UNDERGROUND CABLE INSTALLATION MANUAL

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Prepared by: Kwok Ng

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Document Control

Endorsement Approvals

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Record of Revisions

Revision number	Date	EDM version (published)	Revised by	Description
Original	April 2006	1	Kwok Ng	Issued on the Web
4	March 2017	5	Chris Omodei	General update and review. Key changes are, but not limited to; • Removal of duplicated information and incorrect links. Made reference to relevant location of source documentation • Added Acid Sulphate Soils, Section 11.5 • Clarified how many cables can be pulled in a bore hole, Section 12.1 • Clarified requirements for directional drilling and pulling requirements, Section 12.4 • Clarified above ground marker requirements, Section 0 • Standardised cable installation depth to minimum cover of 750 mm and maximum depth of 1500mm, Section 14.9 • Added Section 14.10 • Clarified marker tape and protective cover requirements, Section 14.11 • Clarified cable sealing, exposed cables and terminated cables requirements, Section 14.13, 14.14 and 14.15. • Added section on Live End Seals, Section 14.16 • Updated conduit sealing requirements, Section 15.4

				• Updated Cable Installation Data, Appendix A: Cable Installation Data
5	October 2019	6	Chris Omodei	Minor general updates • Section 8.6 clarified • Section 10.4 clarified • Section 11.6 clarified • Section 12.1 updated • Section 14.9 updated. Cable shall be installed between 750mm and 1200mm cover • Section 14.11 clarified • Section 14.15 clarified

Documents Referenced In This Document

Doc #	Title of document
EDM# 23169833	Western Power Underground Distribution Schemes (UDS) Manual
EDM# 34137510	Western Power Network Standard NS 11-2013 (Distribution Commissioning Work instruction)
EDM# 31986289	Safety, Health & Environment Policy

Stakeholders (people to be consulted when document is updated)

Function / Section / Position
Asset Management – Asset Performance
Asset Management – Network Planning and Standards
Asset Management – Safety Environment Quality and Training

Notification List (people to be notified when document is updated in addition to the Stakeholders)

Function / Section / Position
Asset Management – Asset Performance
Asset Management – Safety Environment Quality and Training
Asset Operations – Customer Funded and Operational Improvement
Asset Operations – Network Operations
Asset Operations – Operational Maintenance
Asset Operations – Operational Services

This document must not be made available to personnel outside Western Power without the prior written approval of Western Power.

Contents

1 Purpose

This manual (UCIM) formalises the requirements for the safe and efficient installation of all underground cables on Western Power's distribution system. The specifications, procedures, practices and instructions contained in the UCIM detail the technical requirements to be followed by Service Providers; and act as a reference for auditing and assessment.

2 Application

All Western Power staff and Service Providers involved in the installation of high and low voltage distribution cables on the Western Power network must comply with this manual.

However, for subdivisional work, which is managed by a developer and installed on privately owned land, some of the items in the UCIM are not applicable as they are covered by the UDS manual. These Sections and items are Sections 6, 7, 8, 9, 13 and 15 and special requirements for ‘built up areas’.

Where the subdivision requires equipment to be installed on public land, the installation of the assets are subject to the requirements of the UCIM. The UCIM does not apply to the items installed within the subdivided land. Public land is land that at the time of subdivision is freely available for public use, e.g. existing road reserves, POS, PAWs, etc.

3 General

3.1 Definitions

ASS	Acid Sulphate Soils, are naturally occurring soils containing iron sulphides that in their natural state do not present any harm to the environment. However, when ASS is exposed to air, the iron sulfides are oxidised producing sulphuric acid which makes the soil strongly acidic. This change in pH can cause a breakdown of the soil structure releasing aluminium and other heavy metals which can then be mobilised into adjacent environmentally sensitive receptors (e.g. groundwater, lakes, rivers).
Approved	means having appropriate organisation endorsement in writing for a specific function.
CBD	means central business district.
Cable	means an insulated conductor or two or more such conductors laid together, whether with or without fillings, reinforcements or protective coverings. High voltage cables used by Western Power are normally un-armoured single core XLPE insulated earthed screen cables, which may be bundled in twisted trefoil for three phase use. The outer jacket is extruded HDPE with typically 2mm thickness. Low voltage cables are usually three core XLPE insulated with a concentric wave wound neutral and an outer PVC or HDPE sheath.
Conductor	means a wire, cable or form of metal designed for carrying electric current.
Construction Manager (CM)	means a person who will be Western Power's site representative and to whom all technical and contractual matters shall be referred.
Contractor	means a person or persons involved in work on or adjacent to assets for which this standard can be applied. This definition may be equally applied to persons who are or are not considered staff of Western Power.
De-energised	means not connected to any source of electrical supply but not necessarily isolated.
EAP	Electricity Access Permit, refer to the Electrical System Safety Rules
Earthed	means directly electrically connected to the general mass of earth so as to ensure and maintain the effective dissipation of electrical energy.
Energised	means connected to a source of electrical supply.

High voltage	means a nominal voltage exceeding 1,000V ac or exceeding 1,500V dc.
Insulated	means separated from adjoining conducting material by a non-conducting substance which provides resistance to the passage of current.
Isolated	means disconnected from all possible sources of electricity supply which will prevent unintentional energisation of the apparatus and which is assessed as a suitable step in the process of making safe for access purposes.
Live	means energised or subject to hazardous induced or capacitive voltages.
Live Work	means all work performed on components of electrical apparatus not isolated, proved de-energised and short-circuit earthed.
Low voltage	means nominal voltage exceeding 50V ac or 120V dc but not exceeding 1000V ac or 1500V dc.
Safe	means not posing an unacceptable risk to life, health or property.
Safety Observer	means a person competent for the task and specifically assigned the duty of observing and warning against unsafe approach to electrical apparatus, or other unsafe conditions.
Service Provider	means a person or an entity who is going to undertake any construction work, including cable installation, on or for the Western Power underground network.
Shall	is to be interpreted as "mandatory".
Should	is to be interpreted as "advisory or discretionary".
SPUD	Single Phase Underground Distribution, a single phase underground network consisting of underground cables with loop-in and loop-out, tee-off and termination terminals on transformers.
SPURS	Single Phase Underground Rural Supply, a single phase underground tee-off from an overhead supply.
Voltage	means a potential difference between conductors or between conductors and earth.
'Western Power's Representative'	(also called **'Liaison Officer' or 'Construction Manager'**) means the officer appointed by Western Power as it's representative to whom all site, contractual and technical matters are referred.
HDPE	High Density Polyethylene
HV	High Voltage

LV	Low Voltage
PTA	Public Transport Authority
PAW	Public Access Way
POS	Public Open Space
PVC	Polyvinyl chloride
MRWA	Main Roads WA
WAGR	Western Australian Government Railway
WAPC	Western Australian Planning Commission
UDS Manual	Underground Distribution Schemes Manual
XLPE	Cross-linked Polyethylene

3.2 Related Information

Utility Providers Code of Practice, available from Dial Before You Dig website.

Restoration and Reinstatement Specification for Local Governments in Western Australia. Published by the Institute of Public Works Engineering Australia, available from Main Roads WA web site.

Material selection guidelines for bedding sand, backfill sand, general backfill around cables, available on Western Power's website.

Western Power Underground Distribution Schemes (UDS) Manual, available from Western Power's website.

Western Power Network Standard, NS 11-2013 (Distribution Commissioning Work instruction), available on Western Power's Website.

Western Power Safety, Health and Environment Policy, available from Western Power's website.

Dial Before You Dig Service for lodging an enquiry and requesting a plan

Traffic Management for Works on Roads - Code of Practice, (available from Main Roads WA website

WorkSafe Code of Practice: Excavation, available from Department of Commerce website.

