Distribution Design Standard

Underground Systems

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TasNetworks
Delivering your power

Tasmanian Networks Pty Ltd

Authorisations

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Review cycle	5 Years	

Responsibilities

This document is the responsibility of the Asset Strategy Team, Tasmanian Networks Pty Ltd, ABN 24 167 357 299 (hereafter referred to as "TasNetworks").

Please contact the Asset Strategy Team with any queries or suggestions.

- Implementation All TasNetworks staff and contractors.
- Compliance All group managers.

Record of revisions

Section number	**Details**

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1 Introduction

1.1 Prelude

This Underground System Distribution Design Standard (“Standard”) contains the approved design process considerations and detailed standard arrangements for the design of Underground System assets within TasNetworks’ electrical network.

TasNetworks will update this Standard periodically. It is the responsibility of the designer to ensure the latest Standard is used.

1.2 Scope

The Standard applies to the following asset types:

- High voltage underground cables, i.e. 33 kV, 22 kV and 11 kV
- High voltage cable terminations
- Low voltage underground cables
- Low voltage cable terminations
- Low voltage underground furniture i.e. cabinets, turrets, pillars and pits
- Submarine cables

The application of this design standard applies to both the development of new underground networks and modifications to existing networks.

New underground networks will connect to and be supplied from the existing network. The infrastructure at the point of connection may be the existing underground network, a substation, or the overhead network. The design standard for the applicable infrastructure is provided in the corresponding Distribution Design Standard. References to these standards are provided in section 1.5.4.

All designs shall be complaint in full with this standard. If compliance with the standard cannot be achieved then the designer shall consult with TasNetworks’ Asset Engineering team for an alternative solution.

Underground materials shall comply with TasNetworks’ Approved Product List and specifications.

1.3 Definitions

Table 1 – Definitions

Term	Definition
AC	Alternating current. On the electrical network the nominal frequency is 50 Hz
ADMD	After diversity maximum demand
Armour	Galvanised steel wire or tape applied to a cable to provide mechanical protection.
Bedding	A compacted layer of sand or other similar material used to provide a smooth bed for the cable to be laid on. Also, the same material added to a defined depth and compacted after the cable is laid to provide a regulated surround for the cable free of stones, clay, organic material and salts.
Bentonite	A clay mixed with sand, cement and water and pumped into a duct to convert the installation into a direct buried one to improve the current rating of the cable.
Bond	1. An electrical connection between a metallic sheath and armour, or between a metallic sheath/armour and earth. 2. A connection between the sheath/armour across a joint between two consecutive lengths of cable. 3. A connection between neutrals across a joint between two consecutive lengths of cable. 4. Generally, any temporary connection especially as used in safety earthing.
Box, Service Fuse	A box in which service fuses are mounted for the connection of consumer's mains to a service cable.
Cabinet	A steel box mounted at ground level on a steel frame foundation for the termination of low voltage mains cables and to enclose service fuses and other devices for control. Similar in principle to a turret (cf) but of greater capacity.
Cable	One or two or more insulated cores laid up together with fillings, reinforcements and protective coverings.
Cable, pilot	A cable used for control, protection and communication on the supply system. Used in the Hobart area only and is being phased out. Optical fibre cable is now being used for those purposes.
Conductor	The load current carrying part of a cable consisting of stranded aluminium or copper or of solid aluminium. This term includes neutral conductors.
Common MEN System	An earthing system in which the LV MEN system is connected to the HV system earthing. This is used commonly in urban areas where there are numerous interconnected earth rods all meshed together over a wide area and an expected low resistance to earth can be obtained. See 'Multiple Earth Neutral'.
Conductor, solid	A conductor extruded as one wire.
Conductor, stranded	A conductor made up of many single wires. Alternate layers of wire are laid up in opposing clockwise and anti-clockwise

