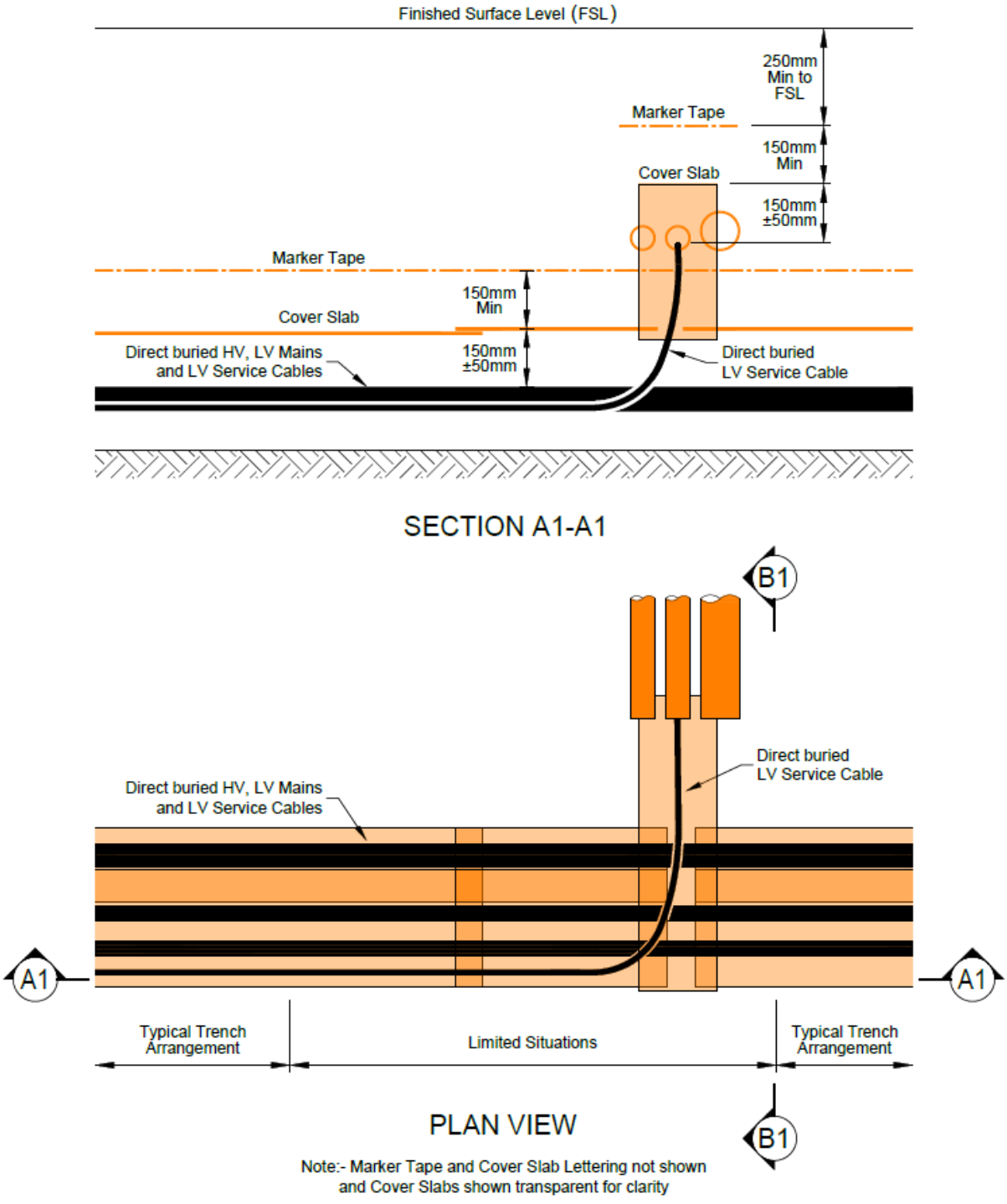


Figure 34 – Limited situations arrangement

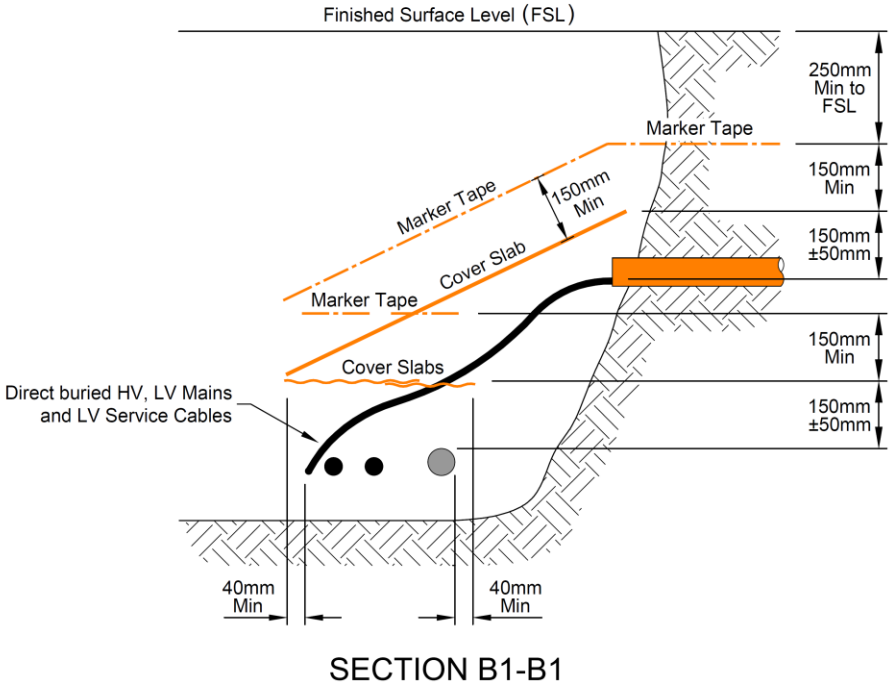


Figure 35 - Limited situations arrangement

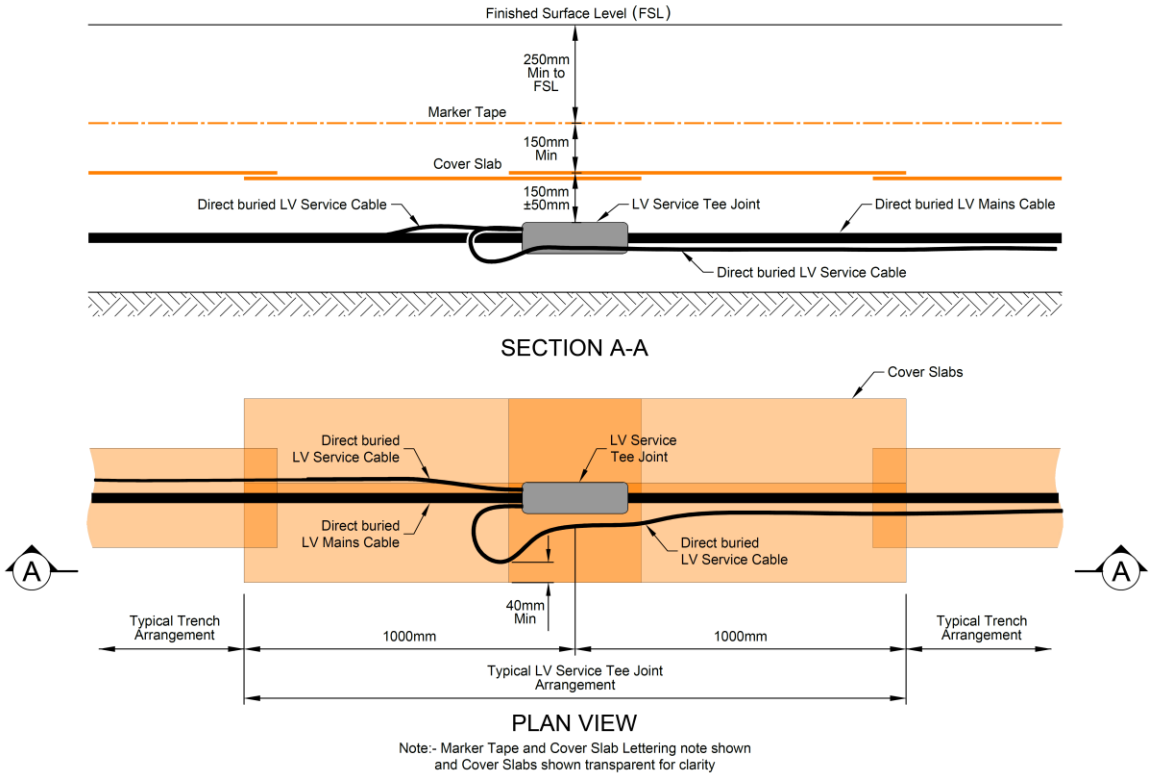


Figure 36 - Limited situations cable joint arrangement

5.5.2 Marker Tape

Marker tape is used to provide a warning to anyone digging by hand or machine that a power cable is in the vicinity and to proceed with caution.
It doesn't provide any mechanical protection but it assists in reducing the risk of hitting cables and injuring people during future excavations.

Therefore the correct installation of marker tape on URD estates is an important safety requirement.

Marker tape is to be installed above all electrical cable cover slabs or open trenched conduits buried in the road reserve or private property.*

Marker tape should be installed centrally above all cover slab/s and or conduit/s to provide coverage to all buried assets.

*The short section of property lead in conduit between the service pit and property boundary is excluded from this requirement.

5.5.2.1 Permitted Material

- Orange 150 or 300mm width marker tape compliant with AS/NZS 2648.1 shall be used
- Marker tape with an internal trace wire, foil backing or any other conductive material shall not be used

5.5.2.2 Installation Requirement

- Marker tape shall be installed no closer than 150mm to the cover slab or conduit and no closer to the final surface level than 250mm. These dimensions do not apply within 1m to an LV asset (e.g. pillar) or 2m to the HV asset (e.g. kiosk) where the cables enter the asset. Refer to section 5.5.1.4 and Figure 32 and Figure 33 for details.
- Marker tape should be located no deeper than 600mm from FSL. If working within AusNet's network and marker tape is required to be located deeper than 600mm please refer to AusNet's policy.
- Multiple runs of marker tape shall be installed to ensure coverage of all cover slabs and conduits
- Longitudinal overlap of multiple runs of marker tape is permitted, any gaps between marker tape shall ensure minimum coverage requirements are met
- Marker tape must provide minimum coverage of 50% to any cover slab or conduit and side overhang from the cover slab or conduit shall not exceed 250mm. See Figure 37 for detail
- Electrical marker tape must not be installed over any other authority's assets other than at crossing locations. See Figure 37 for detail
- In the non-preferred situation where the electrical assets cross one above and one below another authority's asset two separate runs of marker tape shall be installed. One marker tape run shall follow the electrical asset under the other authority's asset and one run will follow the electrical asset above. See Figure 55 for detail

5.5.2.3 Non-Compliant Marker Tape

Marker tape is an important safety requirement and when incorrect installation is identified rectification works shall be undertaken as described below and shown in Figure 38:

- Marker tape located too close to the cover slab or conduit may be left in place and new marker tape correctly installed
- Marker tape installed over other authorities assets shall be removed (excluding under hard surfaces)
- Marker tape too close to the final surface level shall be removed to facilitate new marker tape installation (excluding under hard surfaces)
- Very small pieces or short sections of marker tape offcuts of less than 300mm are acceptable at isolated locations following rectification works
- Any marker tape not compliant with the permitted material list shall be removed

5.5.2.4 Marker tape and bore installations

- Cables or conduits that have been installed by boring and the short section of lead-in conduit between a service pit and a property boundary do not require marker tape.
- Bored cables may be enclosed in HDPVC or polyethylene (PE) conduit. Refer to Section 5.10.1.5 and Table 1 for details.
- All bored conduits must be detailed refer to the relevant DB drafting standards.

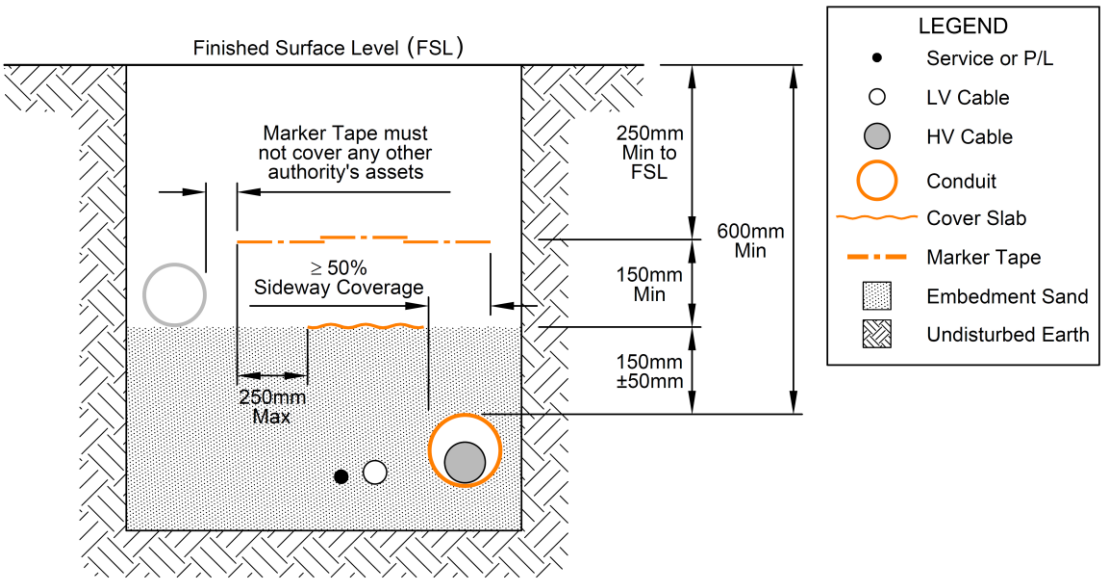


Figure 37 - Marker Tape Installation

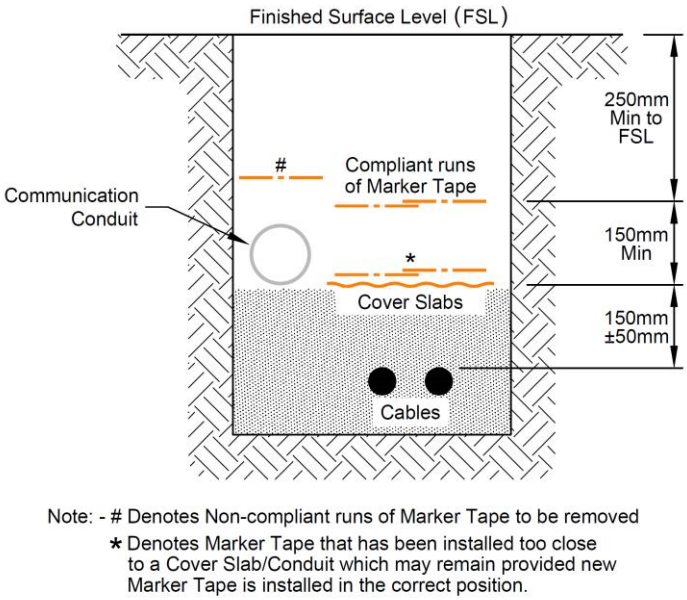


Figure 38 - Non-compliant Marker Tape Removal

5.6 Trench Arrangement - Cables Direct Buried

Trench details for common cable arrangements are given in Table 4 and Figure 39 and Figure 40.