Occupational Safety and Health Act 1984 and Occupational Safety and Health Regulations 1996.

Explosives and Dangerous Goods Act 1961 and Explosives and Dangerous Goods (Explosives) Regulations 1963.

AS/NZS 3000 – Australian/New Zealand Wiring Rules

AS1742 Manual of uniform traffic control devices, Australian Standards

AS4799-2000 Installation of underground utility services and pipelines within railway boundaries

4 General Underground Installation Requirements

4.1 General

All works must be carried out to meet the requirements of WorkSafe and in compliance with the *Occupational Safety and Health Act 1984* and the *Occupational Safety and Health Regulations 1996*. Operations associated with any task must cease if the safety of workers or the public cannot be assured.

4.2 Safety in Pits and Trenches

All pits and trench work shall comply with WorkSafe requirements, in particular the WorkSafe Code of Practice: Excavation. They may include but is not limited to:

- When a pit is to be left open overnight, proper barrier mesh and flashing lights, etc as required or the pit must be covered.
- Soil must be piled safely back from the edge of the pit.
- Pits or trenches deeper than 1500mm in normal soil may require a ladder for access and require shoring, benching or sloping of the sides of them.
- Pits or trenches may require shoring if less than 1500mm deep and the soil is unstable.
- Undermining walls, foundations, streets or pavements are to be avoided otherwise appropriate shoring is required.
- All shoring, benching and sloping must be installed.
- Barriers shall be erected to vehicles inadvertently falling into the excavation. Local councils may have more onerous conditions that need to be met.
- Collapse or flooding of trenches.
- Lack of ventilation or suitable lighting.
- Dangerous gases.
- Confined working space.
- High temperatures.
- Traffic hazards

4.3 Working in the Proximity of Overhead Power Lines or Underground Infrastructure

When working in proximity to overhead power lines and equipment, the requirements of WorkSafe must be complied with.

A 6m radius exclusion zone shall always be maintained around all overhead transmission towers and poles, refer to the link below for clarification.http://www.westernpower.com.au/safety-working-near-electricity.html

Prior to carrying out any above or belowground work near Western Power's power network, the Service Provider should follow the guidelines set out on Western Power Website, refer to the link above.

4.4 Working in the Vicinity of Traffic

When working in road reserves or in the vicinity of traffic, traffic management must be carried out to meet the requirements of the *"Traffic Management for Works on Roads – Code of Practice" available from the Main Roads WA website*.

5 Work Planning

5.1 Responsibilities

The Service Provider shall obtain information from all utilities about the location of existing services within the proposed area of work. To obtain the underground equipment details, the Service Provider shall use the Dial Before You Dig Service detailed in 20. Overhead services will be identified visually on site.

The Service Provider shall also conduct the required tests in accordance with Western Power Network Standard, NS 11-2013 (Distribution Commissioning Work instruction), available on Western Power's Website.

5.2 Planning and Risk Assessment

Before commencing work, a pre-start assessment by all involved parties (including the civil contractor etc.) shall be carried out to address hazard management and work practices and shall include but not be limited to –

- Identify hazards,
- Assess risks that may result because of the hazard,
- Decide on control measures to prevent, or minimise the level of the risks,
- Implement control measures,
- Particular attention shall be given to, but is not limited to:
    - Traffic management, refer to Main Roads Dept Code of Practice (on the MRWA Website), and also Section 5.4 for particular requirements in congested traffic areas such as the CBD.
    - Public and worker safety.
    - Potential weather conditions during the work.

5.3 Notification of proposed works

The Service Provider shall notify MRWA, the local shires and councils and affected public at least five days prior to commencement of work.

5.4 Particular Requirements Relating to CBD Work

Where excavation work is to be carried out, the following factors shall be taken into consideration when planning the job.

- The plan shall be prepared and submitted to the local authority by a person accredited by the MRWA.

- All work shall be done to minimise the interruption to local business and allow continued access to businesses for trade.

The hours of work may be restricted depending on the possible noise pollution created from the excavation works.

- Some councils will not allow mechanical excavation work in footpaths, e.g. City of Perth. The Service Provider will need to check with the local Council.

6 Surveying and 'As Constructed' Records

6.1 Survey Benchmarks and Datum Points

There may be official survey benchmarks installed in the project work area. The Service Provider shall take all necessary precautions to avoid disturbing these markers. Should any markers be disturbed by the Service Provider, it will be responsible for all costs associated with restoring the benchmarks to their correct position.

6.2 As Constructed Records

Upon completion of all work, the Service Provider shall provide the CM with the following "As Constructed" records.

- Cable installation record including but not limited to.
    - Cable route and where cables are installed using directional drilling, the length and depth of cables shall be recorded.
    - Cable joints or live end seals
- Electrical test schedules.
- HV cable joint schedule.
- Materials & equipment schedule.

The "As Constructed" records shall meet the requirements of the UDS Manual.

Standard forms for Electrical Test Schedules, HV Cable Joint Schedules and Materials & Equipment Schedule are available for download from Western Power's web site, refer to Western Power Network Standard NS 11-2013 (Distribution Commissioning Work instruction).

7 Environmental and Aboriginal Considerations

7.1 Environmental and Aboriginal Impacts

Environmental and Aboriginal impacts must be investigated and managed according to Western Powers safety, health and environment policy, refer to Western Powers Website. Impacts may include but not be limited to the following:

- Declared Rare Flora and Threatened Ecological Communities (protected by State and Federal Law).
- Biosecurity. Weeds, Pests and Disease Spread, e.g., the spread of Dieback Disease.
- Vegetation Clearing Permit from Department of Environment and Conservation (DEC).
- DPaW land entry permits (formerly DEC or CALM).
- Protected Wetlands.
- Acid Sulphate Soils. Management plan for the works where they exist.
- Waste Management including Controlled Waste.
- Noise.
- Dust.
- Erosion.
- Incident Response. This includes informing Western Power and relevant departments when unexpected incident or discovery occurs, etc.
- Aboriginal Heritage Sites. Investigate and manage.
- Objects of suspected Aboriginal origin. Policy and Procedure.
- Native Title.

The Service Provider must comply with the requirements of the *Utility Providers Code of Practice* Section 8.8 and 8.9, and any other relevant legislation.

8 Crossings

8.1 Railway

8.1.1 Installation of Ducts and Cables

"Where site conditions permit, the installation shall be by boring or directional drilling for the portion under the tracks and at least 3m beyond the outer rails or 3m beyond the toe of embankment, whichever is the further. (AS 4799-2000, Clause 3.5.1)".

In the case of boring, the diameter of the bored hole shall not exceed the outside diameter of the pipe/conduit by more than 50mm. If the diameter of the bored hole exceeds the outside diameter of the pipe/conduit by 50mm the bored hole needs to be abandoned, the hole shall be backfilled (according to AS 4799-2000, clause 3.9.3) and remedial measures shall be taken to provide support for the railway.

8.1.2 Installation of Markers

Cable markers shall be installed to indicate the location of all underground power cables.

The markers shall be located above or adjacent to the buried cable (AS 4799-2000, Clause 3.10.2):

- At points of entering and leaving the property of the PTA.
- At changes of direction.
- At distance between consecutive markers of the lesser of 200m or line of sight.
- Where specified, at the ends of the under track crossing (the end of the under track crossing is taken as the point 3m beyond the outer rail or toe of the embankment).

The markers shall comply with the following requirements (AS 4799-2000, Clause 3.10.3):

- Stand at least 800mm out of the ground, to the bottom of the marker plate.
- Be of non-combustible material for the marker plates and of at least fire-resistant material for the pole.
- Wording on the markers to be legible, permanent, and formed in a non-combustible medium, or as otherwise approved by the PTA.