	directions.
Conduit (Also ‘Pipe’ or ‘Duct’)	A pipe or closed passage formed underground or in a structure and intended to receive one or more cables that may be drawn through it.
CONSAC	A type of low voltage paper insulated aluminium conductor and concentric aluminium neutral sheathed cable.
Consumer mains	Wiring complying with AS/NZ 3000 owned and maintained by the consumer connected from the service fuses or circuit breaker to the main switchboard of an installation.
Consumer installation	The electrical system owned and operated by an electricity consumer for the purpose of utilising electricity, normally contained within the consumer’s premises.
Core	Of a cable. A conductor with its conductor screen (if any) and its insulation and insulation screen (if any) but not including belt papers or protective covering
Cross-sectional area	Of a conductor. The sum of the cross-sectional areas of the component wires of a stranded conductor or the cross-sectional area of a solid conductor. The material of the conductor must always be quoted.
DBYD	Dial Before You Dig. The process of requesting information of the underground infrastructure installed in a defined location.
DINS (Cable)	Double Insulated Neutral Screened. A cable insulated with pvc having one, two or three cores with copper conductors, a neutral screen of copper wires over the cores and an overall sheath of pvc. Used mainly for road lighting supply.
Duct or conduit or pipe	A pipe or conduit laid underground in which a cable is to be laid. Also refers to a cable way with lids at ground level.
Earthed	A term describing the condition of a conductor or other metallic part of a cable solidly bonded to the general mass of earth.
Earth conductor (Also ‘Ground Conductor’)	The conductor joining earth electrodes to the metallic object being earthed. Also used to interconnect earth electrodes. The term may also refer to an overhead wire used for earth bonding or lightning protection.
Earthing (Also ‘Grounding’)	The process of connecting components of electricity supply networks to ground to prevent dangerous voltages occurring on components which may be contacted by persons or animals, or which may be damaged by the voltages. Usually applied to rods, metallic electrodes or a group of interconnected rods and the wire making connection to the distribution system component that is ‘earthed’.
Easement	A right enjoyed by a party with regard to the land of another party, the exercise of which interferes with normal rights of the owner or occupier of that land.
Conduit	A pipe installed underground in which a cable is to be laid.
Electric & Magnetic Fields	Electric fields (voltage dependent) and magnetic fields (current or load dependent) emitted by electric devices and networks.
Extra High Voltage	Voltages exceeding 66 000 volts (Tasmania only).
Extra Low Voltage	A voltage not exceeding 50 volts AC or 120 volts DC
Ferro resonance	A situation where electrical resonance occurs on a distribution system, typically arising when the distributed capacitance of an underground cable supplying a lightly loaded transformer

	equals or nearly equals the inductance of the transformer. The result is irregular wave shapes and voltages up to four times normal following single-phase switching.
Footpath alignment	A distance relative to the edge of a footpath (usually the property boundary side) used to describe the position of an underground service or pole.
Footpath allocation	A space in the footpath between two alignments designated by the local or public authority in which a pole or underground service may be located.
Gland	A device which enables a cable to pass through a surface and which maintains hermetic sealing of one side of the surface from the other. If the gland is insulated from the metal of the surface through which the cable passes it is known as an insulating gland.
Heat Shrink	Polymeric insulating and stress control materials used in jointing and terminating cables of all types. A memory is established in the materials when manufactured so that the application of heat will cause them to shrink to a pre-set minimum diameter.
High Voltage (HV)	Electrical potential in excess of 1000V. Can be referred to as Medium Voltage (MV) in distribution systems up to 66 kV.
Insulation	Those parts of a cable which serve to insulate the conductors from each other and earth
Isolator (Also 'Ring Main Unit')	A 3-phase ganged switch, used on overhead or underground systems.
Joint	Equipment used to join two or more lengths of cable together. These assets have unique asset numbers.
Kiosk substation	The substation equipment is indoor type, enclosed in a common weather proof housing in which there is little or no working space or passageway. Provision may be made for individual items to be changed for others of different rating of design. Historically, a kiosk substation was normally constructed on site from individual components. Kiosk substations are the normative nomenclature for distribution substation in the form of a single complete assembly which is installed or replaced as a unit on a concrete foundation at ground level. Kiosk substations supersede the naming convention padmount substation
Lug, Compression	A component used to join a conductor to another conductor (or a bus-bar etc) outside of the cable as to switchgear or to an overhead line.
Low Voltage (LV)	Electrical potential in the range of 50 V to 1000 V AC or below 120 V DC.
Maximum Design Temperature	The maximum temperature that conductors or cables reach under the influence of load current (excluding fault current) and ambient conditions. In the case of overhead lines, this includes the ambient temperature of the air and solar radiation. In the case of underground lines, this includes the thermal conductivity of the soil and conduits.
Megger (Insulation resistance)	A manually, battery or motor operated instrument for measuring the insulation resistance of cables and other equipment. To "megger" means to use such an instrument for