Number of Cables	Minimum Trench Width (mm)
1 LV	400
2 LV	400
1 HV	400
2 HV	600
1 HV & 1 LV	600
1 HV & 2 LV	600
1 HV & 3 LV	750
2 HV & 1 LV	750
2 HV & 2 LV	750
2 HV & 3 LV	900

Notes: The above arrangements may also include service cables and public lighting cables. HV cables referred to above are 11 and 22kV only.

* Marker tape is required for all trenches please refer to section 5.5.2.

Table 4 - Common Cable Arrangements

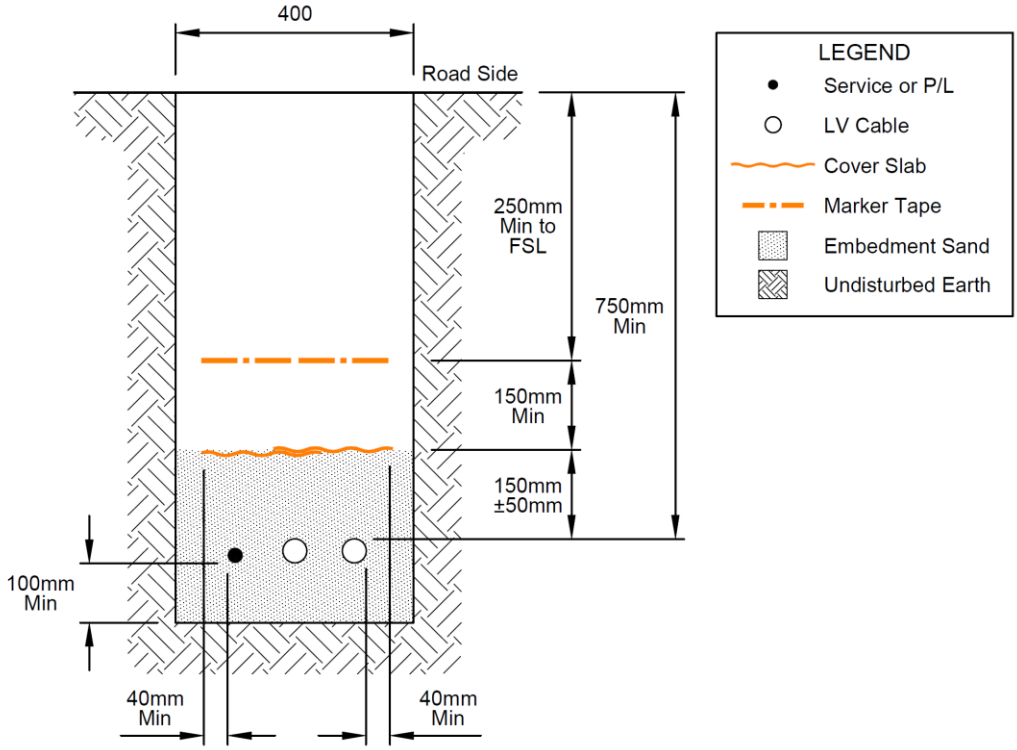


Figure 39 - Typical Trench Section - 750mm Cable Burial Depth
(2 LV, 1 Service or P/L shown)

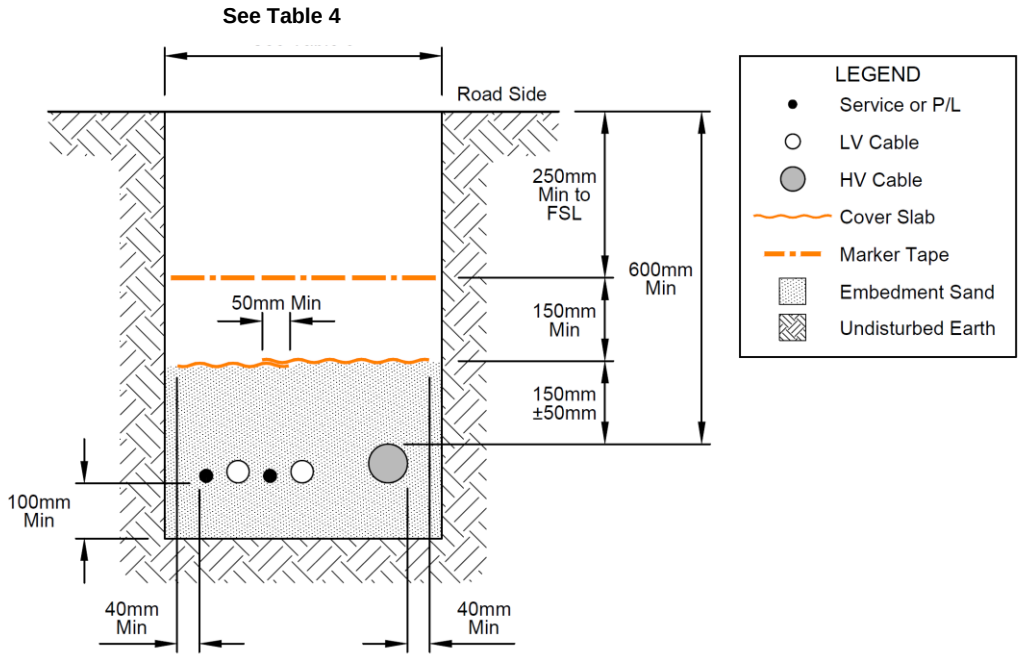


Figure 40 - Typical Trench Section - 600mm Minimum Cable Burial Depth (1 HV, 2 LV, 2 Service or P/L shown)

5.7 Trench Arrangement - Cables in Conduit

Typical trench details contained in this standard apply to road reserves, private property and road crossings. HV cables shall be installed on the road side of LV cables.

Trench details for common cable arrangements are given in Figure 41 through Figure 43.

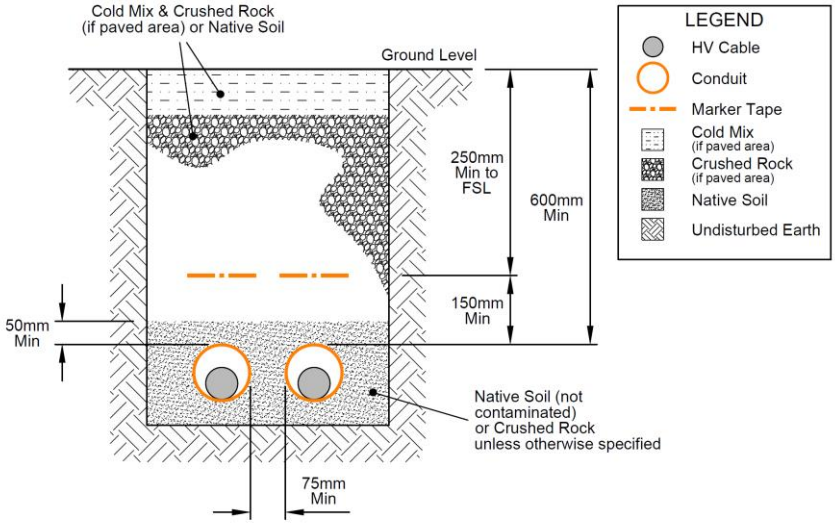


Figure 41 - Typical Trench Section - 600mm Minimum Cable Burial Depth
(2 Conduits shown)

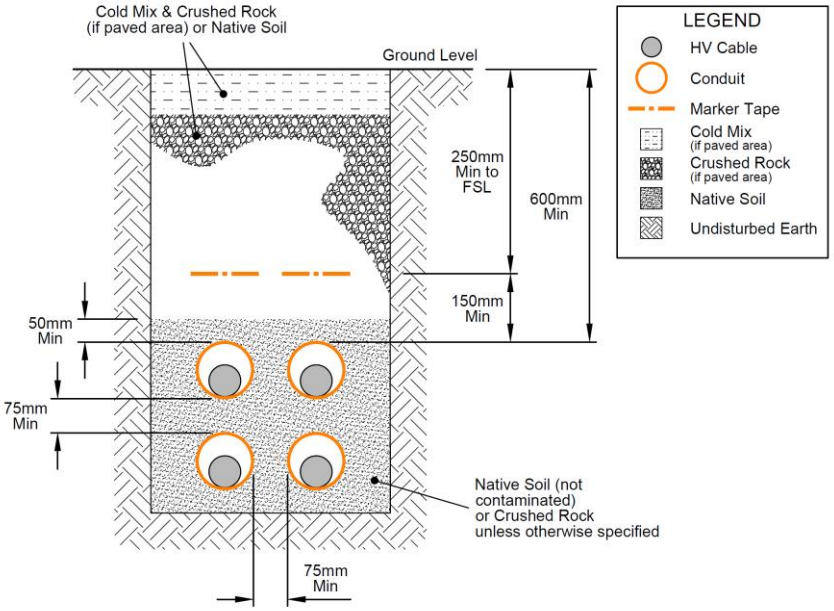


Figure 42 - Typical Trench Section - 600mm Minimum Cable Burial Depth
(4 conduits shown)

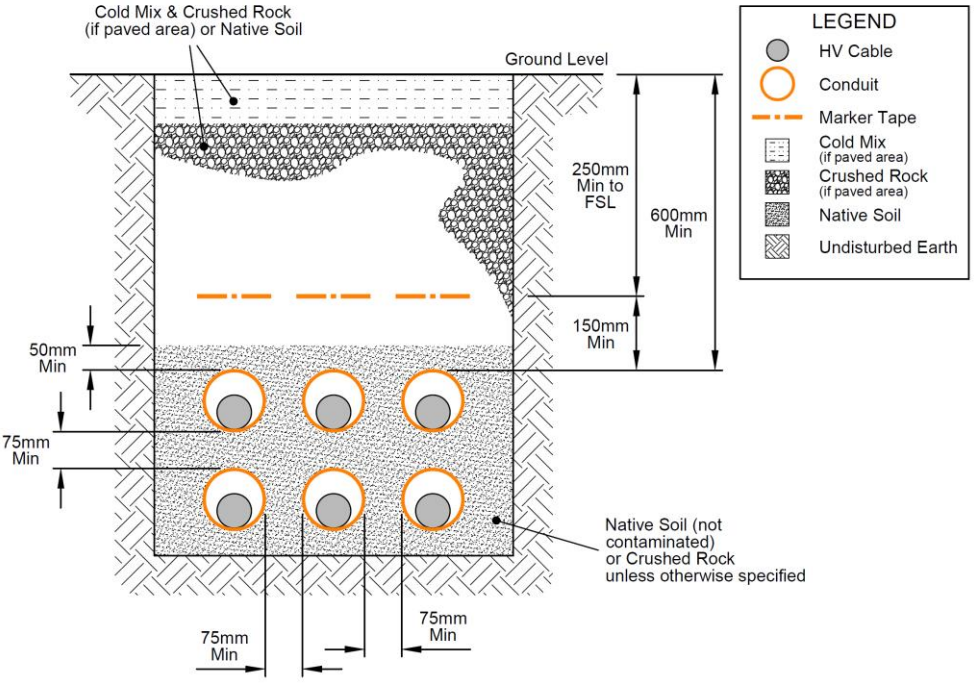


Figure 43 - Typical Trench Section - 600mm Minimum Cable Burial Depth
(6 conduits shown)

Note: Cover slabs are not required where heavy duty conduit to AS/NZS 2053 has been utilised.

5.8 Conduit Installation:

5.8.1 General requirements

The standard conduit used by VESI is an orange solid wall heavy duty unplasticised polyvinyl chloride polymer (UPVC) manufactured to AS/NZS 2053. The wall thickness is “heavy-duty”, to complying with the mechanical protection as defined in the Electrical Safety (Network Assets) Regulations 1999.

The heavy duty corflo or sandwich construction conduits shall not be used in VESI networks.

Conduits are to be provided with suitable non-perishable, watertight, endcaps or plugs. For any other requirements such as draw rope please refer to individual DB installation requirement.

For direct bore installations VESI allow the use of polyethylene (PE) “continuous” conduit manufactured to AS/NZS 4130. Refer to Table 6 below for conduit size selection.

Below details the applicable heavy-duty rigid PVC conduit size for LV mains, service and HV cables.

Cable	Conduit Size (mm)
6mm² Public Lighting Cable	32 (OD)
All LV Service Cables	63 (OD)
4/Core 50mm² LV service Cable (Jemena)*	80 (OD)
4/Core 185 & 240mm² LV Mains Cables	100 (NB)
All 3/Core Al HV Mains Cables up to and including 240mm² cable	125 (NB)
Special application, long or difficult pulls with large cables	150 (NB)

Table 5 - Heavy-Duty PVC Conduit Selection

* Where bend/s installed (Jemena)

Cable	Conduit Size (OD) (mm)
6mm² Public Lighting Cable	63
All LV Service Cables	63
4/Core 185 & 240mm² LV Mains Cables	110
All 3/Core Al HV Mains Cables	140

Table 6 – PE Conduit Selection

The conduit body shall be free of burrs, sharp edges, rough cuts, cracks, UV discolouration, deformations, indentations and divots, especially at conduit ends and conduit joints.

Conduit bend shall not be modified in anyway. Any conduit bends within the conduit system found to be damaged or non-standard, shall be replaced.

The transition from polyethylene pipe used in bore to heavy duty PVC requires approved coupler to connect. Incorrect coupler may result in cable damage.

The following must be ensured to prevent crushing of conduit resulting in change of nominal bore size of conduit:

- Conduit body shall be free of any physical deformations i.e. changes in the shape or size
- No sharp rise or falls in the trench profile
- Conduit must be laid flat against the ground surface
- The ground on which the conduit laid shall not have short lengths of inconsistent hardness, i.e. that would otherwise create a crush point

Installation and jointing of PVC conduits shall comply with AS2032 for non-pressurised systems and joins must be done using solvent cement.

The spigot must be inserted to the full length of the socket as per Figure 44. Excessive pooling of solvent cement at the root of the socket is unacceptable since when it solidifies it can form sharp shards at the joint and can damage the cable while pulling.

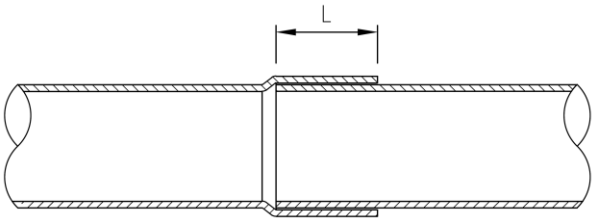


Figure 44 - Correct conduit joint

The following cable pull direction should be followed for pulling of cables.

The ingress of moisture into the cable will cause premature failure of the cable. Cable ends must be appropriately sealed to prevent the entry of moisture into the cable during construction.