The descriptive wording and instructions shown on the markers shall face the railway (AS 4799-2000, Clause 3.10.4).

The wording on the markers shall include the following (AS 4799-2000, Clause 3.10.5):

- The owner's name.
- A warning of the presence of a buried service.
- The nature of the buried service.
- Contact advice in the event of an emergency.

8.1.3 Installation of power cables under tracks and elsewhere on railway property

Power cables passing under the tracks, shall be enclosed in an appropriate 'Category A' system in accordance to AS/NZS 3000. The top of the encasing pipe or conduit shall be at a depth of not less than 2000mm below the top of rail and shall be maintained at this depth for not less 3000mm beyond the outer rails, when measured at right angles to the track (AS 4799-2000, Clause 6.4.2.1), unless otherwise stated in the approved design.

Power cables passing elsewhere on the property of the PTA shall be laid according to AS 4799-2000, Clause 6.4.2.2 and at a depth of not less than 1000mm below ground level, or at the same depth below the level of drain inverts they may cross unless, otherwise stated in the approved design. Where specified by the PTA, the cables shall also be enclosed or covered by protective slabs.

8.2 Pipes or Cables

8.2.1 Existing Pipes or Cables

Whenever a crossing is made of an existing pipe or cable, such pipe or cable shall be securely supported during the progress of the work.

The minimum spaces required between services are contained in the *Utility providers Code of Practice*, summarised as follows:

- Electricity is to pass under gas and water at reticulation crossings.
- Cover bedding and backfill requirements for water reticulation shall be in accordance with Water Corporation requirements.
- All reticulation shall be laid within plus or minus 100mm of the indicated centre line and secured against movement with initial backfill.

8.3 Gas Mains

Where work is required close to the gas transmission system the Service Provider must contact the pipeline owner before any work commences (refer to the Dial Before You Dig Service in 20). When excavating within 15m of a high pressure gas line, the Service Provider must ensure that a safety observer from the pipeline operator is on site during the work.

Whenever hot work is being carried out in a trench or excavation, which includes a gas main, the Service Provider must notify the pipeline owner before work commences. Hot work includes welding, naked flames, grinding, and etc.

In some country areas such as Mandurah and Albany a different gas mixture, which is heavier than air, is used. If any work is carried out in a trench adjacent to a gas main in Albany or the Vines Area, the Service Provider must notify the gas pipeline owner of the work location.

8.3.1 Hot Work Plastic and Steel Pipes

When carrying out hot work involving a naked flame in the vicinity of an exposed gas pipe, a minimum separation distance of 600mm must be maintained from the gas pipe to the flame. If this is not possible, assistance must be sought from the pipeline owner concerned.

A fireproof blanket or barrier must also be placed between the gas pipe and the hot work area.

8.3.2 Hot Work Cast Iron and Old Steel Pipes

The Service Provider must call the pipeline owner to site prior to hot work being started to ensure there is no gas is in the trench or surrounding area.

8.4 Communication Services

Prior to commencement of work, the Service Provider must use the Dial Before You Dig Service, 20, 'to identify the location of communication services and carry out potholing appropriately (typically, vacuum excavation) to identify the actual depth and position of the cables.

The communication services alignment is between 500-1300mm from the verge, and 450mm deep. Whenever a power cable crosses a communications cable, the cable shall be securely supported during the process of the work and the power cable shall go under the communications cable.

The space between the power cable and the communications cables shall be maintained when the trench is backfilled. The spacing requirements are contained in the Ultility providers Code of Practice.

8.5 Other Electricity Services

Work on behalf of Western Power, near other electricity services, shall be in accordance with Western Power's procedures. Work on the Western Power cable shall not commence unless the cable has been identified or located.

The following precautions shall be taken before working on Western Power cables near other electricity services:

a) Identify and safeguard against any electrical hazards that are present on the site. These can include, but are not limited to:

- live electrical apparatus;
- induced voltages;
- transfer potentials;
- the potential for faults on adjacent cables and joints; and
- Capacitive voltages.

b) Identification of cables shall be carried out by or on behalf of Western Power in accordance with Western Power's procedures, i.e. using three methods of identification. A spiking gun is used to confirm if the HV cable is de-energised.

c) Identify and safeguard against any physical hazards present on the site. These can include, but are not limited to:

- possibility of mechanical damage to existing cables or joints; and
- excavating or installing cable.

d) A worker shall not physically handle a high voltage or low voltage cable, whether sheathed or screened, if its condition is suspect to be damaged, unless the cable is proved to be de-energised.

e) A Service Provider shall not move a high voltage cable while it is live.

f) A high voltage cable shall be isolated, earthed and proved to be de-energised and an EAP issued on site prior to commencing work on the cable.

g) All excavation sites should be examined thoroughly for indications of underground cables and/or conduits.

h) Cable covers, such as cover slabs or marker tapes, if present, must not be disturbed, however if disturbed they should be reinstated to the appropriate position.

i) For equipment with earth grids;

- Particular attention should be paid to areas surrounding pole mounted substations and high voltage switches, as there are often earth grids and bare wires buried in the vicinity of the equipment.
- Underground earthing conductors may also have been installed adjacent to certain other poles and structures.
- If any unrecorded underground cables, conduits or bare earth wires are exposed or cut, work in the vicinity must cease and Western Power must be notified immediately.

8.6 Road Crossing

All cables crossing roads shall be installed in cable ducts. Road crossings shall be installed

- perpendicular to property street boundaries, and
- at significant points, e.g., common property boundaries or intersections.

For service cables and streetlight cables, the ducts shall be installed from edge-to-edge of the cable alignment to as practically close to the termination point.

For cables with a large bending radius, road-crossing ducts shall extend a minimum of 1000mm into the roadside verge from the kerb line and as practically close to the termination point as possible. Cable covers, refer to Section 14.10, shall be installed in the gaps between the end of ducts and the edge of cable alignment. Where roads and vehicle crossings are already constructed, thrust boring can be used to install the required ducts.

8.7 Horizontal Cable Clearance to other Services at Road Crossing

All cables and ducts crossing roads shall be installed with a minimum horizontal clearance of 150mm from other services.

9 Cable Tunnels and Support Systems

9.1 General

Cables shall be supported on racking with a maximum spacing of 1500mm however closer spacing may be required depending on the size and number of cables on the racking. Horizontal spacing between parallel cables shall be at least 100mm.

9.2 Access pits

In circumstances where there is a change in route for the cables being installed and the design requires the installation of an access pit. The pit shall be large enough to:

- Allow two people to work comfortably on the cable.
- Install rollers.
- Accommodate for the bending radii of the largest cable available to Western Power. At present this is 22kV 400mm² Al HV XLPE cable.

9.3 Cable Support

If a solid cleating support system is to be employed the following shall be adhered to;

- The cleating distance is such that the cable is maintained in a straight line with no sagging.
- Wooden or specifically sized plastic cleats are to be used for paper/lead insulated cables.
- Ensure the cable is rigidly held at the cleat position.
- Cleats for long vertical runs must be designed to support the weight of the cable.
- Cleats used on single core cable must be of non-magnetic material, such as wood or aluminium. Single core cables shall never be surrounded with a steel ring, as this will cause local heating problems.

When applying cleats to cables care must be taken to ensure the correct size cleat is used otherwise damage to the cable may result. A tight cleat may pinch the cable whereas a loose cleat may allow excessive cable movement.

9.4 Tunnels

Where tunnels are to be used the construction and installation requirements will be included on the design drawings.

10 Cables on and off Alignment

10.1 Cable Alignment

Cables shall be installed in Western Power's standard alignment in accordance with the *"Utility Providers Code of Practice for Western Australia"* Cables can only be installed off the alignment with Western Power's approval and other affected utilities written agreement.

Other services shall not be installed in the power cable alignment without written permission from Western Power.