	this purpose. Megger was the original name of the instruments made by Evershed and Vignoles. The results of the measurements are megaohms thus the term megger has become universal.
MIND (Cable)	Mass impregnated non-draining. A paper insulated cable in which paper tapes are applied during manufacture un-impregnated. The cable is then subsequently impregnated with a compound especially formulated so that it will not drain away if the cable is on a slope. All paper insulated cables for distribution work are now of this type.
Multiple earthed neutral system	A system in which the electricity authority's low voltage neutral conductor is connected to earths at points along its length, at the neutral terminal of distribution substations and to the earths of consumer's installations.
Optical fibre	A "cable" made up of a specially clad glass fibre, or several of them, protected overall with pvc sheathing used for communication and protection purposes by the transmission of signals using light as the carriers.
Phasing	The arrangement of jointing and terminating of cables so that the system phasing is correctly maintained when final connections are made. Colours and numbers on cable cores are not indicative of system phasing and are there for convenience of identification only
Pillar	An enclosure mounted at ground level on a concrete base for the termination of low voltage cables, mains cables and to enclose service fuses and other devices for control. Similar in principle to a cabinet, but of greater capacity.
Pit	Excavation accessing underground cables for installation, maintenance, jointing or repair.
Point of connection	The position on a consumer's premises where the electricity authority's overhead service is electrically connected to the consumer's mains. In the case of underground services the 'Point of Connection' may be in the supply authority's underground connection point (turret, cabinet, pillar or pit) on the footpath.
Polymers	The formal name for plastics
Pot Head	A cast iron box fitted to a multi-core cable in which the cores pass through porcelain bushings and enable the cable to be connected to an overhead line, transformer, switchgear etc. These terminations are discontinued items for TasNetworks.
Pot End	An underground insulated termination of a cable allowing the cable to be put into service at system voltage.
Pulling Eye	1. For paper cables. The end of a cable at which all conductors, metallic sheath and armour are plumbed to a metallic cap. A loop or ring attached to the cap is used to connect the winch wire for pulling the cable. 2. For XLPE cables refers 'Stocking'
PVC	Polyvinyl chloride. A commonly used synthetic plastic polymer.
Ring Main Unit (RMU)	Electrical equipment switching high voltage feeders and protecting transformers. See also 'Isolator'. A RMU typically consists of a combination of isolator and circuit breakers.

Screen (For cables 11kV and above)	For paper insulated cables: 1. Conductor screen. A layer of carbon loaded paper tape is applied immediately over the conductor. This provides a smooth electrode to minimise electrical stress at the conductor/insulation inter-face. 2. Insulation screen. A layer of metallic tape sometimes inter-wound with a carbon loaded paper tape is applied immediately over the core insulation. This ensures that the electric field is restricted to within the insulation and is always radial. Arranged to be in electrical contact with the metallic sheath for fault current carrying. Note. 11kV cables are usually belted, (see Belt) not screened For XLPE insulated cables: 1. Conductor screen. A layer of semi-conducting polymer is extruded immediately over the conductor to provide a smooth electrode for stress minimisation at the conductor/insulation interface. 2. Insulation screen. A layer of semi-conducting polymer is extruded immediately over the insulation to restrict the electrical stress to within the main core insulation. Augmented with copper wires for the purpose of carrying fault currents.
Sheath	For paper insulated cables: An extruded layer of lead applied over the laid up cores of the cable. Provided for fault current return and to prevent the entry of moisture. For XLPE insulated cables: A general use term for the layer of pvc or layers of pvc and HDPE applied over the laid up cores of the cable. Its proper name is non-metallic sheath. Used as a barrier against moisture entry. The pvc sheath of high voltage cables is always coloured red or orange.
Sealed end	A termination of a cable underground unsuitable for system voltage but arranged so that insulation resistance testing can be done if required.
Service cable	A cable owned and maintained by TasNetworks used to supply a consumer’s premises or a group of consumers’ premises
Service fuse	Protection between a service cable and consumer’s mains (cf). Takes the form of a fuse up to 100 amps/phase or a circuit breaker above 100 amps/phase. TasNetworks owns these devices.
Service pillar/pit	An enclosure where underground supply to a customer’s premises is connected to the secondary distribution network through a primary fuse. (Also see turret)
Site identifier	The means by which a ‘Site’ is discretely identified, eg a pole number or distribution substation number. Identifiers vary