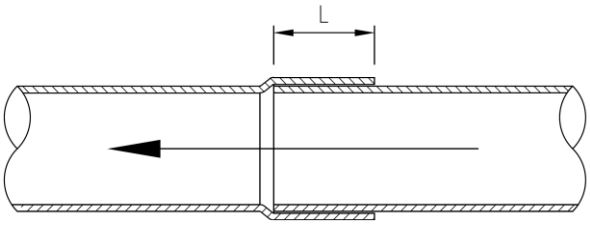


Figure 45 - Cable Pull Direction

5.8.2 Conduit Bending Radius

Conduit bends in a conduit run should be avoided where ever possible. However, where conduit bends are necessary, to avoid mechanically overstressing cables during installation it is necessary to establish the minimum safe bending radius and the maximum safe pulling tension.

Power cables have limitations with regard to the radii around which they can be pulled and the pulling tension which can be used; due to this cable bending radius during installation and after installation must be considered. Refer to Table 9 through Table 11 for minimum cable bending radius information.

To ensure cable bending radii are not exceeded conduit bending radii are set larger than the during installation bending radii of the cable. Refer to Table 5 and Table 6 for the appropriate conduit and conduit bending radius for the cable being used.

Conduit Nominal Size (mm)	Min. Bend Radius (mm)
32 OD	315
63 OD	325
80 OD*	600
100 NB	625
125 NB	2200
150 NB	2500

Table 7 - PVC Conduit Bend Selection

*Jemena requirement - 4/Core 50mm² LV service cable where bend/s installed

For auditing and construction purposes length of bend can be measured between inside conduit collars, refer to Table 8 & Figure 46.

Conduit Nominal Size (mm)	Approx. Bend Length (mm)		
	90°	**45°**	**22°**
32 OD	450	250	150
63 OD	500	250	150
80 OD (Jemena)	845	455	230
100 NB	900	500	250
125 NB	3015	1630	830
150 NB	3500	1850	945

Table 8 – Approx. Conduit Bend Length Guideline

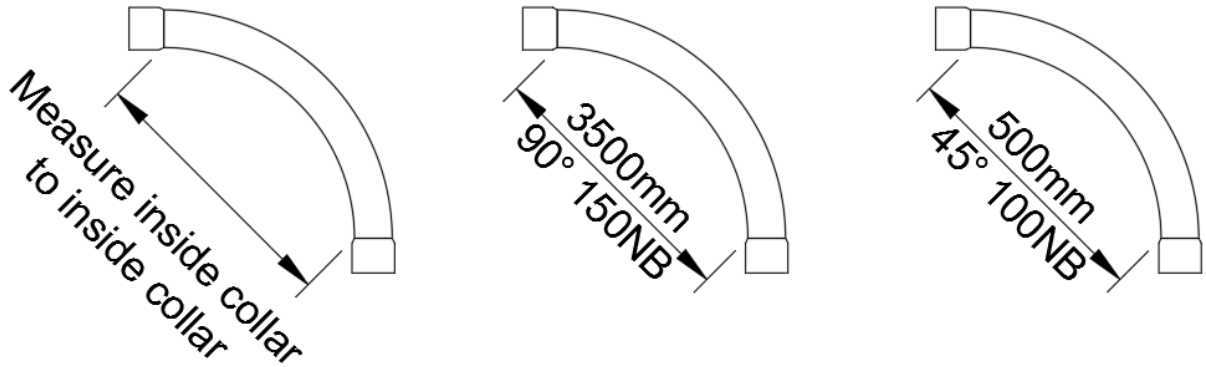


Figure 46 – Conduit Bend Length

5.8.3 Cable Bending Radius

Cable	Min Bending Radius (mm)	
	During Installation	**After Installed**
3/Core 35mm^2 Al	1480	890
3/Core 70mm^2 Al (AusNet)	1525	915
3/Core 70mm^2 Al Low Capacitance (AusNet)	1820	1090
3/Core 185mm^2 Al	2000	1200
3/Core 185mm^2 Al Low Capacitance (AusNet)	2160	1300

3/Core 240mm² Al	2130	1280
3/Core 240mm² Al Low Capacitance (AusNet)	2320	1390
3/Core 300mm² Cu	2300	1400

Table 9 - Minimum Bending Radius - HV 22kV Cable

Cable	Min Bending Radius (mm)	
	During Installation	After Installed
3/Core 240mm^2 Al	1860	1100

Table 10 - Minimum Bending Radius - HV 11kV Cable

Cable	Min Bending Radius (mm)	
	During Installation	After Installed
4/Core 16mm^2 Cu	150	100
4/Core 35mm^2 Cu	285	190
4/Core 50mm^2 Cu	300	200
4/Core 185mm^2 Al	550	370
4/Core 240mm^2 Al	620	410

Table 11 - Minimum Bending Radius - LV Mains and Service Cable

5.8.4 Cable pulling tensions

Refer to specific DB requirements for cable pulling tensions.

5.9 Installation of Service Pits

Service pits are the standard method of providing an underground service for LV supplies up to170A per phase as per the Service Installation Rules (SIRs).

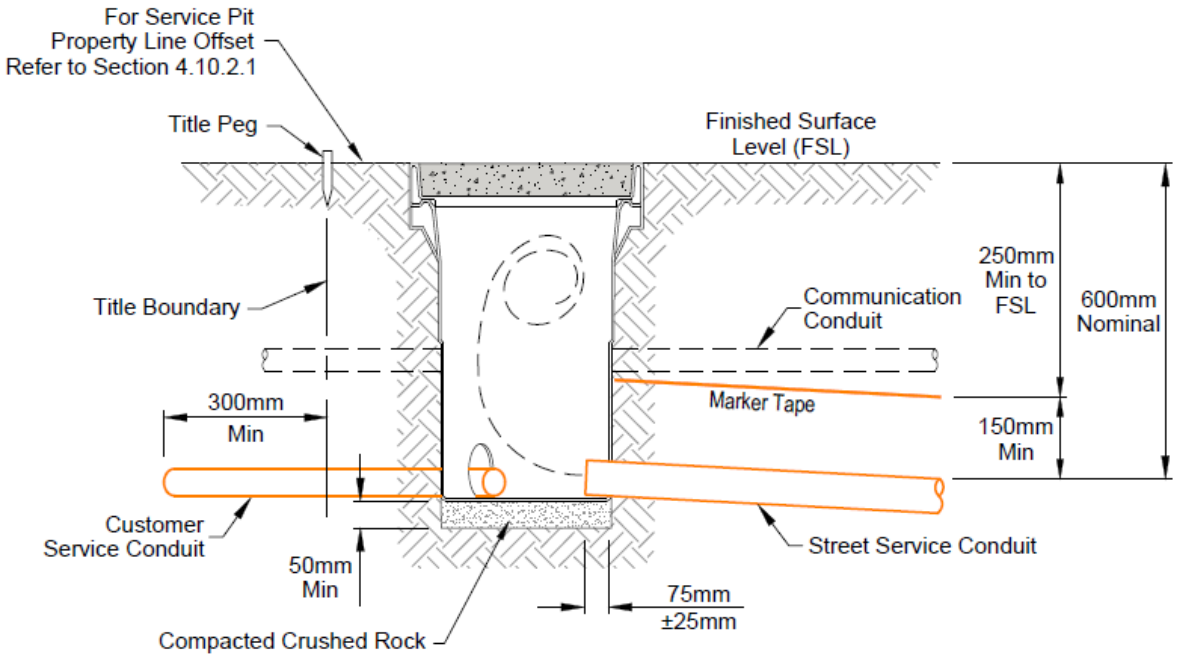
Refer to section 4.10 for service pit location details.

The following section outlines the installation requirements for service pits.

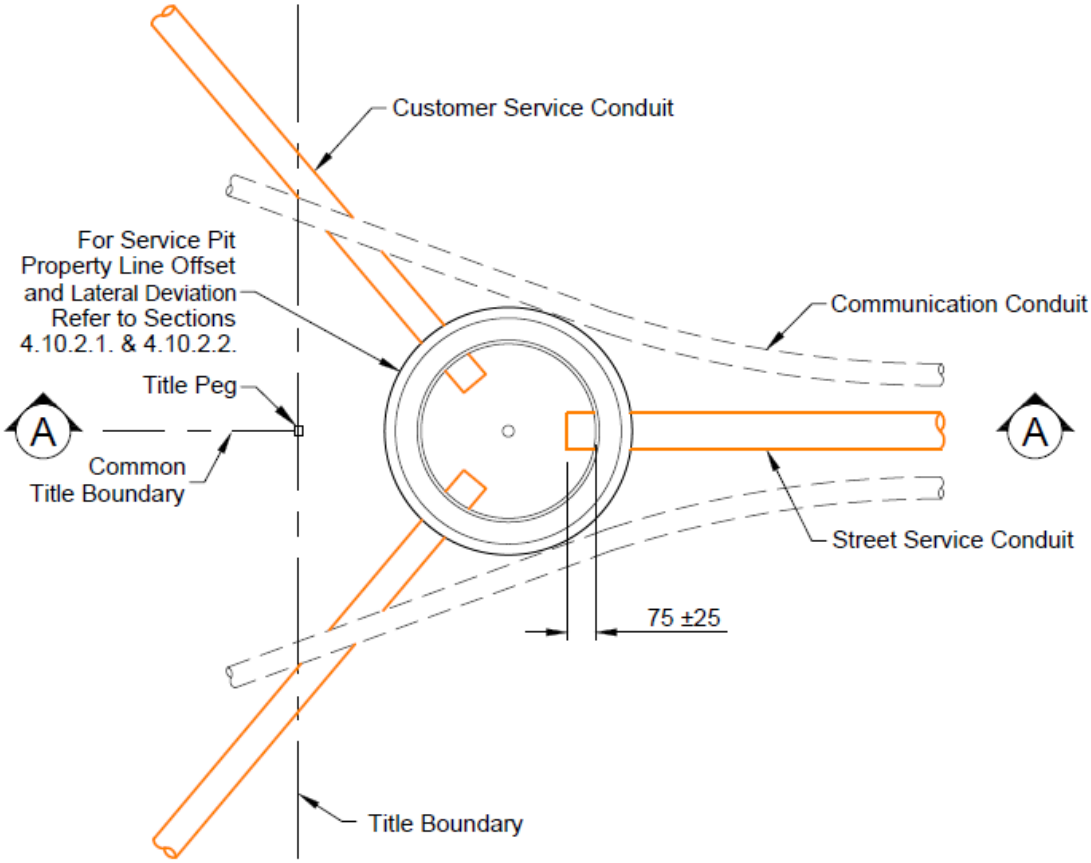
5.9.1 Circular Service Pit Installation – Non-Footpath Installation

As shown in Figure 47 below, the customers pit entry conduits are to extend 300mm inside the front title boundary. These conduits shall be sealed or plugged to prevent entry of silt and dirt. Any conduits entering the service pit shall protrude through the entry holes by between 50 to 100mm.

The nominal burial depth of the service conduit in the street side should be 600mm nominal to align with the entry holes of the service pit. The entry holes are ø100mm, and can therefore accommodate the standard ø63mm service conduit and an additional ø32mm public lighting conduit if required.



SECTION A-A



PLAN VIEW
(Service Pit Lid and Marker Tape Removed for Clarity)

Figure 47 - Non Footpath Installation

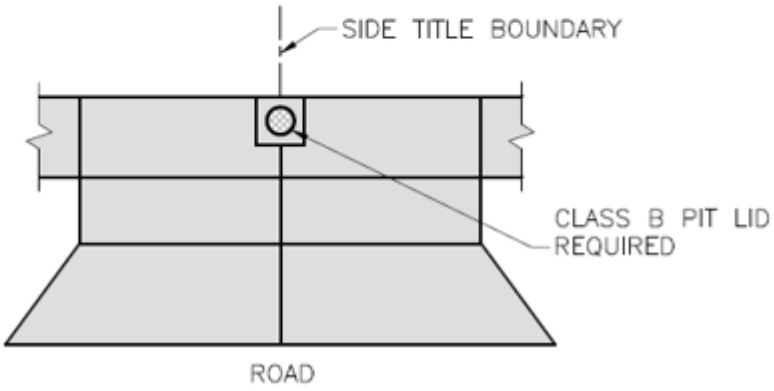
5.9.2 Circular Service Pit Installation – In Footpath or Driveway

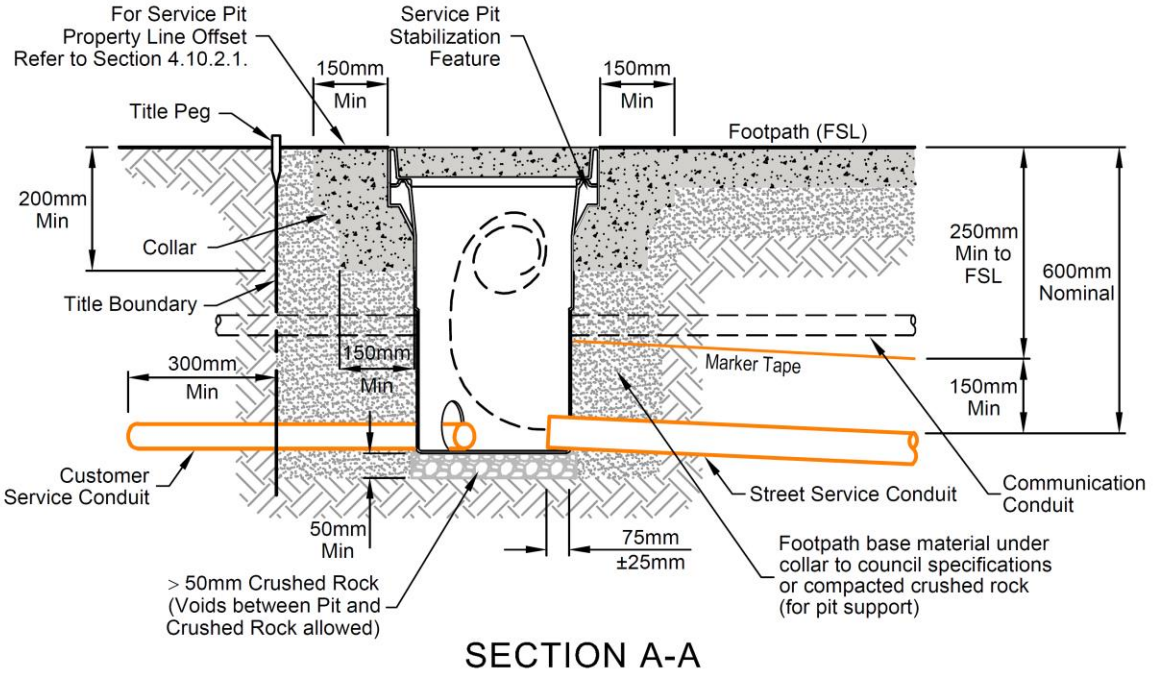
Where the service pit is situated in the footpath or trafficable location, such as a driveway, it shall be installed with its outer edge not less than 150mm from the edge of the footpath or driveway. The footpath or driveway shall be thickened a minimum of 200mm to form a concrete collar used to support the pit, as shown in Figure 48.

Tool, or cut 'joints', may be installed at the centre alignment to the pit to Municipal Council requirements. For installations in double driveways, expansion joints are permitted only if the separate sections of concrete are tied together to Council requirements.