10.2 Easements

Where cables, HV and LV, are installed outside the standard alignment or on locations other than road reserves, which includes private property, POS or PAW, they shall be protected by surveyed easements.

Two classifications for underground distribution easements exist and one of these will be selected and documented in the design file.

1. Through the WAPC process easements are applied under Section 167 of the Planning and Development Act 2005.

2. Cables requiring protection outside this process will need to register the easement under the Energy Operators (Power) Act 1979.

For subdivision developments, developers must comply with the requirements of the UDS Manual.

10.3 Greenfield (Common Trenching)

It is the Service Provider's responsibility to identify all front boundary pegs prior to commencing excavation.

10.4 Retrospective

For retrospective underground areas where the standard cable alignment is not practically available, the outer alignment of 2.4-3.0m is typically preferred from the property line, refer to the Utility Providers Code of Practice. The identification of the correct property line is the responsibility of the Service Provider and if there is any doubt as to its correct location, the Service Provider shall obtain directions from the relevant authority.

Where the poles and trees alignment is not available special arrangement will need to be determined.

11 Trenching and Excavation

11.1 General

The Service Provider shall

- Excavate the trenches to a width sufficient for satisfactory and safe working conditions and shall comply with all relevant Acts, Regulations and requirements of public or statutory authorities.

- Excavate as necessary to provide the specified minimum cover, including joints, but so as to avoid damage or loss of support to, obstacles such as pipes, drains, cables and other utilities and services.

- Restore the area to be excavated to its original condition when the excavation is complete. All excavations shall be completed in a timely manner to minimise disruption to all parties.

- Provide all materials required for the excavation including, but not limited to pumping equipment, shoring, backfill, etc. The equipment must be provided for the entirety of the project.

11.2 Exceeding Extent of Excavations

Excavation in excess of that specified for the laying of the cables shall be made good at the Service Provider's expense. In the case of excessive excavations, approved sand filling for the bottom of the trenches shall be used.

11.3 Rock breaking equipment

Rock shall mean limestone (cap stone), ironstone, igneous rock and concrete etc which occurs in solid masses, or any other material that cannot be practically excavated by a backhoe-type machine or bored, using an approved boring machine. When using rock breaking equipment minimum approach distances shall be adhered to.

11.4 Blasting

On occasions blasting operations are undertaken as an aid to excavation in rock, limestone and clay.

Blasting shall not be carried out within the road reserve where other utilities are in close proximity and blasting will affect their equipment. Blasting is not to occur within 30m of an existing cable.

All explosives handled in the course of blasting operations shall be carried out under the direct supervision of a licensed shot firer in accordance with all relevant Acts and Regulations including the Explosives and Dangerous Goods Act 1961 and the Explosives and Dangerous Goods (Explosives) Regulations 1963.

Blasting must be on a very limited scale in built up areas and should only take place after all nearby buildings have been thoroughly inspected, photographed if required and recorded. Adequate warning signs must be displayed and all precautions against flying material taken by the use of pegged or weighted blasting mats or similar aids.

In open country it is possible to make maximum use of explosives. With shallow trenches, up to 1.5m deep, the ground can often be broken up to its full depth in the one operation. In deeper trenches, benching would have to be undertaken.

It is important that all drilling for blasting be carried out as quickly as possible and extraneous matter is cleared soon after to avoid entering drill holes. It is good practice to temporarily plug drill holes prior to charging. If extraneous material is allowed to enter drill holes the amount of charge possible in each hole will be reduced, thereby diminishing the force of the explosion and fragmentation of the rock.

The Service Provider shall pay for any damage or injury caused by blasting.

11.5 Excavated material

In built up areas, where permitted by the relevant authorities, the Service Provider shall, where practicable, neatly stack reusable top layers of material such as lawns, pavers, etc on one side of the trench and shall stack the bottom layer of soil separately on the opposite side of the trench. Excavated soil must be maintained within the area and not be washed or blown away.

Some councils require all excavated materials to be removed from site to enable continued pedestrian access without having to walk on the road. Unsuitable soil may have to be disposed of and graded backfill brought in.

No excavated material shall be placed on, or encroach on private property.

Acid sulphate soils (ASS) need to be managed in the correct manner. ASS can

- Contaminate water resources as the ASS create acidic water and heavy metals can kill fish and increase their susceptibility to disease.
- Damage infrastructure as the sulphuric acid degrades concrete and steel leading to structural weakness and failure.
- Produce iron staining (rust-coloured iron stains) on concrete structures or soil and oily-looking bacterial scums on effected water.

11.6 Trench Cross-Sections

Trench cross-sections shall meet the requirements of Drawing No. UDS-6-2 in the UDS Manual.

12 Directional Drilling

12.1 Directional Drilling

Cable spacing shall meet the requirements of Drawing No. UDS-6-2 in Appendix 22 of the UDS Manual.

A maximum of one 240mm^2 LV cable and one 16mm^2 streetlight cable can be installed in a common drill tunnel if there will be no tee or service joints along the cables.

Two 240mm^2 LV cables can be installed in the one drill hole if the above separation can be achieved and for installation of any service joints, planned or future. This is typically achieved using conduits or separators. Any method used for installing two 240mm^2 LV cables in one bore hole needs to be approved by Western Power.

Multiple high voltage triplex cables (35mm^2, 50mm^2, 95mm2, 185mm^2, 240mm^2 or 400mm^2 etc) shall not be combined into a single drill tunnel with any other cable.

Separate tunnels shall be used beyond 900mm depth.

12.2 Digging Entry and Exit Pits

An appropriate entry and exit pit are required for directional drilling.

12.3 Protection of Cables in Special Terrain

Where terrain consists of solid rocks or broken rocks, or was a land-fill site, cables installed by directional drilling must be protected by suitable poly-pipes.

12.4 Drilling and Pulling

During construction continuous monitoring and plotting of the pilot drill and back reamer progress shall be recorded to ensure compliance with the required alignment and depth. The monitoring may be accomplished either be manual plotting based on the location and depth readings provided by the tracking system or by computer-generated track logs fed by this information. The tracking method may be by walkover, wireline, or wireline with a wire surface grid. The tracking system shall provide information on:

- Clock and pitch.
- Alignment and Depth.
- Position (x-y).
- Azimuth - where walkover is not possible.

The bore logs shall show a depth and bore position from a known boundary every 3m along the bore line. These records shall be made available to Western Power electronically as a permanent record.

To prevent collapse of the borehole, drilling mud or similar rather than just water shall be used for both drilling and back reaming operations.

The pilot hole shall be reamed to provide free sliding of the cable or conduit inside the borehole.

Drilling, back-reaming speeds, and fluid flow shall be set so spoil is removed without putting unacceptable pressure on the surrounding soil (e.g. surface humping).

Pull-back tension shall be set so as not to stretch the cable or conduit beyond it's design limit. See Appendix A: Cable Installation Data for maximum pulling tension for various cable sizes. It is not acceptable to use the drill rig to pull back the cable by 'feel' or by monitoring uncalibrated controls. The pull-back tension must be monitored by one of the following

- Pulling tension logs of the borer which have appropriate maintenance calibration.
- Load cell

12.5 Drilling Fluids Management Plan

A drilling fluids management plan shall be completed for directional drilling work.

This shall contain the following:

- Method of slurry containment.
- Method of recycling drilling fluids and spoils if applicable.
- Method of transporting drilling fluids and spoils off site.
- Drilling fluid pressures.
- Measures to contain and clean the affected area for inadvertent return of drilling or hydraulic fluids.
- Measures to adequately cleanup surface seepage of drilling fluids and spoils.

13 Ploughing

Ploughing technology allows cables to be ploughed into the ground with an envelope of clean backfill sand.