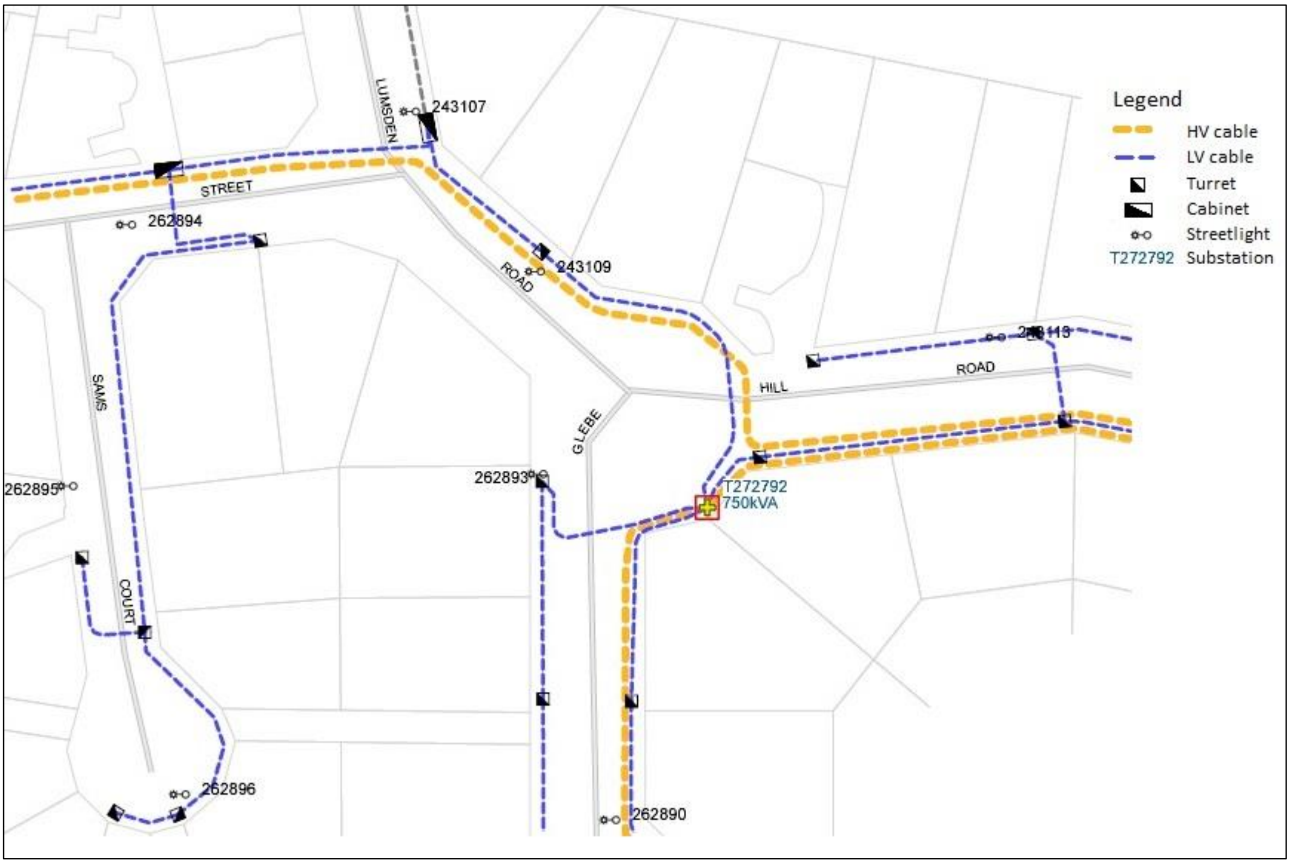
	amongst supply authorities and are usually constructed according to a protocol.
Special location	With regard to earthing, this is a 'high risk' area where electrical step and touch potentials need to be minimised. A special location may refer to school grounds, a children's playground, within a public swimming pool area, bus stop, at a popularly used beach or water recreation area, or in a public thoroughfare within 100 metres of any of the above-named locations.
Spreader	A mechanical separator usually made of shaped wood used to temporarily hold direct buried cable cores apart while laying long runs and jointing is done
Stocking	A device made of flexible metal wire, attached over a cable at the end and used to pull the cable. Used when no pulling eye is available
Stress relief	Precautions taken to reduce the electrical stress in joints and terminations at the area where the screen ends in paper insulated and XLPE insulated high voltage cables
Surge diverter (Also 'Surge Arrester', 'Lightning Arrester')	A device designed to protect apparatus (eg distribution transformers, UG cables) and lines from over voltages caused by lightning, switching transients or other similar disturbances.
Termination (Underground) (Also 'Pothead', 'Cable End')	A HV or LV cable end fitting or joint, where a cable terminates on a pole or plant item.
Transformer	Static apparatus that uses electromagnetic induction to transform alternating voltage and current in two or more windings at the same frequency but different voltage/current values.
Turret	A plastic enclosure mounted on a PVC base, to house LV electrical reticulation for the termination of mains cables and enclosure of service fuses. Used mostly in URD Subdivisions
Type test	Testing undertaken to demonstrate the capabilities/performance of a particular type of equipment.
UGO	Underground to overhead transition
URD	Underground Residential Development
Voltage	System voltages are classified as: Extra High Voltage (EHV) – 66 000 volts and above (in Tasmania only). High voltage (HV) - Voltages exceeding 1000 volts and less than 66 000 volts. Low Voltage (LV) – Voltages below 1000 volts