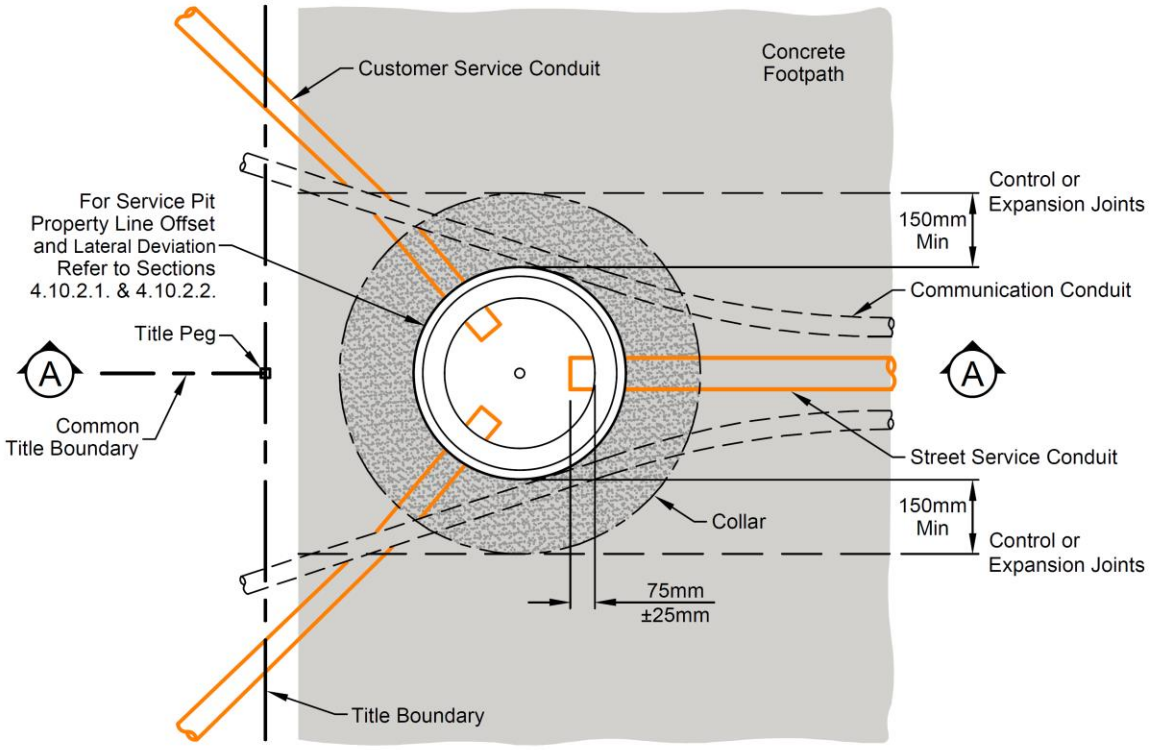
PITS LOCATED WITHIN, OR THAT ENCROACH INTO VEHICLE CROSSINGS:

1. The placement of service pits within or encroaching into vehicle crossing shall be avoided.
2. Where it is not practical to do so, a pit lid with a minimum **Class B rating to AS 3996** shall be used.





SECTION A-A



PLAN VIEW

(Service Pit Lid and Marker Tape Removed for Clarity)

Figure 48 - Footpath or Driveway Installation

5.9.3 Footpath Cracks Around Pits

Pits installed in footpaths must meet the requirements specified in section 5.9.2 including a 200mm thick concrete collar strengthening around the pit.

For new installations in URD projects subject to Network Final Audit inspection, there must not be any footpath cracks from the pit to the edge of the footpath or an expansion joint. This may lead to future footpath displacement and a tripping hazard.

5.9.4 Pit Tripping Hazards

Pits are to be installed within +/- 5mm of the finished footpath surface. Pits installed higher than the surrounding footpath by 5mm or more must be recast in a new footpath panel. It is not permissible to modify or grind the pit in any way or add a filling material (e.g. bondcrete mix) to the footpath around the pit.

Pits that are 5mm or more lower than the surrounding footpath may have the footpath ground down to a maximum of 10mm with an appropriate surrounding gradient slope. It is not permissible to use a filling material around the pit. Otherwise the pit will need to be recast in a new footpath panel.

Figure 49 - Non-Compliance – Use of Filler

Figure 50 - Acceptable - Grinding of Footpath

5.9.5 Expansion Joint Foam

The use of expansion joint foam strip around a pit body installed in a concrete footpath is not permitted. This could prevent the concrete from filling under the pit body collar to provide support and lead to sinking of the pit and a tripping hazard.

5.9.6 Excess Concrete Slurry & Shrinkage.

When pits are installed in concrete footpaths, care must be taken to ensure excess concrete slurry does not prevent the lid from opening or fill the lifting bar well or obscure the word “ELECTRICITY”. Similarly shrinkage during curing of the concrete can distort the pit body and jam the lid. Pit lids must be cleaned and checked for ease of opening using a standard tool.

5.9.7 Control Joints

Trowelled or cut control joints may be installed as specified in section 5.9.2. Whilst a central joint is preferred, offset joints must intersect the pit - otherwise they must be installed at least 150mm from the pit edge. Refer to Figure 51 below.

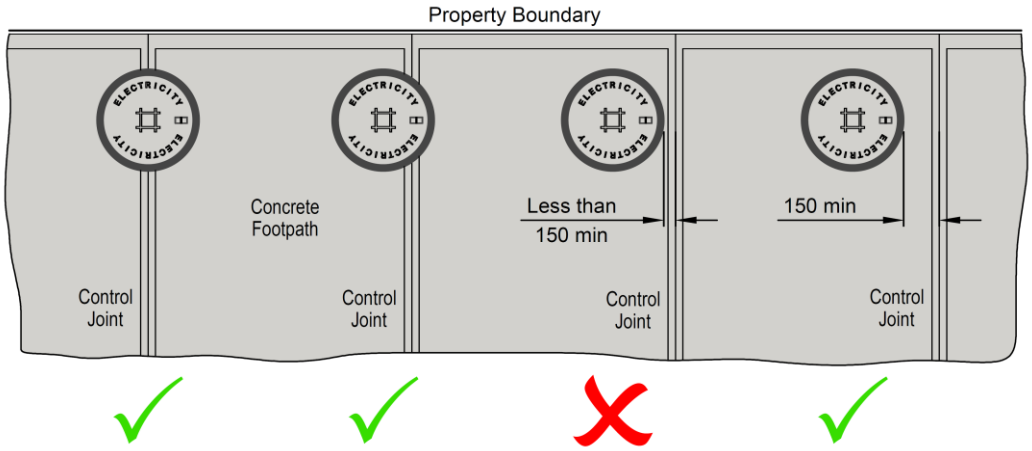


Figure 51 – Service pit installation & control joint

5.9.8 Pit Modifications

5.9.8.1 Disallowed Modifications

Pits must be installed at correct final finished surface levels and appropriate clearances to other authority’s assets must be maintained. Cutting and joining of multiple pit bodies or modifying the height/depth of the pit body is not permissible.

Similarly cutting or grinding the top or internal lid lip of the pit body to rectify a footpath tripping hazard is also not permitted.

5.9.8.2 Pit Bottom Entry

Bottom entry into a pit is allowed in situations where one or more of the existing side entry holes cannot be utilised due to the proximity of other utilities.

In these situations a pit bottom entry is permissible with a single hole of not more than 63mm diameter cut into the bottom of the pit in the centre or offset up to 100mm towards the “front” (incoming supply side). The opening must be cut with a hole saw and employ neat workmanship. Conduit entry must be perpendicular to the base and extend 75mm +/-25mm into the pit. Service pit with bottom entry must be installed with concrete encasement.

The as-built detail records must be noted “Pit bottom entry” and the conduit depth below the pit recorded where practical.

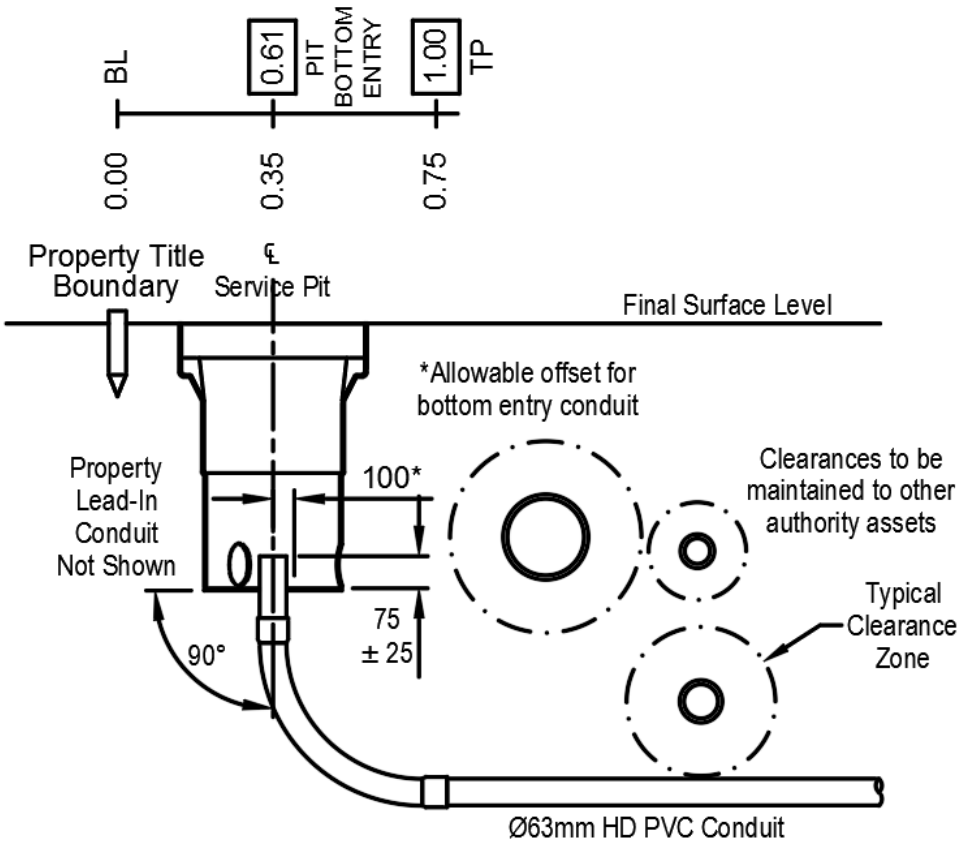


Figure 52 - Bottom entry modification

5.9.8.3 Existing hole expansion

Where necessary to accommodate an additional conduit exit that will not fit with a 63mm conduit already installed, an existing pit opening can be neatly enlarged horizontally or vertically as follow:

- Horizontally, by not more than 50mm to a maximum overall size of 150mm
- Vertically, by not more than 25mm to a maximum overall size of 125mm

Service pit can be cut only once, additional cuts will not be accepted as may affect the integrity of the pit.

Note that a single 32mm PL and a 63mm conduit will fit through an existing 100mm opening.

No additional side entry holes may be made into the pit body, as the structural integrity of the pit is compromised with the additional hole.

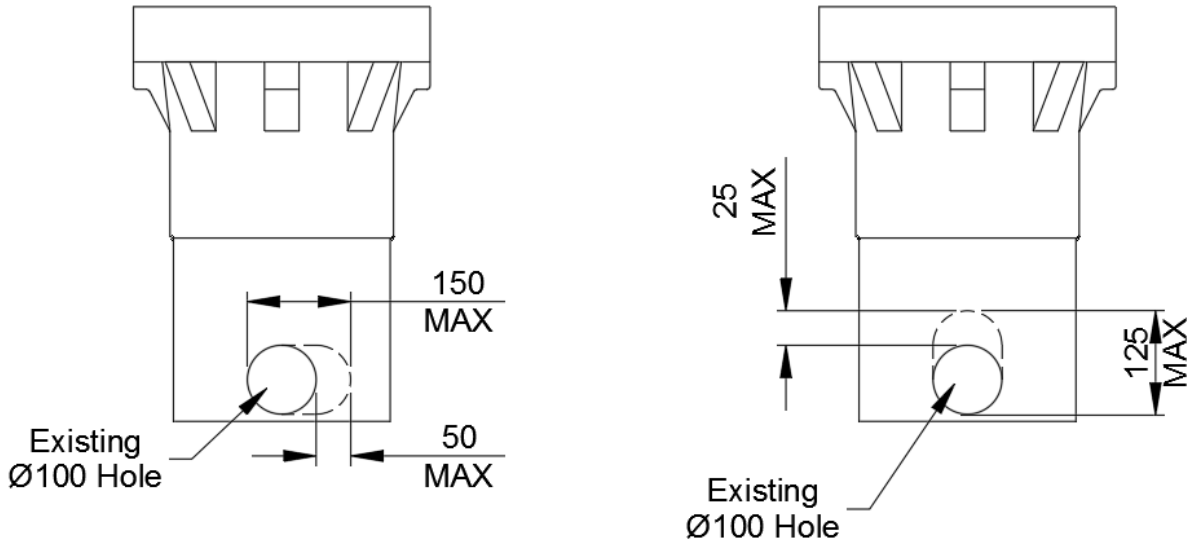


Figure 53 - Hole expansion

5.10 Underground Clearances

Clearances are required between individual electrical assets and between electrical assets and the assets of other authorities.

Separations between electrical assets must be maintained to ensure the long term reliability of the electrical network and for future maintenance purposes.

Clearances to other authorities are included in this standard. These clearances are usually set by the authority that owns the asset. The specified clearances are required for other authorities and the DB to safely access each other's assets for future maintenance or connection purposes.

All specified distances are the minimum required measured between asset edges or faces

5.10.1 Underground Clearances between Electrical Assets

5.10.1.1 Horizontal Clearances for Assets in Parallel

Minimum horizontal clearances are shown in Figure 54 for HV, LV, public lighting and service cables.

The clearances are separated into direct buried cables, cables in conduit and mixed trench (direct buried and cables in conduit).

5.10.1.2 Vertical or Crossing Clearances

In normal construction situations the clearances shown for horizontal in section 5.10.1.1 shall apply for vertical or crossing clearances.

However in limited construction situations, a reduced working clearance of 25mm may be applied between electrical cables where clearances specified in 5.10.1.1 are impracticable to achieve, such as where minimum ground cover depth cannot be achieved if normal clearances are maintained between assets.

In this situation the HV, LV, service or public lighting cables must be in HD PVC conduit (or have a plastic cover slab section installed between).

Refer to Figure 55 & Figure 56 for further details.

5.10.1.3 Stacked Conduits

Where shown on the approved plan or by prior written approval by the DB Responsible Officer conduits may be stacked in vertical alignment. The clearances listed above and below shall apply and must be maintained when transitioning from horizontal to vertical.