Refer to below sub-sections for design detail when choosing cable ploughing as the installation method for underground cables.

Please note that Western Power will not accept any cable to be installed directly into soil without an envelope of clean backfill sand when ploughed.

13.1 Capability of Ploughing Equipment

Ploughing equipment shall have the capability of installing cables in various arrangements:

i. Three (3) single core cables (not twisted) in flat or trefoil (triangular) formation, refer to Figure 1 and Figure 2 below

ii. Triplex (twisted)

The three (3) single core cable arrangement allows Western Power to get longer lengths of cable in this manner, resulting in a longer cable run. Longer cable runs result in fewer joints to be introduced into the Western Power network resulting in a more cost effective installation.

Installation time, cost and logistics will also be a great advantage when opting for three (3) single core cable installation over the other various arrangements. Installation time will be minimized with longer cable runs due to less frequent stoppages (less drum changes required).

13.2 Core Arrangement

Each core in a three-phase circuit can be placed in two different formations, trefoil (triangular) and flat formation. The choice between these depends on several parameters including conductor area, available space and loss factors.

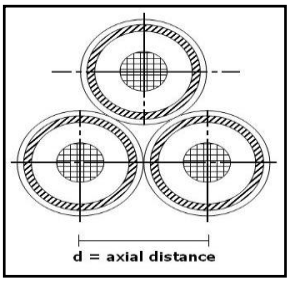


Figure 1: Illustration of trefoil (triangular) formation

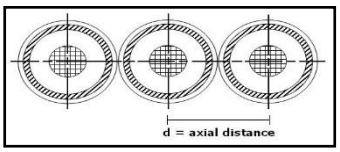


Figure 2: Illustration of flat formation

In most cases, for cable ploughing to be cost effective, the cable shall be installed in the flat formation with the maximum allowable separation of 30mm between cores. This reduces the number of joints and allows for longer continuous plough runs.

For flat formation, to ensure losses are evenly distributed across all three (3) phases the cores must be transposed at every cable drum change as show in Figure 3. This

transposition also minimises any net induction into other services in the vicinity (e.g. telecom, pipeline).

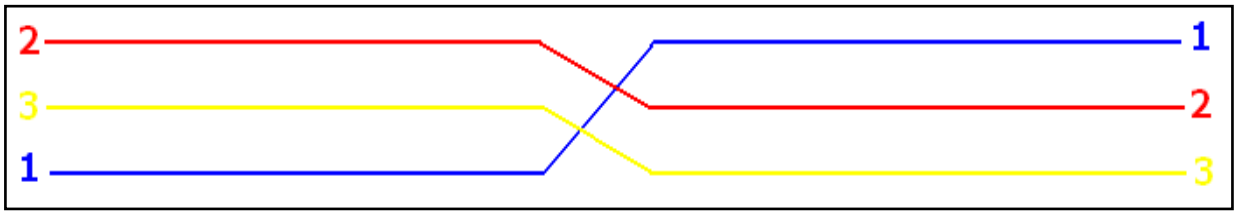


Figure 3: Illustration of a transposed system

13.3 Backfill Requirements

When cables are ploughed in, the cables must be bedded in clean sand. Backfilling shall comply with the published "**Material selection guidelines for bedding sand, backfill sand, general backfill around cables" or** "Subdivision Design Guideline – Number 4, Bedding Sand and Backfill Around Cables and General Backfill for Cable Trenches – materials Selection Guidelines", on Western Powers website.

All cables shall be firmly and uniformly bedded in sand free from rocks or other hard formations. The cable configuration must be surrounded with clean backfill sand all around and the thickness of sand shall be:

- Bottom: **150mm**
- Two sides: **50mm**
- Top: **300mm**

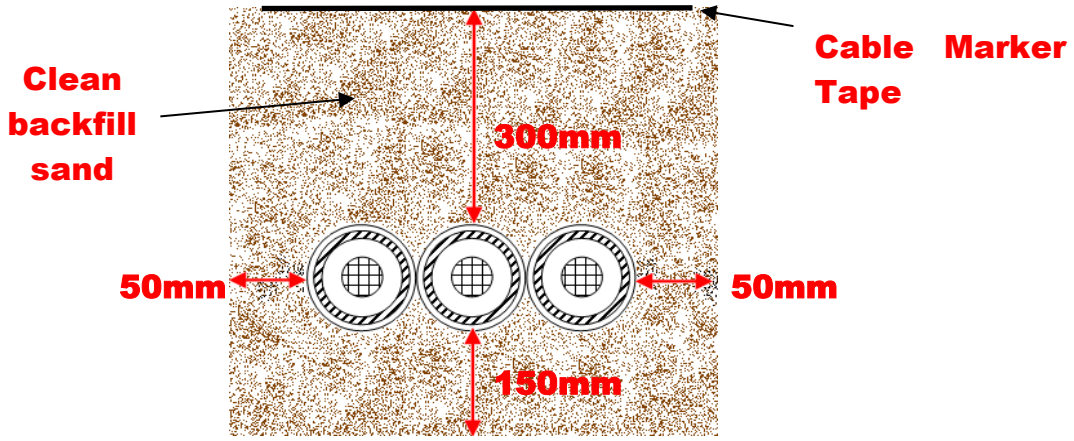


Figure 4: Illustration of thickness of backfill sand around cables (Flat Formation)

This is consistent with the Underground Distribution Schemes (UDS) manual and practised by other utilities.

13.4 GPS Coordinates

The cable route shall be mapped by onboard GPS technology offered by the cable ploughing contractors. During the cable run the GPS coordinates shall be monitored and noted. These GPS coordinates shall then be plotted and supplied with the as-constructed drawings.

14 Cable Laying

14.1 Drum Inspection and Mounting

Prior to installation, the cable drum should be visually inspected for damage, which may have occurred during transport. The manufacturer's seal on the inner and outer cable ends should be examined and the condition of the sheath inspected for mechanical damage. If the cable is found defective it shall not be installed and the cable shall be returned to the supplier for replacement.

During installation the cable should be carefully examined for any sign of damage as it leaves the drum. This is particularly important on the outer layers, where drum batten nails can cause damage.

If it is necessary to roll the cable drum, it should be rolled in the direction indicated by the arrow on the drum.

The drum should be mounted on jacks, cable trailer or cable stands. The cable can be rolled or pulled off the drum as indicated on the outside of the flange. Lighter cables may be laid by mounting the cable drum on its side on a truck-mounted turntable and laying the cable directly into the trench. When pulling from large drums, i.e. over 2m in diameter, the cable should be supported to prevent stressing the cable, from the drum to the trench on a suitable ramp.

Alternatively, cables can be rolled directly into a trench from the drum mounted on an excavator moving along the trench.

To limit the chance of damage to the cable prior to removing the cable drum battens, a check should be done to ensure that the drum-spindle is level and permits even rotation of the drum.

During pulling there is a tendency for cable slack to accumulate on the drum. Slack shall be avoided and one possible method to achieve this is to limit drum rotation by using plank brake shoes against one or both flanges of the drum. If the inner end of the cable on the drum, referred to as the "Z" end, protrudes through the side of the drum, then it should be watched during pulling to ensure it is not damaged. It is advisable to tie a rope to the Z end, and pull through any slack cable that appears. Pulling through Z end prevents buckling, and possible damage to the inner coils on the drum.

14.2 Drum Positioning

Cable drums shall be positioned in line with the direction of cable pull.

14.3 Protection of Cables from Damage

Cables being drawn into place shall be kept clear of abrasive surfaces by suitable means, e.g. rollers, cable tiles, etc., to prevent any damage to the cable sheath. The cable must be placed in the trench without sustaining abrasion damage, and without allowing rocks etc., to fall into the trench.