1.4 Distribution asset records

TasNetworks' distribution records are managed by the Asset Records groups. For the purposes of distribution design, the following applications are relevant:

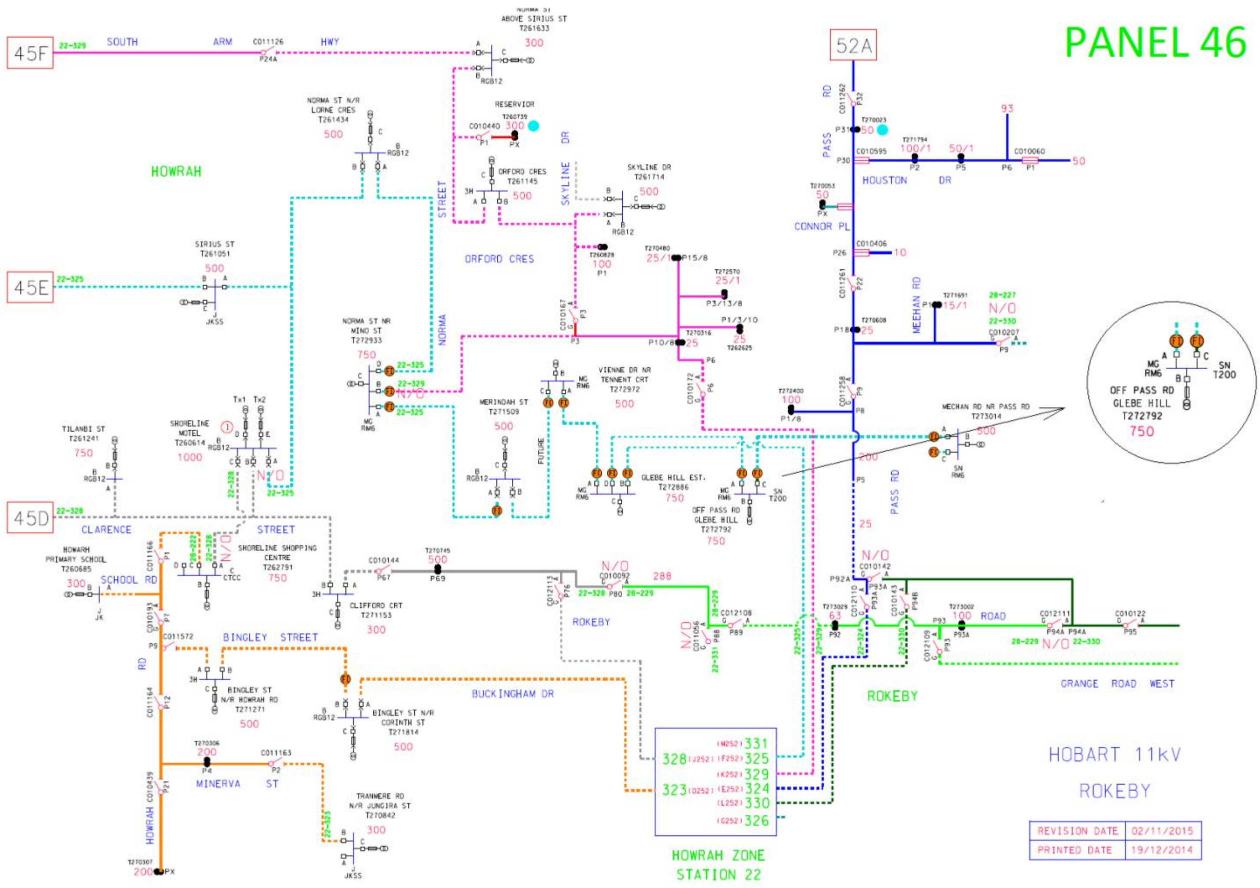
- Webmap – internal Geographic Information System (GIS) which combines a large number of TasNetworks' distribution assets. The tool gets used to identify, track and plan distribution related work. From a design perspective, Webmap provides the designer with a street view superimposed with electrical reticulation assets. For further details refer to the Asset Records documentation.