5.10.1.4 Other Clearances

Asset clearances:

- Electricity poles and public light columns to all assets above or below ground 300mm
- Electricity poles and public light columns to property building lines 300mm
- All conduits to metallic, earthed or conductive assets 25mm

Cable / Conduit to non-conductive assets:

- Pillar skirts 25mm
- LV STJ, MTJ and STRJ casings or heat shrink to cable or conduit 25mm
- HV STRJ and cables or conduit 25mm
- Insulated earth conductors 25mm

Cable / Conduit / Column to conductive assets:

- Public light column and its earth electrode 2000mm
- LV cable and earthed or conductive assets 100mm*
- HV cable and earthed or conductive assets 300mm*
- All conduits to metallic, earthed or conductive assets 25mm

*Refer to limited clearances special circumstances LV pillars, kiosks and switch cabinets

Within LV Pillars, kiosks and Switch Cabinets

The following reduced clearances may be applied as described below

- Within the LV pillar skirt the LV mains cable to LV mains cable minimum clearance of 25mm shall be maintained. The inner cores of the individual conductors shall not contact each other above the crutch seal. The crutch seal shall be above the cable embedment material.
- Within the kiosk or switch cabinet the LV mains cable clearance to metallic or earthed assets may be reduced to 25mm. The inner cores of the individual conductors shall not contact each other above the crutch seal. The crutch seal shall be above the cable embedment material.

  In kiosk or switch cabinet, HV cable entry contact with earthed steel such as under the cable clamps is permissible

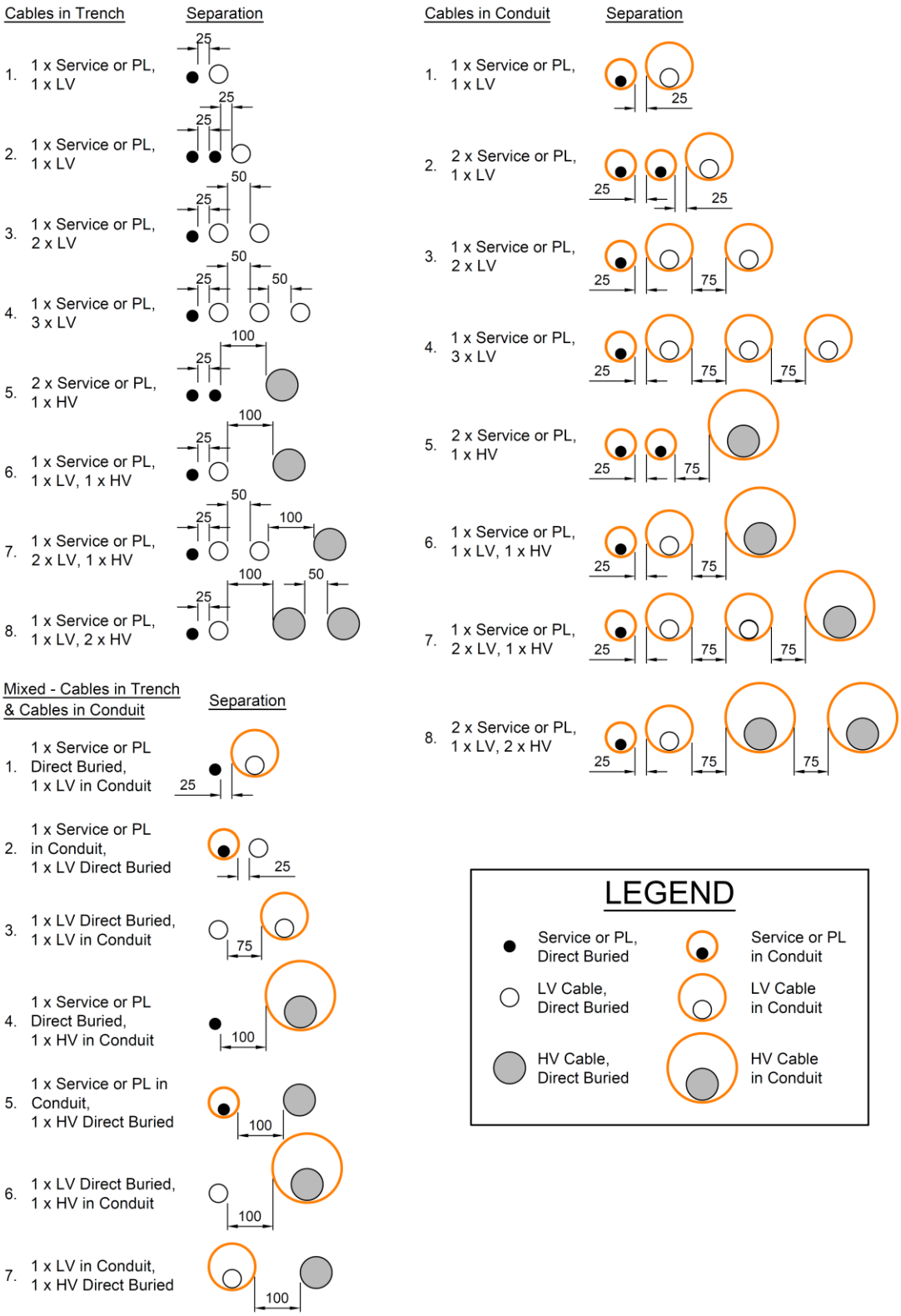


Figure 54 - Typical Clearances between U/G Assets

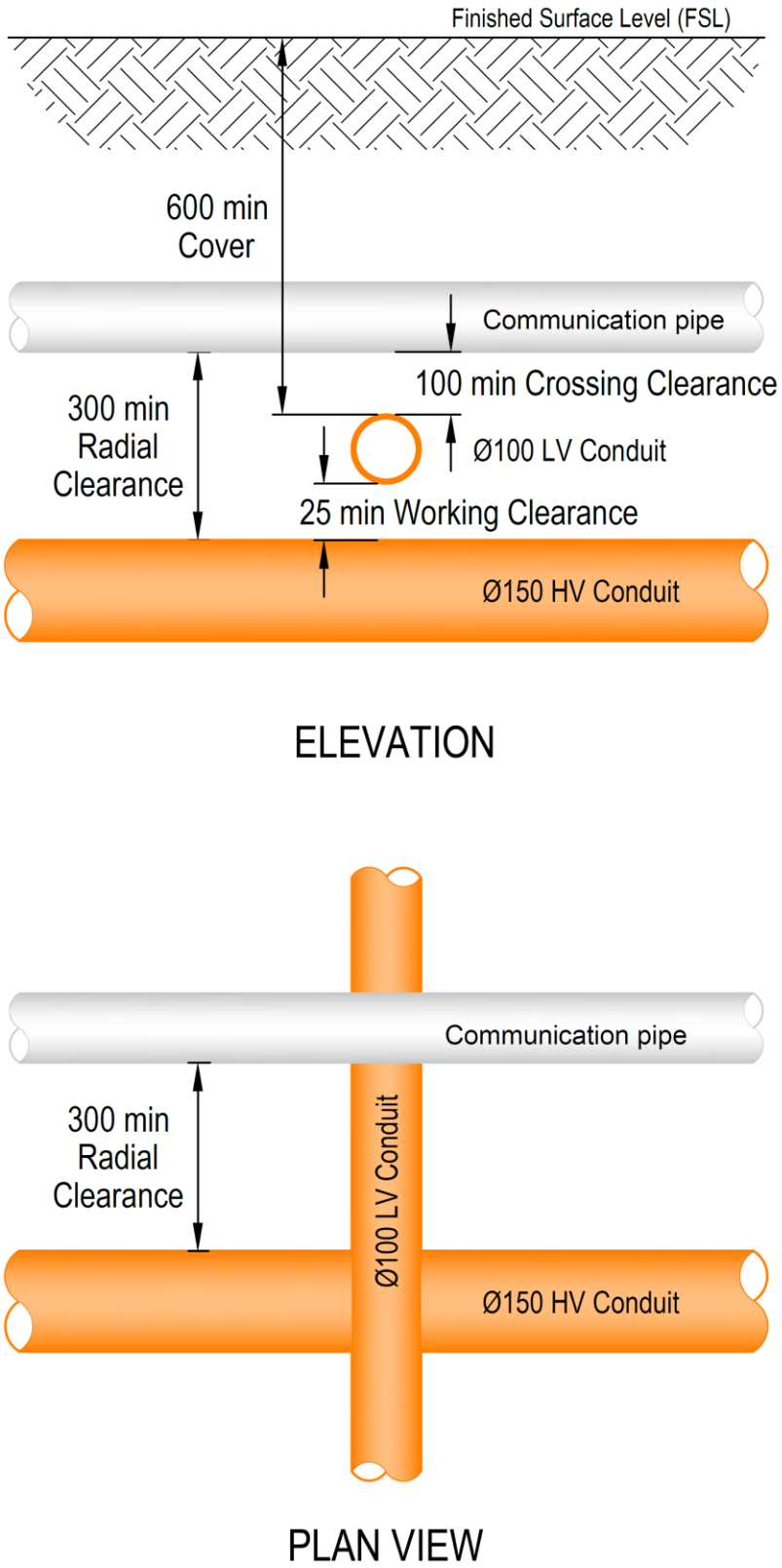


Figure 55 - Clearance Example

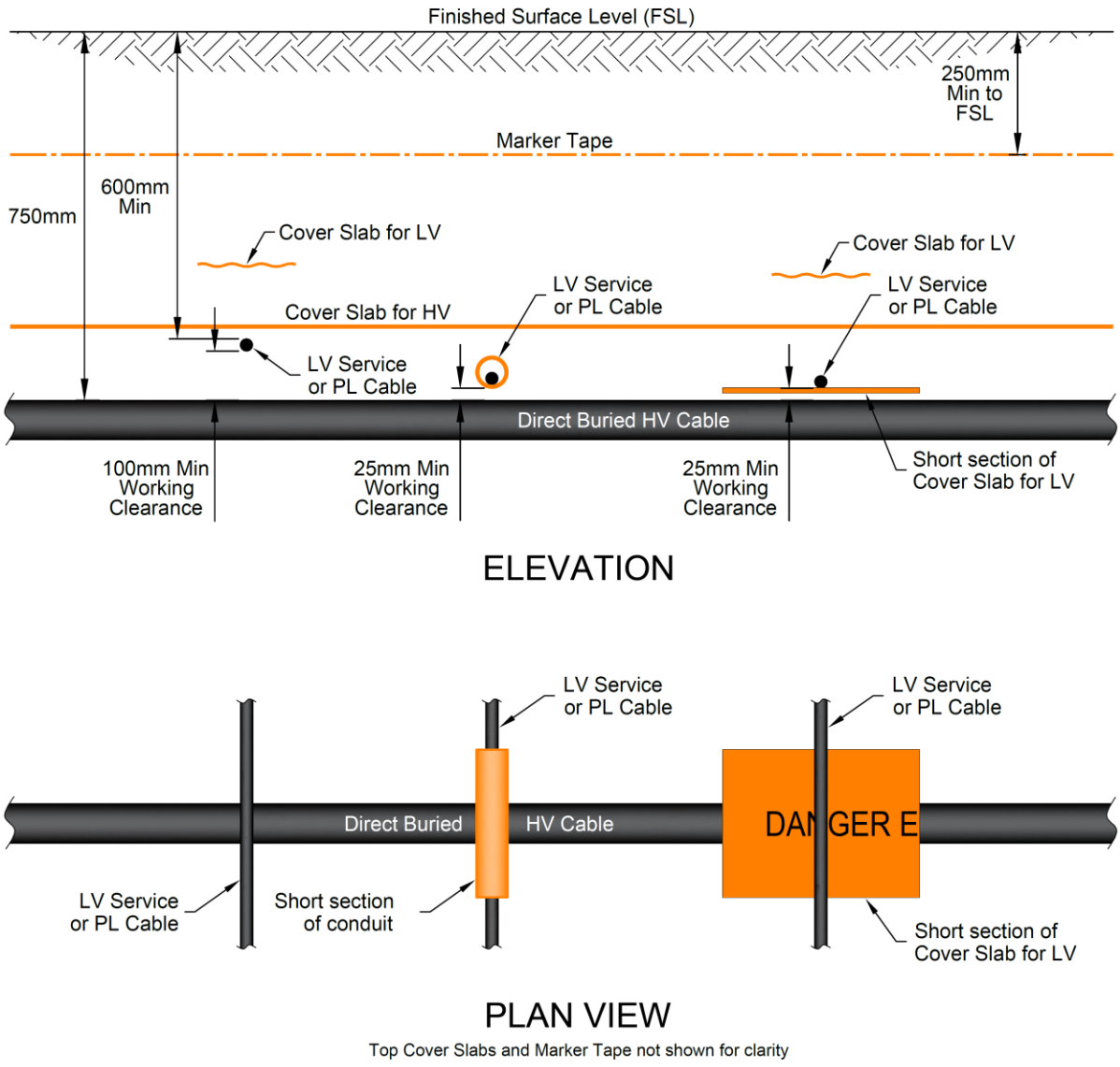


Figure 56 - Service/PL Cable Crossing HV Cable

5.10.1.5 Bore Conduits

Unless otherwise specified on the approved construction plan conduit clearances listed above shall be maintained. Where PE conduit is installed LV conduit and HV conduit separation listed above shall be used.

Where shown on the approved construction plan or where prior written approval has been provided by the DB Responsible Officer multiple bore conduits may be inserted into one bore hole. Note: Such approvals cannot be granted during the progression of works as Network System Planning may be required. Pressure filling or grouting of the voids between the conduits (with thermal control material or otherwise) may be required.

When multiple conduits are installed into one bore hole care shall be taken to ensure the conduits do not rotate during installation. Accurate detailing of conduit positions must be undertaken.

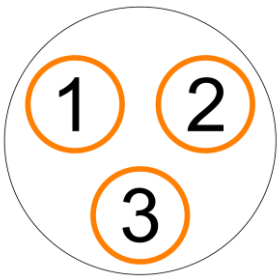


Figure 57 - Multiple Conduits Inserted in a Larger Diameter Bore

5.10.2 Coordination With Other Authorities

Coordination of the construction works with other authorities is the developer's responsibility.

The developer must provide all relevant authorities (including the DB) with details of the proposed works and determine if there is any conflict with, or precautions required due to, existing assets or proposed works. Any alteration to the construction plan must be referred to the DB Responsible Officer for approval.

5.10.3 Shared Trench Arrangements and Clearance to Non Electrical Assets

This section includes both shared trenching requirements and minimum clearances required to other service utility or authority assets.

A shared trench should be employed wherever practical to reduce the cost of providing electricity and telecommunications services to the community. It should be used in new developments (e.g. URD), redevelopment and sometimes with work associated with road reconstruction.

Shared trench agreements or combined service asset locations should be reached with the relevant servicing agency. It is usual for this to be coordinated by the site developer or their consultant for URD projects; however the Municipal Council in which the combined assets are being installed must also be consulted in relation to their Streetscape code of practices and approval obtained from them prior to construction.

In all cases the clearances and separations specified are the minimum acceptable, based on relevant codes and regulations, however some service utilities may require additional clearances. Local utilities or authorities should be contacted at design stage to verify their specific requirements, and these should be complied with where possible. If the clearances required by other utilities or asset owners are excessive and not able to be complied with the DB Responsible Officer will facilitate arbitration between the DB (Design, Project Management, Construction, Network Safety and Compliance) and the owners of the affected assets.

Use of spacers to maintain clearances between assets and those of other authorities is permitted subject to limited conditions. Use of “hard” spacers against pressurised pipes of other authorities is not permitted under any circumstances. Refer to section 5.10.19 for further information.