If the cable is hand flaked directly from cable drum or coil into final position or other method that does not drag the cable over ground cable rollers are not required.

On long cable runs where a cable changes direction, both horizontal and vertical, rollers shall be used to ensure a smooth pull and avoid damage to the cable. Cables, which are pulled into position by a winch, must use suitable cable stockings and swivels to prevent damage.

When pulling a cable, particularly by directional drilling, it is essential the cable is not dragged over ground outside the drill hole or prepared trench, since abrasion is likely to damage the outer jacket and cause sheath faults.

14.4 Cable Pulling Tensions

The tensions of the pull shall not exceed that specified in Appendix A: Cable Installation Data for the particular type and size of cable being pulled and shall be smoothly and continuously applied.

The trench or duct line should be set out so that any necessary deviations from a straight line occur over the largest possible radius. When pulling cable into duct lines incorporating bends lower maximum pulling tensions may be necessary to avoid the wire pulling rope cutting into the side of the duct.

Any winch used to pull cables shall have either a facility to automatically limit the pulling tension applied to a cable or a continuous reading dynamometer incorporated in the pulling arrangement to enable the actual pulling tension to be monitored.

Cable pulling pits are required at each significant change in cable route direction.

14.5 Pulling Speed

To avoid damage due to overruns, the cable should be pulled at a speed to keep the drum rotating smoothly and be easily controlled by the operator.

Drums with long lengths of cable, however, should not be rotated rapidly as overrun can cause cable damage if pulling is slowed or stopped suddenly.

14.6 Cable bending Radii

The permissible bending radii of all cables are given in Appendix A: Cable Installation Data. No twists, knots or kinks are permitted.

Where a 3x1 core HV cable is to be laid to transformers or switchgear, the three twisted cores can be separated into three individual cores to reduce the minimum bending radius required. The bending radii are given in Appendix A: Cable Installation Data.

14.7 Laying to Poles

Where cables are to be laid to termination poles, a complete loop shall be buried on the property boundary side of the pole to allow sufficient slack for future replacement of the pole or failed cable termination. Alternatively, the cable shall be laid in the 0-500mm alignment, past the pole, loop back in the 2400-3000mm alignment and ascend the pole. The loop shall have a radius not less than the maximum, being the radius of the cable. The cable shall be protected by cable slabbing and marker tape around the loop.

14.8 Bedding and Backfill

Cable shall be bedded in clean sand, which shall extend 100 mm around the cable.

Backfilling shall comply with the published material selection guidelines for bedding sand, backfill sand, general backfill around cables, available on Western Powers website.

All cables shall be firmly and uniformly bedded on sand free from rocks or other hard formations. The cable shall be surrounded with a thickness of sand prior to backfilling, bottom by 150mm and two sides by 100mm, top by 300mm. The upper 300mm of the backfill shall also meet the local government authority's requirements.

14.9 Depth of Cover of Cables

The depth of cover of cables shall not be less than 750mm The depth of cover of cables shall be increased as required so that cables joints will have the necessary 750mm depth of cover.

The requirements below are to be followed with regards to depths and cable markers.

Table 1: Cable depth requirements

Alignment Category	Description and Depth
Cable within standard 0-500mm alignment	Cable to be installed with a minimum cover of 750mm. Cable shall be installed between 750mm and 1200mm cover[#].
Cable within 2400-3000mm alignment	Cable to be installed with a minimum cover of 750mm. Cable shall be installed between 750mm and 1200mm cover[#].
Cable outside road reserve	Cable to be installed at a minimum cover of 750mm or 1200mm for remote areas*. For cases where the cover is 750mm, cable shall be installed between 750mm and 1200mm cover[#].
Cable into network equipment	Protective cable slabs shall be applied over cables that deviate from the 750mm minimum cover to accommodate the required bending radii when they are being terminated, i.e. pole, pillar, transformer etc.
[#] Where a cover of less than 1200mm is not practical, i.e. third-party assets are obstructing, approval can be sought from a Western Power Engineer to install the cable beyond 1200mm cover. Consideration needs to be given to excavation depths, for planned and future jointing requirements in accordance with the "Excavation and Trenching Procedure" (EDM# 43740956). * In remote areas where there are no other services or infrastructure in the vicinity of the cable the cover shall be 1200mm to avoid damage from machinery, i.e. ploughs, rippers, graders.	

14.10 Substandard Depth Cables

The installation of a cable at a substandard depth must be a last resort and all other avenues for installation shall be exhausted. During the design risk mitigation strategies must be developed and guidance provided to construction for the safest possible installation. The most common application of a substandard cable depth is where cables are within concrete structures, such as bridges. An example of risk mitigation is the use of suitably etched brass labels continuously attached to the concrete surface along the cable route.

14.11 Cable Cover and Marker Tape

The PVC maker tape shall comply with the requirements of AS/NZS 3000. Where more than one cable is installed, the PVC maker tape or cable cover must be wide enough to fully cover the cables, otherwise additional maker tapes and covers shall be installed.

A cable cover shall consist of a mechanical barrier to protect the cable. Western Power typically uses concrete slabs or corrugated plastic cover for cable covers. If there is a requirement for PVC marker tape and cable covers, a corrugated plastic cover that complies PVC tape requirements of AS/NZS 3000 can be used.

Table 2: Cable marker and cover requirements

Alignment Category	Description and Depth
Cable within standard 0-500mm alignment	PVC Marker tape shall be applied. The exception to the PVC Marker tape is when the cable is directionally drilled and tape cannot be installed.
Cable within 2400-3000mm alignment	PVC Marker tape shall be applied. The exception to the PVC Marker tape is when the cable is directionally drilled and tape cannot be installed.
Cable outside road reserve	750mm cover – Mechanical protection must be applied. If ducts have been used a PVC Marker tape shall also be applied. The exceptions to PVC Marker tape are as follows; • when the cable (and in this case duct) is directionally drilled and tape cannot be installed or • when a cable cover has been used for mechanical protection and as a PVC Marker tape replacement 1200mm cover – PVC Marker tape or equivalent corrugated plastic covers shall be applied in all cases, including ploughing a cable. Directional drilling should not be applied in this case. Ducts are highly advisable but not necessarily required due to the increased installation depth, refer to Section 14.9.

14.12 Above Ground Cable Markers

Permanent above ground cable markers are installed along a cable route in order to mark the location of cables. The exact placement of above ground cable markers should follow the basic guidelines below:

Road Crossings:

- Steel markers are to be placed at both sides of the road.

Boundaries:

- Wherever the cable route enters/exits a boundary line (i.e. road reserve, property boundary, etc) a cable marker should be placed, as close as is practically possible to the cable installation.

Paddocks and Open Spaces:

- When markers are used in open areas they should be placed to minimise the possibility of damage to or from livestock or machinery.
- It is preferable to keep the cable installation close to fences and/or boundaries so markers do not have to be installed in open paddocks.
- When a cable has to be run through paddocks or open spaces, markers should be placed on the fence line or boundary.

Distances between markers:

- Any change in direction of the cable route shall be marked, i.e. if the cable deviates from the straight line route.
- From any cable marker, you should be able to see the adjacent markers, both in front and at the back.
- Even where visibility between two cable markers is satisfactory, a maximum distance between markers shall be 150m.

The approved above ground cable marker is the ezy-drive flexible steel post, stock code CR0327.