Figure 1 - Webmap view



- Operational schematics – are schematic drawings of the electrical network which contain a more detail view of the distribution network interconnection for HV installations only. These drawings are divided into panels for the purposes of TasNetworks' Operations centre daily functions. For further details refer to the Asset Records documentation.

Figure 2 – Typical operational schematic



- Single Line Diagrams – are site specific electrical schematics of both the HV and LV components. This information forms both a critical input to understand the existing infrastructure and a critical deliverable of the design.

1.5 Acts, Regulations and Standards

1.5.1 Acts and regulations

Designers must consider and comply with any relevant legal or statutory requirements, which may include the following:

- Aboriginal Relics Act 1975
- Electricity Supply Industry Act 1995;
- Electricity Supply Industry (Tariff Customers) Regulations 2008;
- Workplace Health and Safety Act 2012
- Workplace Health and Safety Code 2012
- Workplace Health and Safety Regulations 2012
- Occupational Licensing Act 2005
- Environmental Management and Pollution Control Act 1994
- Crown Lands Act 1976
- Crown Lands Regulations 2001

- Environmental Management and Pollution Control (Controlled Waste Tracking) Regulations 2010
- Environmental Management and Pollution Control (Waste Management) Regulations 2010
- Forest Practices Act 1985
- Forest Practices Regulations 2007
- Historic Cultural Heritage Act 1995
- Threatened Species Protection Act 1995
- Nature Conservation Act 2002
- Land Use Planning and Approvals Act 1993
- National Parks and Reserves Management Act 2002
- National Parks and Reserved Land Regulations 2009
- State Policies and Projects Act 1993
- State Policy on Water Quality Management 1997
- Weed Management Act 1999
- Wellington Park Act 1993
- Electricity Industry Safety and Administration Act 1997 and Regulations 1999
- Occupational Licensing (Electrical Work) Regulations 2008
- The Occupational Licencing Code of Practice 2013
- Environment Protection and Biodiversity Conservation Act 1999

For further details on environmental law/regulations, refer to the Environment & Heritage Design and Construction Standard.

Designers must comply with the Occupational Licencing Code of Practice 2013 (as amended or replaced), including compliance with:

- AS 2067 (Substations and high voltage substations)
- AS/NZS 3000 (Wiring Rules)
- AS/NZS 7000
- any additional obligations imposed by AS 2067, AS/NZS 3000 and AS/NZS 7000 referring to further Australian Standards or documents, including any amendments or revisions of those Australian Standards or documents from time to time

The above information is a guide only. New designs must be compliant with all legislative requirements, relevant standards and guidelines.

1.5.2 Applicable Australian and international, standards and guides

These standards/guides are common standards to be used by the designer for the purposes of distribution design work. These lists are not exhaustive, and number references to standards within this document are for the convenience of the service provider. The current standards at the time of the project shall be used.