Refer to Appendix 1 – Table of General Clearances for the *Clearance of Electrical Cables and Conduits (up to 22kV) to Other Utility Assets and Structures* table to be included on UG cable construction drawing templates for works in the vicinity of other utility assets, particularly for URD projects. This table identifies the minimum clearances required for standard installations.

5.10.4 Nearest Communications Carrier

There are a number of communication carrier companies that are part of a shared trench arrangement, e.g. Telstra, Optus, NBN etc. This standard provides details on minimum clearances to the nearest installed communications conduit and gives trench widths for common cable/conduit arrangements. These trench widths are shown in Table 12, a typical shared trench section drawing is shown in Figure 58 and Figure 59.

Number of Cables	Minimum Trench Width (mm)	
	With 1xP100 Communications Conduit	With 1xP100 & 1xP50 Communications Conduit
1 LV	600	600
2 LV	600	750
1 HV	600	750
2 HV	900	900
1 HV & 1 LV	900	900
1 HV & 2 LV	900	900
1 HV & 3 LV	1100	1100
2 HV & 1 LV	1100	1100
2 HV & 2 LV	1100	1100
2 HV & 3 LV	1100	1200

Notes: The above arrangements may also include service cables and public lighting cables.
HV cables referred to above are 11- 22kV.

Table 12 - Common Cable Arrangements - Shared Trench (Communications Carrier)

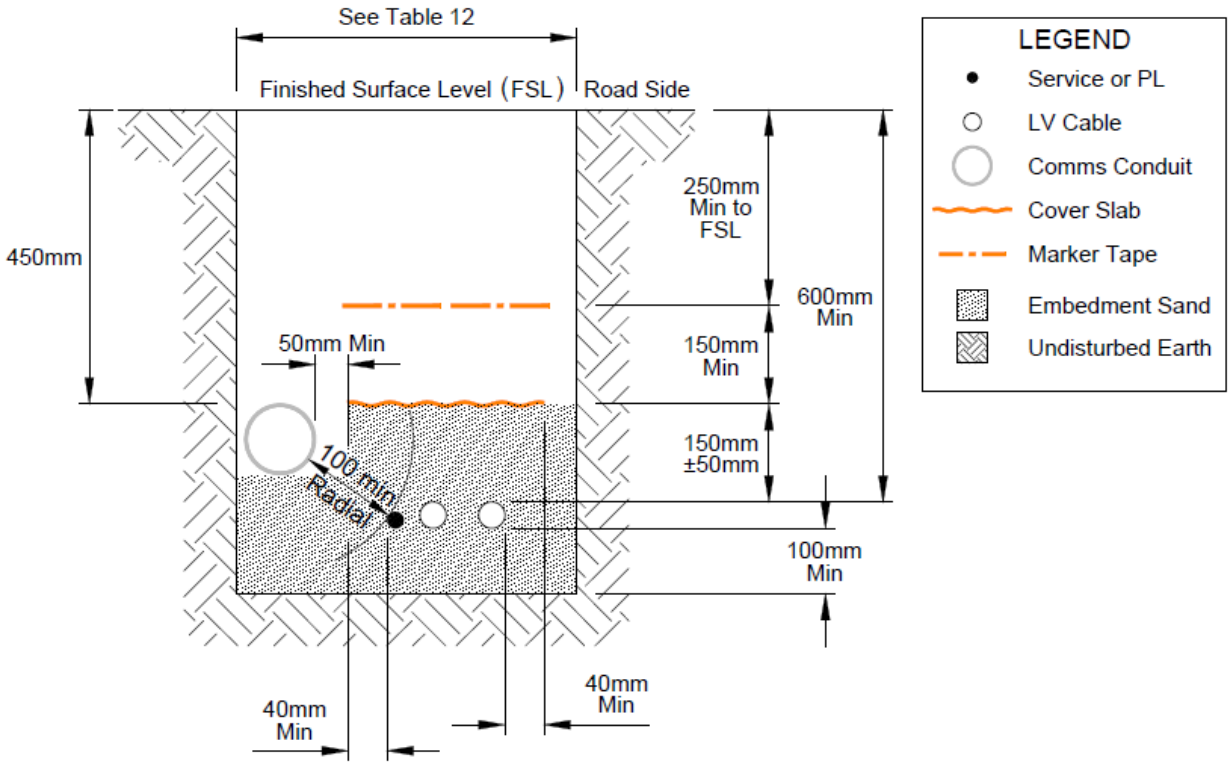


Figure 58 - Typical Shared Trench TR Non-critical Section
(2 LV, 1 Service or P/L, 1 Communications P100 shown)

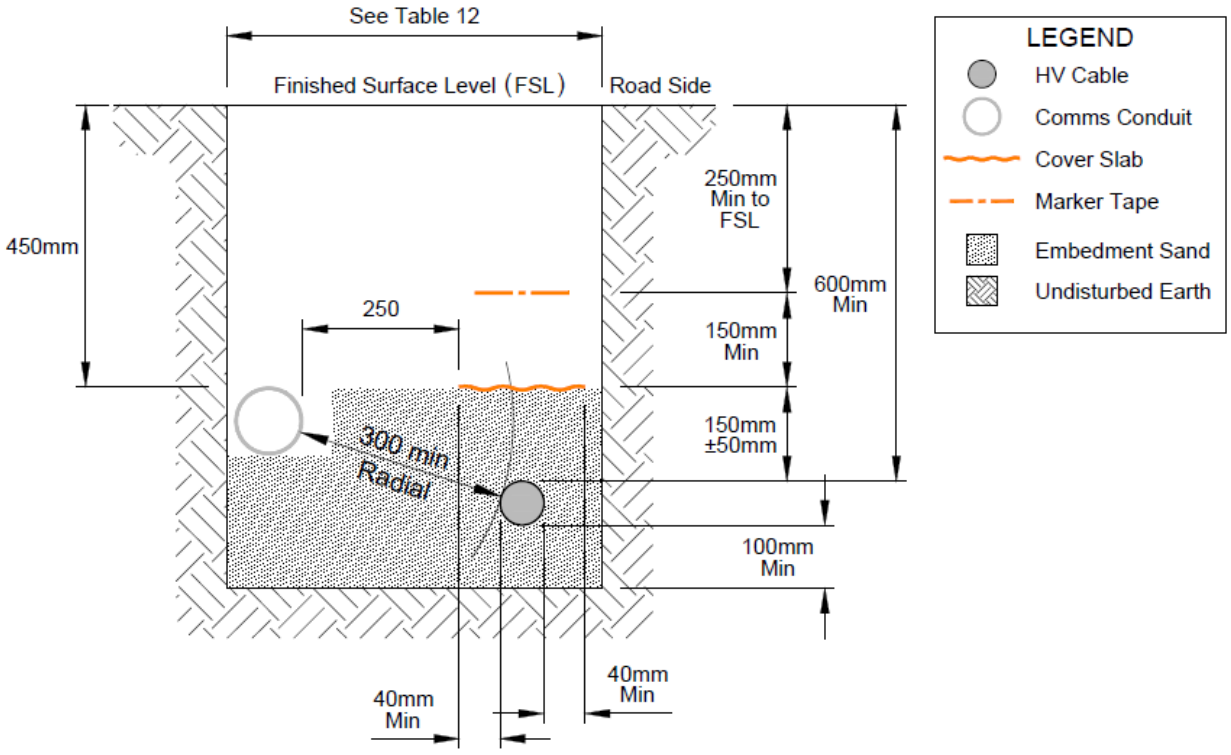


Figure 59 - Typical Shared Trench TR Non-critical Section
(1 HV, 1 Communications P100 shown)

Communications conduits should be laid as close as possible to the building line side of the trench. Cable cover slabs shall be laid as close as possible to the road pavement side of the trench with HV cables on the road side of LV cables.

The minimum horizontal offset between the nearest communications carrier conduit and cable cover slabs or electrical conduits shall be:

- 50mm for a conduit or slab covering LV cables
- 250mm for a conduit or slab covering HV cables

Notwithstanding the minimum separations stated above however, at all times a minimum radial separation of 300mm for HV cables/conduits, and 100mm for LV cables/conduits is required between the cable and the nearest communications carrier conduit (both parallel and crossing), including communications property lead-in conduits. Refer to Figure 58 and Figure 59.

For example, a parallel communications conduit and LV power cable/conduit may have only 50mm horizontal offset clearance looking from directly above, but they must maintain 100mm minimum radial separation based on installation at different levels. Similarly, where an HV cable crosses a communication conduit, 250mm must be maintained between the cable cover slab and the communications conduit, but 300mm minimum separation must be maintained to the cable. Where a crossing occurs, DB cables shall cross underneath communications conduits.

Communications conduits must not be installed directly above DB cables and no portion of any communications pit or cabinet (including large fibre-optic and NBN pits P6 - P9), especially the TOP portion, shall be directly above DB conduits, cables and their associated cover slabs. Where compliance to this requirement is impractical, individual variation approval may be sought through the DB Responsible Officer.

The clearances shown in Figure 58 and Figure 59 shall also be maintained between electrical assets and any part of a communications pit body.

Where additional communications carrier assets are installed, the common trench widths given in Table 12. should be increased by an additional 100-150mm for every additional communication carrier conduit that is to be installed in the trench, as a minimum of 100mm separation is required between these assets. The minimum separation from DBs cables shall be maintained as shown in Figure 54.

For earthing requirements in the vicinity of communications pits please refer to the earthing standards of the specific distribution company within the network where the installation is.

Where a shared trench agreement exists, any subsequent work in a shared trench (for maintenance, renewal or re-arrangement) is the responsibility of the asset owner. No parties shall alter the position of its assets in the shared trench nor add to it without consultation with the other party.

For installations not involving shared trenching (either communications carrier or electricity assets pre-existing new installation), the clearances as detailed in 5.10.13 shall be maintained. Clearances for shared and non-shared trench arrangements should be verified at design stage.

5.10.5 Gas reticulation mains and services

Gas reticulation mains and services operate at pressures of up to 515kPa. The following minimum clearances are required from gas reticulation mains and services to underground electrical cables. These clearances are based on VESI Standard “UG Cable Design Manual” and AS/NZS 4645.3 Gas Distribution Network - Plastic Pipe Systems.

- 150mm when crossing gas mains or services
- 500mm horizontal clearance when laid in parallel from a gas pipe 50mm outer diameter and greater
- 300mm horizontal clearance when laid in parallel from a gas pipe less than 50mm outer diameter.

5.10.6 Gas transmission pipelines

Gas transmission pipelines and mains operate at pressures between 515 kPa and 7600 kPa and it is of the utmost importance that the continuity of pipeline operation be maintained. Additional precautions should be undertaken when excavating in the vicinity of transmission pipelines. They are also often installed in registered easements and a permit is required for excavations within 3m of pipelines. As a minimum the following clearances shall be used as a guideline. These clearances are based on VESI Standard “UG Cable Design Manual” and AS/NZS 2885.1 Pipelines - Gas and Liquid Petroleum – Design and Construction.

- 300mm vertical/crossing clearance for trenched that are up to 1.5m wide.
- 500mm vertical/crossing clearance for trenched that are greater than 1.5m wide.
- 1000mm horizontal/parallel clearance when laid in parallel

However, the requirements of local gas authorities should be determined at design stage as they may exceed the above clearances. For example Ausnet Services typically requires 1.0m minimum vertical/crossing clearance and 3.0m minimum horizontal/offset clearance. Victorian gas distributors can be found on the Australian Energy Regulator website.

5.10.7 Urban water authorities

The minimum clearance required from urban water supply assets to underground electrical cables and conduits are given in Table **13**. Require clearances are to be determined in consultation with the local water authority at the design stage.

Minimum Horizontal or Parallel Clearance (mm)		Minimum Vertical or Crossing Clearance - All Situations (mm)
Separate Trench		
≤DN200 Water Main or Service	>DN 200 to ≤DN 375 Water Main	
500	1000	225

– Pipes larger than 375mm may require greater clearances for operation and maintenance. Required clearances are to be determined in consultation with the local water authority at design stage.

Table 13 - Clearances from urban water supply mains and service tappings

Minimum Horizontal or Parallel Clearance (mm)		Minimum Vertical or Crossing Clearance - All Situations (mm)	
Separate Trench			
≤DN300	>DN300	≤DN300	>DN300
500	1000	225	300

Table 14 - Clearances from Sewers

Electrical cables/conduits are not to be installed in a shared trench arrangement with sewer pipes unless by agreement with the owner of the sewer asset at a clearance agreed with the owner of the sewer asset.

In addition to the clearances noted above, DBs require a general horizontal clearance of 100mm LV and 300mm HV (cables or conduits) to any other water authority assets, e.g. water valves, sewer inspection point shafts etc.

5.10.8 Rural Water Authorities

Boring, either directional or using conventional boring techniques, should be considered for rural waterways crossings. In general, the following conditions should be maintained for cable crossings of waterways:

- Cable should be laid a minimum of 1 metre below the hard bed of the lowest point of the waterway.
- Construction must not erode or otherwise damage the waterway or its surrounds. To achieve this with boring techniques, the cable should be installed a minimum of 5 metres separation from the top of the batter either side of the drain.

However, the regional waterway authority must be consulted for all proposed crossings of waterways (channels, drains, pipelines, etc.) or other works which may affect these waterways.

5.10.9 Storm Water Drains

Storm Water Drains are usually owned and maintained by the local Municipal Council, but may come under the control of the water supply authority. This standard is concerned with buried or covered drains - not roadside spoon or swale drains, culverts or channels.

Drains may be constructed from a variety of materials including plastic and reinforced concrete pipes, or in the case of very old drains, clay or asbestos cement pipes, bricks or even pitch stopped timber.

The minimum vertical or crossing clearance to rigid drain pipes (including house drains in the road reserve) shall be 100mm to LV cables or conduits and 300mm to HV cables or conduits.

The minimum vertical or crossing clearance to flexible subsoil “agi” pipe drains (typically 65 or 100mm socked) near the Back of Kerb shall be 100mm for both LV and HV road crossing conduits only. Where required, subsoil drains may be temporarily relocated for electrical works in the vicinity and then reinstated to the previous location and condition, subject to the clearances above. Refer to Figure 60.

The minimum horizontal or parallel clearance to all drain pipes, rigid or flexible, shall be 300mm for both HV and LV cables and conduits. The minimum horizontal clearance for cables or conduits passing the rear of storm water pit boxes shall be 100mm LV and 300mm HV. For clearances to very old infrastructure, contact the local Council.