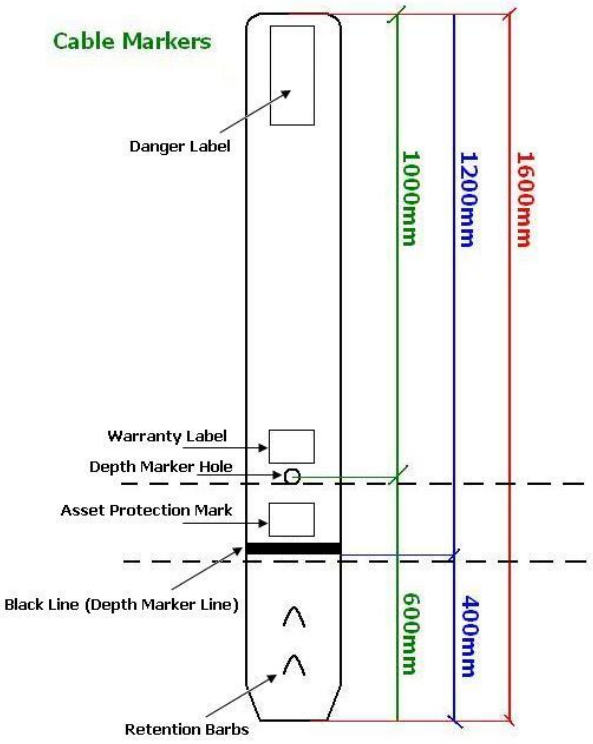


Figure 5 – Above Ground Marker, Ezy-Drive Flexible Type

CR0328 is the correct installation tool needed for installation of the above ground marker.

14.13 Cable Sealing

On completion of the pull, any pulling eyes fitted should be removed and the cable resealed unless terminating that day. Cables shall be sealed by abrading the outer sheath with sand paper, cleaning and then capping. The sealing and resealing of cables after pulling is required to maintain cable integrity during construction, ultimately preventing water ingress.

14.14 Exposed Underground Cables

The cable must be blinded with clean backfill sand as soon as practical after installation, to reduce the chance of damage or theft and then backfilled to full cover as soon as practically possible. All open cable trenches and joint holes must be inspected daily.

14.15 Terminated Cables

When cables that are terminated to switchgear, irrespective of whether this equipment is live, the following must be applied;

- Not be left unattended in excavations without approved barriers and signs;
- Not be accessible to the public; and
- Not be left without having been fully backfilled to ground level for more than 5 working days, or over a weekend or public holiday.

14.16 Live End Seals

Cables for both HV and LV may be extended beyond a subdivision scheme boundary for future extension into the next stage. In this case a Developer shall ensure these working end cables are terminated into live end seals as defined in the UDS.

15 Conduits

15.1 Application

Conduits and ducts complying with Australian Standard AS2053 shall be used to protect cables installed in the following situations:

- Cables installed outside the 0-500mm or 2400-3000mm standard alignments.
- Cables installed in an easement.
- Exit cables of a distribution substation that is set back from road or property boundary.
- Cables near to retaining walls.
- Cables crossing roads.
- Cables crossing water course and drains.
- Cables crossing high pressure gas pipelines.
- Cables crossing under railway.
- Cables within bridge crossings.

15.2 Buried direct

Direct buried cables outside the 0-500mm or 2400-3000mm standard alignments require ducts or cable covers to be installed as per Section 14.11. .

15.3 Encased ducts

In some locations PVC ducts may be encased in concrete ducts or concrete. Cables shall never be installed in concrete ducts.

15.4 Sealing

All spare conduits must be sealed against the ingress of water and any foreign material that may hinder in the pulling of future cables.

Sealing of the conduits must be carried out to prevent blockage, and flooding of cable pits and basement-type substations and switch rooms.

There have been a significant number of instances where distribution feeder cable entries in zone and distribution substations buildings were incorrectly sealed and resulted in the underground basement being flooded. In most cases expanding foam has been used and this can become dislodged over time.

It is now a requirement to seal conduits into basement substations using wall inserts split press seals.

15.5 Coupling

PVC cement shall be used to join ducts to prevent entry of water and foreign matter into the conduit.

15.6 Installation of Ducts

All ducts shall have a minimum cover of 750mm to the top of the duct. Where cables in a trench are all installed in ducts, local soil excavated from the trench can be used for bedding and backfill, provided it is free of organic matter and rocks of 75mm diameter or larger.

Ducts are to be laid in horizontal formation, up to four in parallel, and thereafter in tier formation.

Road crossing ducts shall be installed in accordance with Section 8.6.

All ducts shall be plugged with suitable end caps. Draw wires shall be provided in spare ducts. When the ducts are installed prior to the main cable trenching, marker tape shall be installed 300mm above the duct, and brought out to ground level at each end with a marker peg at one end. Marker pegs are not required for greenfield subdivision developments.

The most economic method shall be used to install conduits across roads. Subject to cost, boring is preferred for all single or double conduit crossings, where conduits of 100mm size or larger are to be installed. For locations where more than two ducts are to be installed together, open excavation methods may be used for crossing roads.

15.7 Pulling through Ducts

Care shall be taken to avoid damaging the outer sheath of the cable where it enters and leaves the duct. Triplex or three by single core bundled XLPE high voltage cables are particularly susceptible due to their uneven shape and thin outer sheath. A suitable lubricant should be used to reduce the friction between the cable and the duct. A tapered or belled entry shall be used at the entry end of ducts during pulling to prevent damage to cable.

There are numerous methods by which the cable can be pulled into the final installed position. Generally, the most economical methods employ power winches. If considering only those pulling methods using mechanical winches, then there are four distinct methods:

15.7.1 Armour Pulling

This system uses the actual armour wires of the cable as the pulling medium. The armour wires, left extended past the end of the cable, are formed into a pulling eye and the winch rope attached to it. This method is not applicable to XLPE cables.

15.7.2 Stocking Pulling

Cable pulling using a cable stocking is probably the most common form of installation for cable up to and including 33kV. The cable stocking is slipped on to the end of the cable and the winch rope attached. On applying tension the stocking shrinks diametrically until a firm grip is obtained. Care must be taken when using this method to ensure that pulling tension is not excessive, otherwise sheath stretch may result.

15.7.3 Nose Pulling

The strength of the cable sheath limits the length and size of the cable that can be pulled by stocking pulling. For long and large cross section cables, pulling-eyes can be fixed directly to cable conductors for pulling the cable.

15.7.4 Bond Pulling

When pulling tensions exceed the tension limit of the cable, straight end pulls may have to be replaced by bond pulls. The cable is lashed to a steel wire rope, which takes all the strain of the pulling.

16 Reinstatement

16.1 General

In built up areas the Service Provider shall restore the excavated land to its original condition. Backfilling shall occur to ground level within no more than five working days of cable laying, ensuring that these days do not extend over a weekend or public holiday

Road reserves and all work sites shall be levelled and left clean and tidy. Debris, trees, stumps and excess soil dug from the excavation shall be removed from site when finished trench backfilling

All materials, stakes, plant and equipment used during installation shall be removed by the Service Provider and all work sites left in a safe condition.

The initial backfill over the bedded cables shall be carried out in accordance with Section 14.8.

Trenches shall be subsequently backfilled, reinstated compacted to their original level and/or in accordance with that required for footpaths by the Local Government Act 1960.

16.2 Compaction

Spoil or other approved filling shall be carefully placed in the trench. Stones, rocks and paving material shall be removed. Backfilling shall be carried out so as to avoid future subsidence.

In all other cases the backfilled material shall be compacted to the same density as the surrounding soil.

16.3 Levelling

The surface shall be left in such a condition as not to constitute a hazard and shall be the same as the original unexcavated land.

16.4 Removal and disposal of surplus material

The Service Provider shall be responsible for removal and disposal of all surplus spoil from the Site.

Any pipe or cable off-cuts shall not be buried in the trench.

All unusable cable lengths and unsuitable material supplied by Western Power shall be reconciled and returned to Western Power's stores.

16.5 Restoration of surface

In all areas except greenfield subdivision developments, upon completion of any operation affecting pavements or constructed surfaces, the Service Provider shall restore the pavements or constructed surfaces in accordance with the Restoration and Reinstatement Specification for Local Governments in Western Australia, published by the Institute of Public Works Engineering Australia.