AS ISO 1000 The International system of units and its application

AS/NZS 1026 Electric cables- impregnated paper insulated – up to and including 19/33 (36) kV

AS/NZS 1125 Conductors in insulated electric cables (and flexible cords)

AS 1319 Safety signs for the occupational environment

AS/NZS 1429 Electric cables – polymeric insulated from 1.9/3.3 (3.6) kV up to and including 19/33 (36) kV

AS 1470 PVC pipes and fittings for pressure applications

AS 1931 High voltage testing techniques

AS 1939 Degrees of protection provided by enclosures for electrical equipment

AS/NZS 2053 Conduits and fittings for electrical installations

AS 2067 Substation and high voltage installations exceeding 1 kV a.c

AS/NZS 2648 Underground marking tape

AS/NZS 2893 Electric cables – lead and lead alloy sheaths – composition

AS/NZS 3000 Electrical Installations Wiring rules

AS/NZS 3008 Electrical installations - Selection of cables

ASNZS 3500 Plumbing and drainageAS/NZS 3560 Electric cables – XLPE insulated – aerial bundled up to 0.6/1 (1.2) kV

AS/NZS 3599 Electric cables – polymeric insulated – aerial bundled - 6.35/11 (12) and 12.7/22 (24) kV

AS/NZS 3863 Galvanised mild steel wire for armouring cables

AS 3865 Calculation of the effects of short-circuit currents

AS 3983 Metal drums for insulated electric cables (and bare conductors)

AS/NZS 4026 Electric cables – for underground residential distribution systems

AS/NZS 4130 Polyethylene (PE) pipes for pressure applications

AS 4202 Insulating covers for electrical purposes

AS/NZS 4325 Compression and mechanical connectors for power cables

AS 4702 Polymeric cable protection covers

AS 4799 Installation of underground utility services (and pipelines) within railway boundaries

AS/NZS 4805 Accessories for electric cables – Test requirements (1.9/3.3 (3.6) up to & incl 19/33 (36) kV

AS/NZS 4961 Electric cables – polymeric insulated – for distribution and service applications (up to 0.6/1 (1.2) kV

AS 5601 Gas Installations

AS 60270 High voltage tests techniques – partial discharge measurements

HB101 Co-ordination of power and telecommunications – Low frequency induction – Code of Practice

HB102 Co-ordination of power and telecommunications – Low frequency induction – Application Guide

IEC 60287 Current capacity of cables

IEE837 Standard for Qualifying Permanent Connections Used in Substation Grounding

1.5.3 Applicable regulatory standards

Design and Construction Related Standards

NCC National Construction Code Series

Volume One - Building Code of Australia Class 2 to 9 Buildings

Volume Two – Building Code of Australia Class 1 and Class 10 Buildings

Volume Three - Plumbing Code of Australia

1.5.4 TasNetworks standards

	Distribution Planning Requirements
R324108	Distribution Design Standard - Kiosk Substations
	Distribution Design Standard - Building Substations*
R354148	Distribution Design Standard – Public Lighting
	Distribution Design Standard – High Voltage Regulators*
	Distribution Design Standard – Overhead Systems*
DS P PC 01	TasNetworks Distribution Standard Protection and Control
NP R AG 05	General Drafting Requirements and Standards
NP R ON 01	TasNetworks Label Standard
	TasNetworks Environmental and Heritage Design and Construction Standard

*These standards are currently in development

2 Design framework

Distribution designers need to consider various elements including key stakeholders, electrical utility planning, relevant standards and guides and whole of life cycle management of the design.

2.1 Design implementation

The design implementation for the electrical distribution network is an iterative process. The objective of design implementation is to achieve a sustainable electrical network that meets business and customer requirements. To achieve this objective, electrical network asset life must achieve 40+ years, be cost efficient to both customer and TasNetworks and compliant with business and legislative requirements, including alignment with existing industry guides and standards. An Underground System design requires a large amount of integration with other electrical components; as such the designer must have an in-depth knowledge of the associated Australian standards and the relevant TasNetworks standards.