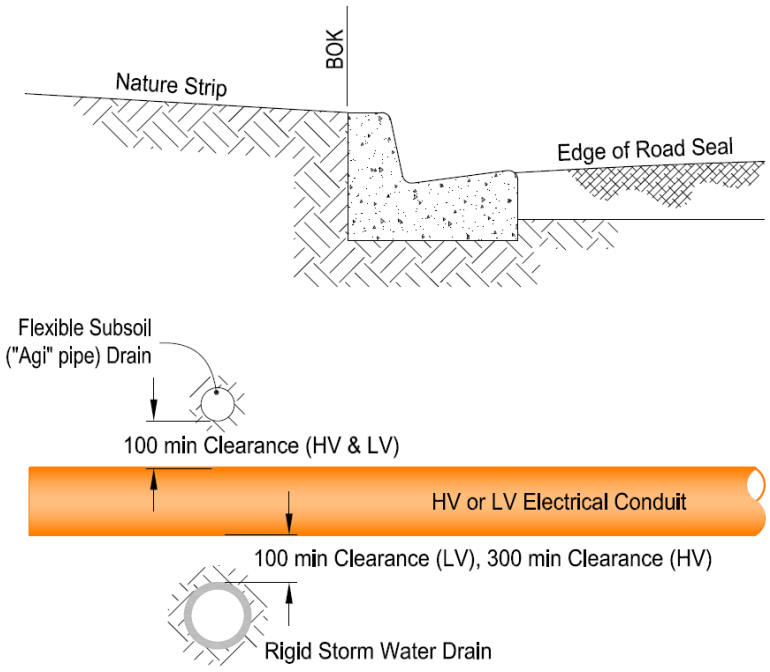


Figure 60 - Conduit Crossing of Subsoil Drains

5.10.10 Tramway Assets

Tunnelling or boring methods should be used under concrete tracks as trenching is prohibited across tram tracks. A clearance of not less than 1.2 metres below rail level shall be achieved so as not to interfere with the tram track structure, unless otherwise specially authorised by the DB. Yarra Trams (for metropolitan Melbourne and suburbs), or the local tram authority should be contacted prior to commencement of construction works.

5.10.11 Railway Assets

Please refer to the clearance standards of the specific rail authority and distribution company within the network where the installation is occurring.

5.10.12 Clearance to Electricity Poles

To allow for future pole maintenance and replacement, 300mm clearance is required between the outer edges of electricity poles (metal, concrete or timber) and all other assets or obstructions including concrete footpaths. This applies to both the assets of other service utilities and other electricity assets. This clearance should be provided for both new works with coincident pole installation (e.g. URD projects) and where new assets are to pass existing poles.

Where lighting poles are fully encased in concrete (e.g. in centre medians or laneways), expansion joint foam strip shall be installed around the pole and a trowelled/cut construction joint or expansion joint (round or square) provided around the pole as a break-out panel. This also applies to frangible poles with a stub base, but note the requirement for 150mm joint clearance to service pits. The concrete joints must not be less than 300mm offset from the pole edge and not more than 500mm - measured to the closest side of a square panel.

5.10.13 Appendix 1 – Table of General Clearances

Clearance of Electrical Cables and Conduits (Up to 22 kV) to Other Utility Assets and Structures - Generic Table for Auditing Purposes

Minimum Horizontal or Parallel Clearance (Offset) to Cable or Conduit			**Minimum Vertical & Crossing Clearance[3]**
Water	≤ 200 Water Main: 500mm - Separate Trench	> 200 to ≤ 375mm Water Main 1000mm - Separate Trench	225mm
Sewer	≤ 300DIN Sewer Main: 500mm - Separate Trench	> 300DIN Sewer main 1000mm - Separate Trench	225mm (≤ 300 DIN) 300 (>300 DIN)
Gas - reticulation	OD ≤ 50mm Gas Pipe: 300mm	OD > 50mm Gas Pipe 500mm	150mm
Gas - Transmission	1000mm		300mm (Trench ≤ 1.5m wide) 500mm (Trench > 1.5m wide)
Communications[5]	100mm to LV Cable/Conduit (See Figure 58) 300mm to HV Cable/Conduit (see Figure 59) 50mm to LV cover slab, 250mm to HV cover slab		100mm LV 300mm HV
Lighting & Distribution Poles	300mm to all other assets (including concrete footpaths and building line) 1000mm to driveway crossings and pedestrian/pram crossing (Refer to section 4.11)		N/A
Storm Water Pipe	300mm to all other assets		100mm LV, 300mm HV[6]
Other Assets/ Structures[7]	100mm LV, 300mm HV		100mm LV, 300mm HV

Notes:

1) All specified distances are the minimum required measured between asset edges or faces

2) Specified clearance applies to both LV and HV electrical assets where not noted

3) Crossing clearances documented are to the electric cable or conduit.

4) Larger Pipe Sizes may require additional clearances - consult relevant water authority

5) Includes property lead in conduits

6) Except conduit crossing of flexible subsoil (“agi”) drains at BOK where the clearance is 100mm to both HV and LV conduits

7) Includes storm water pits, sewer inspection point shafts etc. (all cable joints minimum 300mm clearance)

5.10.14 Installation Above and Below Another Asset

Where unavoidable, installation of mains cables and conduits in open trenches is permissible both above and below an asset of another authority subject to all required depths and clearances being maintained. This arrangement is non-preferred, but may be utilised to achieve crossing clearances and cover depths as well as minimising cable de-rating. In this situation the crossing shall be appropriately recorded on the as-constructed detail drawing (except where the crossing is of service tappings or property lead-in conduits), and a second run of marker tape must be installed not less than 150mm above the lower asset for a minimum distance of 2m either side of the other asset crossed. Refer to Figure 61.

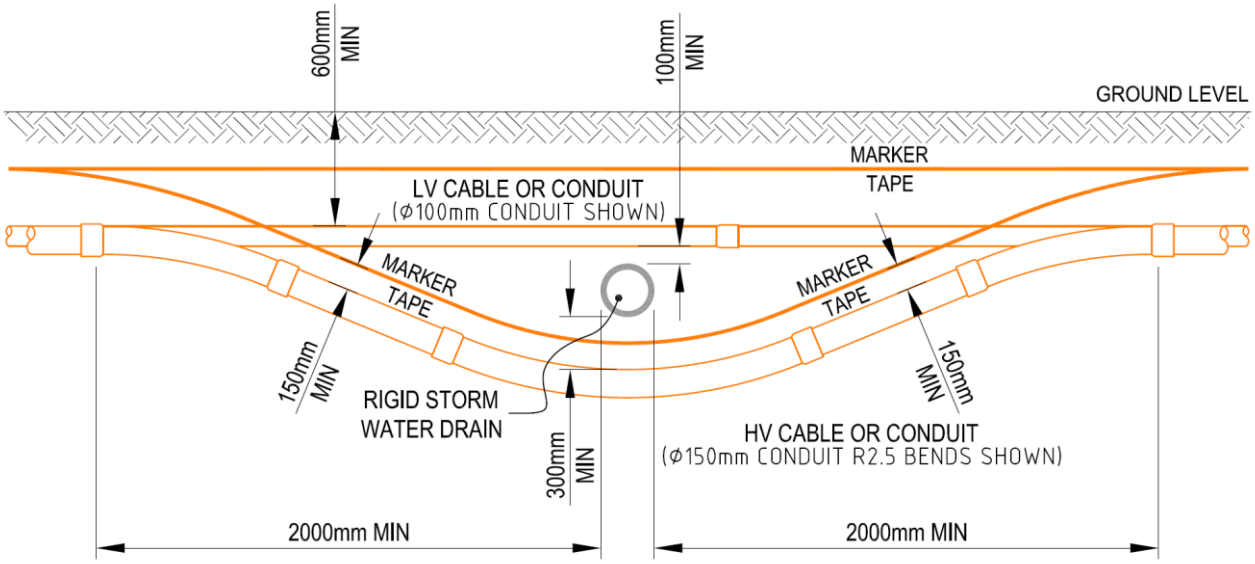


Figure 61 - Installation Above and Below Other Assets

5.10.15 Under-crossings of Other Assets

Where HV/LV UG mains assets require to cross below assets of other authorities to maintain cover depths and clearances, a cross-section detailing all depths and clearances shall be shown on the cable proposal plan (prior to construction) for approval by the DB Responsible Officer. This includes communications pipes. Accordingly the crossing shall be appropriately recorded on the as-constructed detail drawing. This requirement applies to both URD type projects with coincident infrastructure planning and design; and where electrical assets are installed in an existing established area. It does not apply to service cables or other authority service tappings and property lead-in conduits.

5.10.16 Other Authority's Assets

The separation of power cables to other service authority assets or structures not listed should be determined in consultation with the relevant servicing agents.

The minimum horizontal or vertical requirement shall be 50mm from a cover-slab protecting a (centrally positioned) cable, provided that a minimum of 100mm for LV and 300mm for HV assets is maintained at all times and in all directions. These minimum clearances apply to both cables and conduits for horizontal, parallel, vertical and crossing situations.

Where joint locations (HV or LV) are specified or known in the vicinity of other assets, an additional 300mm radial clearance is required.

Where possible, it is preferred that electrical assets are installed below (deeper than) other assets.

5.10.17 Separation from Trees

Ownership or responsibility for trees may be categorised as under administration by a Municipal Council or other Responsible Authority for trees in roads, parks, reserves, forests or Crown Land; or private ownership on private property.

Trees roots, in particular the roots of certain species, can have a detrimental impact on underground power assets over a long period of time. Designers must take this into consideration when planning the coexistence of underground electrical assets and trees to ensure that each is protected from the other.

There are 3 situations whereby trees may be in close proximity to UG cables:

5.10.17.1 New UG cables installed in close proximity to established trees

Where new UG cables are to be installed in an area where trees are established, a vegetation/tree management plan that may include a co-ordination drawing shall be sent to the Municipal Council or Responsible Authority with the presence of the established trees clearly marked. This may be undertaken as part of the Roads Management Act referral process. Where not unduly restrictive or will not involve significant additional project costs, Council requirements (such as boring past or under trees etc.) should be complied with. Impositions considered unreasonable should be negotiated where possible.

5.10.17.2 Coincident planning, design, or installation of trees and UG cables

Coincident installation means that both new UG cables and trees were part of the design and planning process for a development but may not necessarily have been installed and/or planted at the same time.

To assist designers the following guidelines are provided and include information taken from the Road Management Act 2004 - Code of Practice - Management of Infrastructure in Road Reserves:

- Trees should be planted centrally within a 'tree zone' as per the Road Management Act 2004.Refer to Figure 62.
- As stated in the Road Management Act 2004 the 'tree zone' is defined as a 5 metre diameter area of roadside, and with a depth of 600mm.
- Tree location and species type shall be determined in consultation with the DB and based on the specific site and the ability of the tree to both enhance local amenity and co-exist with utility services infrastructure. The location of all trees shall be shown on a 'master services plan' which is the cable proposal plan submitted for approval, along with all other proposed utility infrastructure, and represented by a 5m diameter circle accurately located and drawn to scale.
- The following critical assets are not permitted to be located within the 5m diameter tree zone:
    - Underground cable joints (including below the tree zone)
    - Any conduit ends (including below the tree zone)
    - Street lighting and distribution poles
    - Paralleling or distribution pillars and switching cabinets
    - Substations
- All underground cables should be placed outside the 'tree zone' where practicable. Underground cables installed in close proximity beside or below the 'tree zone' shall be mechanically protected within conduits or by cover slabs. It is recognised that tree roots will grow outside the specified 'tree zone'.
    - The 'tree zone' has been defined to enable the inclusion of street trees into the streetscape and to minimise the impacts on street trees due to future maintenance of utility services.
    - For subdivision projects subject to a DB Network Final Audit, the trees form part of the overall infrastructure and amenities. Accordingly, to ensure appropriate asset clearances the trees should be planted prior to commencement of the Network Final Audit.

Tree planting contractors or arborists must be able to identify the nominated critical assets and the cable/conduit locations and depths from as-constructed drawings obtained through Dial-Before-You-Dig or the Project Manager.

Alternatively they may seek advice from appropriate electrically trained personnel. Tree planting must not occur without reference to electrical as-constructed drawings.

Where possible, planting of trees directly on top of electrical cables/conduits should be avoided due to potential disturbance of marker tape that could be encountered at 250-450mm depths, and cover slabs that could be as shallow as 450mm. Trees should be offset 200mm from the edge of the root-ball to the edge of the closest cover slab or conduit if practicable, and care must be taken for stakes also to be installed at least 100mm clear of the electrical assets. Any

excavation near underground cable should be done by hand and Worksafe No Go Zone requirements must be followed. Refer to Figure 63 for the preferred tree planting location in the vicinity of underground electrical cables and conduits.

Where planting directly on top of cables or conduits is unavoidable, then marker tape should be neatly cut and re-laid below the root-ball still in line with the cable (refer Figure 64). Additional tape may be required and it is permissible for tape to rest on cover slabs in this situation only, provided the tape is at least 150mm above the cable as determined from as-constructed details. Note that marker tape must also be a minimum of 150mm above conduits. Refer to Figure 64 for details.

Cover slabs must not be disturbed under any circumstances. If a cover slab is encountered and the tree planting depth conflicts, then the tree must be offset as mentioned above or the root-ball trimmed back to suit the cover slab depth. In this situation tree stake depths must be limited to 450mm.

The Municipal Council or responsible authority shall be informed as part of the design and approval process of their liability for any costs associated with the damage of underground cables due to the planting of trees.