Restoration of surface includes restoration of the footpath for all type of materials, e.g. bitumen, brick paving, liquid limestones, etc.

If pavements or any constructed portions of any road reserve are broken to any particular extent without prior approval of Western Power's Representative no payment will be made to the Service Provider and the Service Provider will be charged with the restoration costs incurred by Western Power.

Where cement footpath slabs have been removed to allow cable trench excavation, they will be replaced and reinstated in accordance with the Local Council's requirements, unless otherwise directed by the Western Power's representative.

17 Damage to Property

17.1 General

In built up areas property or services damaged by the Service Provider shall be repaired or replaced at the Service Provider's cost (or at the cost of developers in the case of subdivision development) as soon as possible after making safe.

Fences around areas holding livestock shall be secured at all times and if damaged during construction shall be repaired or made safe immediately to prevent the stock from straying.

The Service Provider

- Shall be responsible for the cost of repairing any damage to reticulation systems and underground services that are disturbed or damaged in the performance of the services and for restoring them to working order.
- Trees planted in the road verge shall be protected as far as possible. Tree limbs interfering with the construction shall be removed appropriately by pruning and sealing and the trees left in a reasonable condition.
- Inspection of structures located along the cable trench route shall occur prior to installation and arrangements to protect these structures shall be made if there is a possibility of damage or hazards occurring.
- Shall notify the Western Power's representative forthwith in all cases of such damage or hazards occurring.

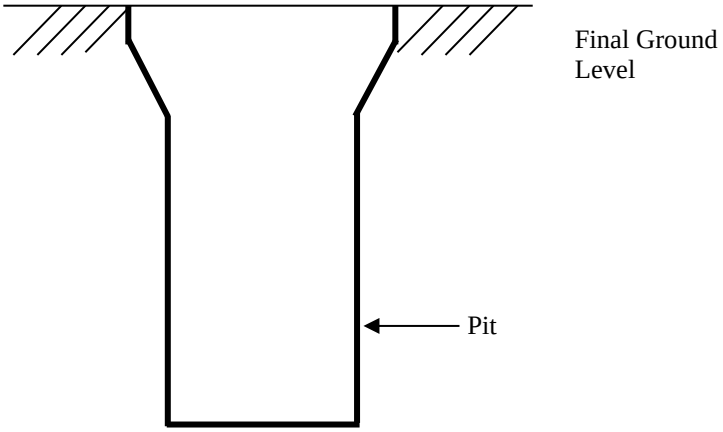
18 Pillars & Pits

18.1 General

Service pillars must be located within the lot boundaries at the corner as shown in the Utility Providers Code of Practice. Service pits are an alternative to pillars and should be used as a last resort. Pillars are Western Power's standard supply arrangement.

Service pits which replace pillars shall only be used where it is impractical to install a pillar, such as in a narrow driveway. Service pits shall only be used in brownfield applications where the final ground level is clearly defined.

Service pit installation



1 Locate the service pit in the preferred location taking into account:

- Available space
- Trafficable areas
- Proximity of other utility pits

2 Determine ***final*** ground level

3 Install pit so that top of pit is flush with final ground level

4 Install utility service cable conduit

5 Leave ground open for installation of customer service/s and street lighting cable conduits

6 Partly backfill and compact soil around pit

7 Install insulating barrier

8 Fit pit lid and keyhole plug

When customer service/s and street lighting cable conduits have been installed complete backfilling and soil compaction around pit

19 Appendix A: Cable Installation Data

Type of Cable	Voltage (kV)	No of Cores	Cable Size (mm ^{2})	Conductor Material	Reel Length (m)	Nominal Overall Cable Diameter (mm)	Maximum Pulling Tension (with sock on cable as described in No. of cores column) (kN)	Minimum Bending Radii (Bundle/One Cable)		Stock Code	
								Installing (mm)	Installed (mm)	Standard cable	Termicide treated
Transformer Cable	33	3x1	50	Al	250	81.4	7.5	1220/945	815/565	EE2003	EC1336
Transformer Cable	33	1	50	Al	1000	37.8	2.5	945	565	EE2004	NA
HV Feeder Cable	33	3x1	185	Al	250	98.4	11.8	1475/1140	985/685	NA	EE2551
HV Feeder Cable (labelled Core 1)	33	1	185	Al	1250	45.6	5.5	1140	685	NA	EE2171
HV Feeder Cable (labelled Core 2)	33	1	185	Al	1250	45.6	5.5	1140	685	NA	EE2172
HV Feeder Cable (labelled Core 3)	33	1	185	Al	1250	45.6	5.5	1140	685	NA	EE2173
Transformer Cable	22	3x1	35	Al	250	66	5.3	990/765	660/460	EE2101	EE2558
Transformer Cable	12.7	1	35	Al	500	30.6	1.75	765	460	EE2141	NA
HV Feeder Cable	22	3x1	95	Al	250	78	9.4	1170/905	780/545	EE2151	NA
HV Feeder Cable	22	3x1	185	Al	250	87.6	10.5	1315/1015	875/610	EE2163	EE2557
HV Feeder Cable (labelled Core 1)	22	1	185	Al	1250	40.6	4.9	1015	610	NA	EE2175
HV Feeder Cable (labelled Core 2)	22	1	185	Al	1250	40.6	4.9	1015	610	NA	EE2176
HV Feeder Cable (labelled Core 3)	22	1	185	Al	1250	40.6	4.9	1015	610	NA	EE2177
HV Feeder Cable	22	3x1	240	Cu	250	92.5	11.1	1390/1075	925/645	EE2165	EE2164
HV Feeder Cable	22	3x1	400	Al	250	105.4	12.7	1580/1225	1055/735	EE2168	EE2169
HV Feeder Cable (labelled Core 1)	22	3x1	400	Al	1250	48.9	5.9	1225	735	NA	EE2181
HV Feeder Cable (labelled Core 2)	22	3x1	400	Al	1250	48.9	5.9	1225	735	NA	EE2182

HV Feeder Cable (labelled Core 3)	22	3x1	400	Al	1250	48.9	5.9	1225	735	NA	EE2183
LV Feeder Cable	415	1x3	120	Al	250	37.7	4.5	680	450	EC1100	NA
LV Feeder Cable	415	1x3	240	Al	250/ 750	50.9	6.1	915	610	EC1102	-
						53.9	6.5	1350	810	-	EC1337
Service	415	1x3	25	Cu	250/ 1000	25.5	2.3	460	305	EE1425	NA
Street Lighting	415	1	16	Cu	1000	14.1	0.7	255	170	EE1421	NA

Note: The Service Provider shall obtain and verify the cable installation data from the cable manufacturer.

20 Appendix B: Dial Before You Dig Service

General

Dial Before You Dig Service (DBYD) provides a single state-wide point of contact between excavators and major utilities which own buried pipes and cables, as well as the owners of other buried services.

This free service makes it safer and easier for people undertaking excavation activities and can be accessed through their website, https://www.1100.com.au/.

This information is needed to clearly identify the precise location where excavation is proposed, the potential impact of the activity, a contact person and their address for issuing of the services information, and whether or not on-site assistance is required.

When contacting Dial Before You Dig be ready to provide the following information:

- Your name and address
- name of company (if applicable)
- contact telephone number
- contact on site
- site address
- commencement date of the proposed work
- type of work being carried out

Note: No work is to commence until all relevant information has been received.

If you have already received information from Dial Before You Dig, further data and other information can be obtained by telephoning the contacts listed on the cover sheet provided.

Be aware that not all underground service owners are members of Dial Before You Dig. Refer to relevant road authority (Main Roads WA or Local Government).