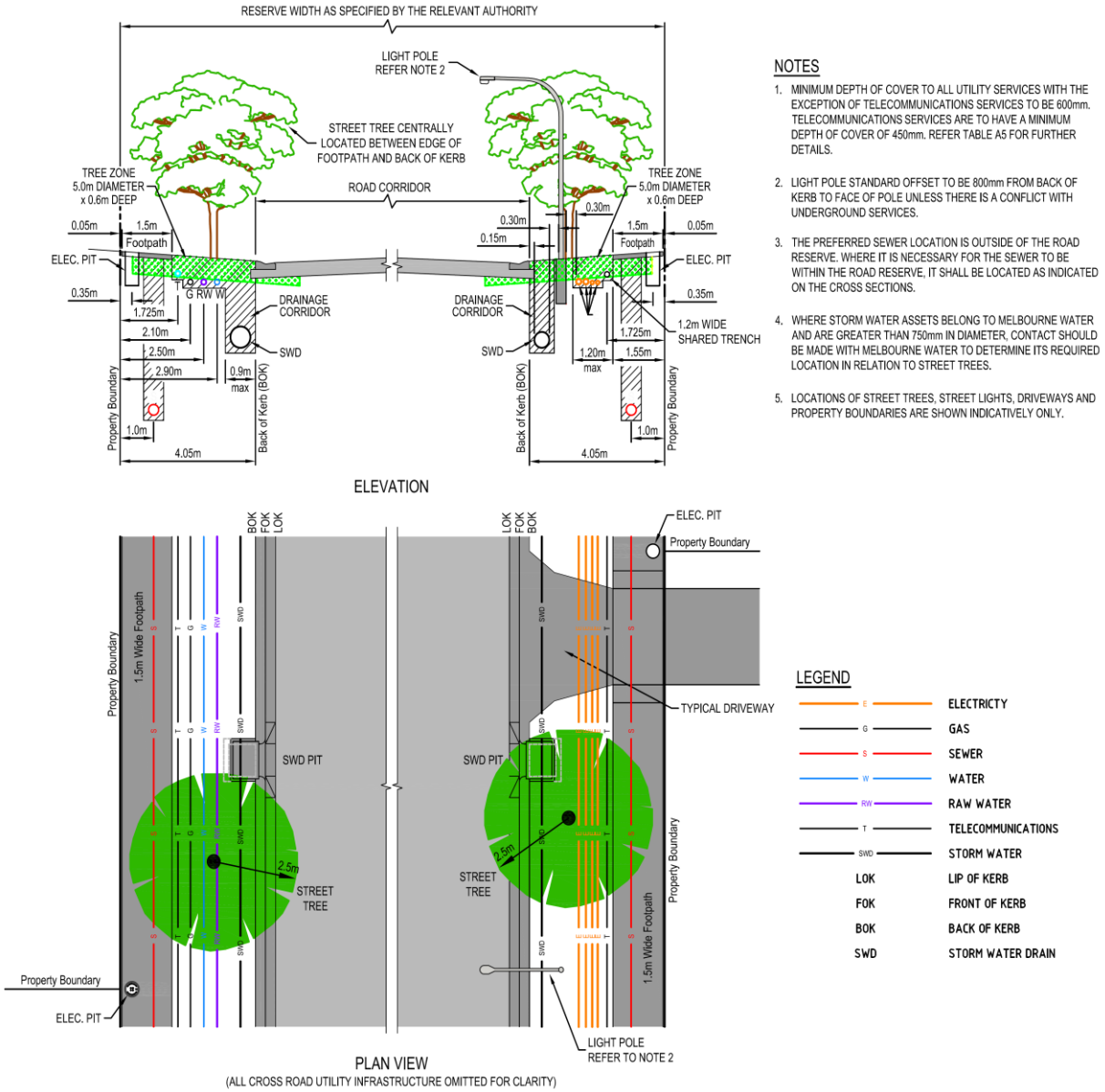


Figure 62 - Preferred Tree Planting Near UG Electrical Assets

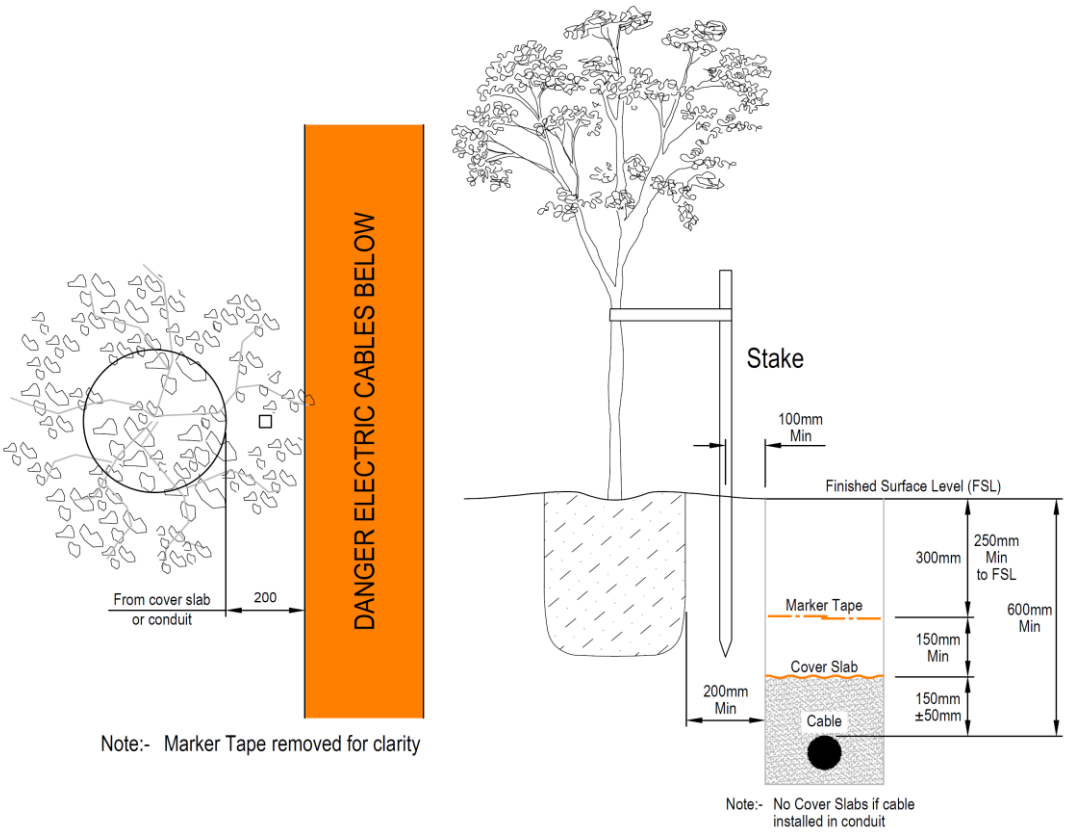


Figure 63 - Preferred treatment for residential streets

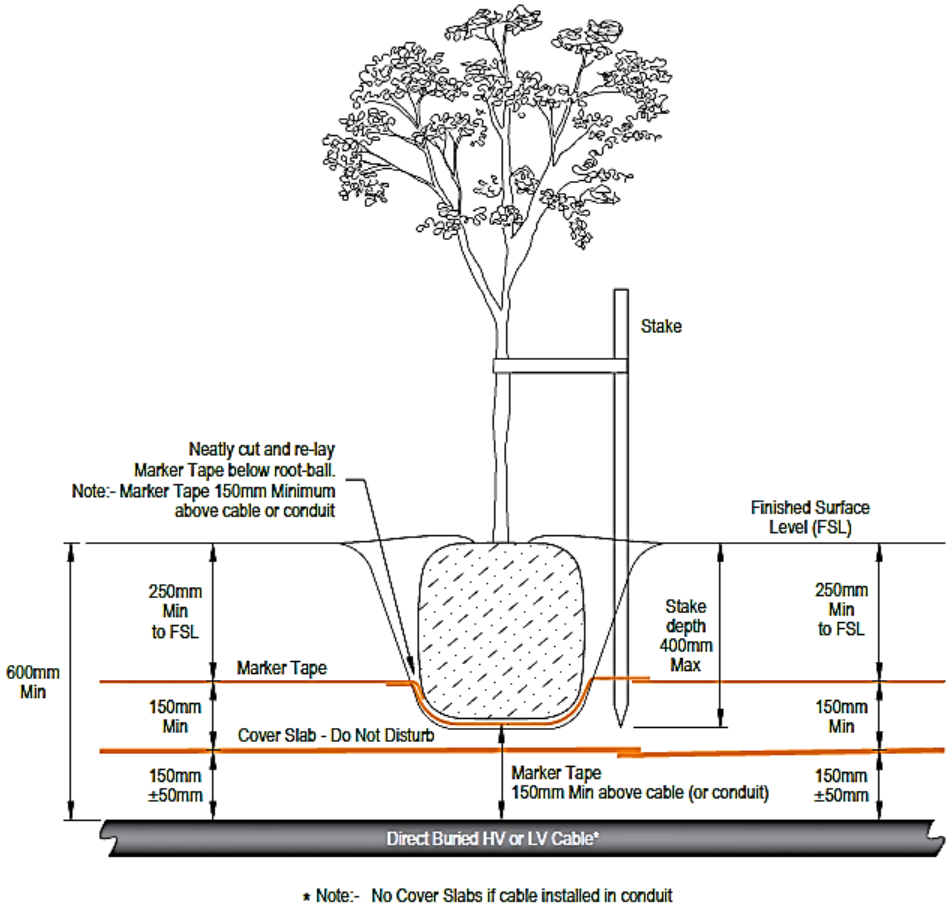


Figure 64 - Tree Planting Above UG Electrical Assets

5.10.17.3 New trees planted in the vicinity of existing UG cables

Parties seeking to plant trees or bushes in the vicinity of existing underground cables shall do so under a mutually agreed with the distribution business.

Where tree planting encroaches into the Worksafe No Go Zone, consultation with the DB is essential.

5.10.18 Clearances to other assets

5.10.18.1 Between Cables/Conduits and Insulated or Non-Conductive Assets:

A minimum horizontal and vertical working clearance of 25mm must be maintained between cables/conduits and all insulated or non-conductive assets, e.g. between joint casing “boats” or heat-shrinks (STJ, MTJ or STRJ) and adjacent cables (HV or LV); between paralleling pillar skirts, plastic bollards and adjacent cables (HV or LV); between insulated earth conductors and cables. Refer to Figure 65 for an example.

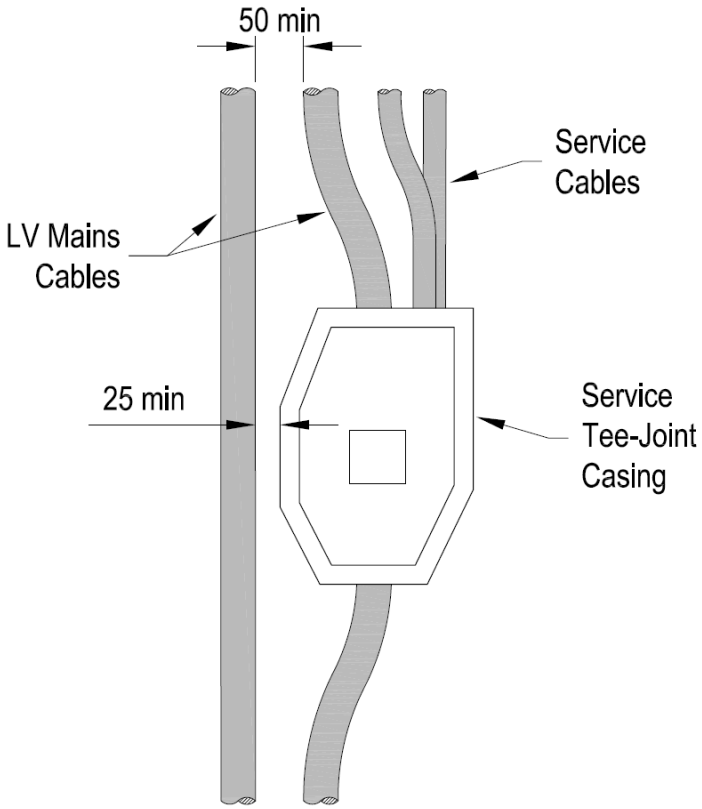


Figure 65 - Working clearance between insulated assets

5.10.19 Cable/Conduit Spacers

(Also applies to Section 5.10.3 Clearance to non assets)

Spacers may be used to maintain clearances between conduits, cables and other assets only where necessary and as noted below. They must not be inserted or driven between assets under force and there shall be no visible conduit distortion. Spacers introduce foreign material into the cable/conduit backfill or embedment, so need to be limited in size.

Spacers may be defined as hard or soft:

- Hard spacers include timber, conduit offcuts or commercially available purpose specific plastic spacers. Hard spacers should not exceed approximately 150mm square/round in the bearing area, and where possible they should be vee-shaped or profiled to engage a large surface area of the conduit(s) and not at small or localised pressure points.
- Soft spacers include sand bags (filled with the same sand/soil used for backfill or embedment), or polystyrene blocks not exceeding 150mm square in the bearing area.

Spacers may be applied as follows:

- Between DB conduits: Hard or soft spacers may be used to maintain clearances provided there is no conduit distortion evident. Staking of conduits to achieve desired bends is not permitted.
- Between DB cables or cables and conduits: Between direct buried cables or a mixture of cables and conduits, only soft spacers may be used.
- Between DB assets and pipe systems of other authorities (gas, water, recycled water, comms, sewer and storm water): Soft spacers only permitted where absolutely necessary, and this is particularly critical with pressurised assets (e.g. gas and water).
- Between DB assets and other rigid structures or assets (e.g. concrete storm water pits, inspection point risers): Hard spacers to conduits and soft spacers to cables. Note: Where installed, water anti-hammer blocks (sometimes just concrete poured around water pipe bends) must include a soft spacer interface with electrical conduits or cables in the vicinity.
- Roadway conduit positions should be marked with an "E" on both kerbs in the general vicinity of the conduit/s as a guide.

5.11 Cable Location Plan

The Electricity Safety Regulations require that the distribution company keep a register of all its underground lines which must detail (as a minimum):

a) the location of the cable; and

b) the depth of the cable; and

c) the size and type of cable used.

This register is to be kept open for inspection to the public during normal business hours.

Please refer to the drafting standards of the specific distribution company within the network where the work is being undertaken.

5.11.1 Earthing System

Measurement of the earth resistance of both the high voltage and low voltage earthing systems must be carried out. For URD substations the measured values of earthing resistance must not be greater than that specified on the earthing standards of the specific distribution company within the network where the installation is.

5.12 Materials

5.12.1 General

All materials used on the distribution network must be a DB approved materials. For safety and reliability reasons non-approved/non-compliant materials shall not be installed on the network. Any non-approved/non-compliant materials that are installed on the network will be required to be removed.

Please refer to each DB for their approved materials.

Where requested by the developer, the distribution company may supply designated materials to the developer under commercial arrangements. The advice of individual distribution companies should be sought in this regard.

Materials are categorised as ‘designated’ and ‘other’ materials. Designated must be supplier and part number whereas other material do not specify a supplier or part number but must meet a performance specification mentioned in this standard.

5.12.2 Designated Materials

The following materials are categorised as designated materials:

- Power cables
- URD substations and cable entry conduits
- Earthing conductor, earth rods and clamps
- Cable jointing and terminating materials
- Connectors
- Paralleling pillar components specified on the relevant drawing
- Public lighting columns, fuse panel and fuse cartridge
- Cable guards
- Service pits and lid
- Cover slabs and marker tape
- Conduits

5.12.3 Other Materials

All other materials will be sourced and supplied by the developer to the distribution company’s requirements as specified in this standard. These materials include, but not limited to:

- Sand
- Crushed rock
- Concrete

6 DRAFTING REQUIREMENT FOR CONSTRUCTION PLANS

6.1 General requirements

The following section will outline common drafting requirements across VESI, however for DB specific requirements please refer to the drafting standards of the specific distribution company within the network where the work is being carried out.

6.2 VESI Assets

As shown in Sample Underground Cable Construction Plan, the drawings are to include the following:

- Cable route and offsets to property boundaries
- Cable installation details
- Size and type of cables
- Cable Alignments
- Dimensioned trench cross sections in locations where more detail is necessary
- Dimensioned cable/conduit crossings
- HV and LV joint locations
- Dimensioned location, type and size of all conduits including conduit bending radii
- Location of Service pits;
- Dimensioned paralleling pillars and bollards position
- Dimensioned locations of substation/s;
- Dimensioned location of public lighting columns;
- Public lighting column, lantern and lamp details;
- Location of drains and drainage pits;
- Property crossovers and footpaths;
- Building lines;
- Kerb lines;
- Lot numbers and street names;
- Service offsets;
- Cable easements;
- A schematic drawing of each kiosk with a table showing labels for all cable terminations and HV switch numbers;
- Location of existing underground cables and poles relevant to the construction works; and
- Drawing standard notes and references
- Location of CHP's and HV phasing
- Labels Schedule - A table showing labels for all cable termination's, substation name and, switch and pole numbers.

- Details of any temporary arrangements to be undertaken where connection to apparatus which is live or capable of being made alive is required. (e.g.; the burying of cable at the base of an existing in-service pole onto which the cable is to be connected.
- Attention Note -May include but not limited to LV and HV tie in not shown on the main plan
- Legend
- Scale Bar
- North Point
- DBYD block
- Drawing standard notes including adjoining drawing reference numbers
- Cable pulling directions (if required)

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