Table 2 : TasNetworks standards and purpose

Documentation title	Description
Planning Strategy	High Level strategy of TasNetworks Distribution Assets
Distribution Planning Requirement	Detailed Design framework to meet the Planning strategy
Distribution Design Standard – Overhead	Detailed Design framework for Overhead assets to meet the Design System strategy
Distribution Design Standard – Kiosk Substations	Detailed Design framework for Kiosk assets to meet the Design System strategy
Distribution Design Standard – Building Substations	Detailed Design framework for Building Substations assets to meet the Design System strategy
Distribution Construction standard – URD	Detailed construction framework to meet the design requirements for Urban Residential Developments
Distribution Design standard – Public Lighting	Detailed Design framework for Public lighting assets to meet the Design System strategy
Environmental and Heritage Design and Construction Standard	Framework for environmental due diligence, including TasNetworks' requirements

2.2 Design methodology

2.2.1 Assessment of connection

2.2.1.1 Customer load requirements for the purpose of cable sizing

Calculation of the maximum demand of a new development to determine the electrical network capacity is required. The new load must be calculated in accordance with AS/NZS 3000, in conjunction with TasNetworks planning requriements. When the load requirement is not known at the time of initial discussions, the basis for the load can be assessed by analysing the purpose of the building/dwelling allotment, ie size and type. Table C3 of AS3000 provides an example reference.

2.2.1.2 TasNetworks Planning Requirements

The planning requirements cover the critical elements for a sustainable electrical network and designers must consider the following:

- Any easements that may be required. For further details refer to TasNetworks' Planning Standards and the Connection Contract published on TasNetworks' website.
- The calculated loading for the design shall be revised, if applicable, to include potential future load for the area, public lighting, After Diversity Maximum Demand (ADMD if required) calculations and also for temporary augmentation of the electrical infrastructure during both planned and unplanned outages.
- Type of load – the designer shall review the type of load associated with the new design, to ensure specific requirements are met e.g. a sawmills, or pumps will have high start stop loads versus a shopping centre/residential development which has static loads or may cell storage devices if photovoltaic have been installed.
- Local Government Authorities – councils have varying mandatory requirements relating to electrical infrastructure, which can exceed the requirements of Australian Standards and TasNetworks design standards and planning directives.
- The size of the development with respect to total surface area (small, medium and, large) and any staged development for the area is also a crucial consideration that will influence the end design.

2.2.2 Cable route

The designer shall ensure site visits are completed to understand the onsite elements present for the underground design for the purpose of cable route selection. The minimum elements the designer shall consider as part of the cable route selection are:

- Accessibility – for future operations and installation – eg. free from trees and fences
- The cable route selection should reduce sharp bends and ensure that cable minimum bending radii are not exceeded.
- Cable joints – reduce the number of cable joints in alignment with minimum cable lengths for HV cable. There shall be no joints on LV cables. All LV cables to be terminated on turrets or cabinets as required
- Cable lengths –maximising cable lengths in alignment with cable joints is critical.
- Surface layer – soil, road crossing, concrete cover, etc
- Avoidance of unstable ground and waterways where possible.
- HV and LV reticulation (ie location of substation and other services)
- Minimise total route length to critical electrical infrastructure
- Existing residential, commercial and industrial infrastructure
- Potholing every 100-200m in areas where suspected poor soil conditions for the purposes of ambient ground temp, soil thermal resistivity and moisture content where applicable

Environmental conditions to minimise environmental harm (to be considered in conjunction with TasNetworks' Environmental and Heritage Design and Construction Standard):

- Aboriginal heritage and historic cultural heritage
- Threatened species and threatened communities
- Land tenure e.g reserves and Crown land
- Land usage – assessment of the chosen cable route impact on current and future use
- Declared weeds and environmental weeds
- Contained sites
- Acid sulphate soils
- Waterways
- DBYD – detailed review and identification of other utility infrastructure to ensure the minimum clearances from other amenities (e.g. gas, water and communication reticulation)
- Ground conditions – slope, flooding level, soil structure, soil resistivity, dispersive soils, temperature, wind extremes and run-off that impact waterways and wetlands
- Safety from inadvertent damage by vehicles or other commercial or industrial work processes in the vicinity.
- Hazardous locations as specified in AS/NZS 3000

Refer to the TasNetworks Environmental Design and Construction Standard for further detail of the required environmental design considerations.

Site location cost comparison

- Proximity to load for voltage drop purposes (LV reticulation shall not exceed a 300 m radius, unless proven otherwise in the detailed electrical design)
- The designer should allow for a number of options are made available for the site selection and documented in a compliance/cost trade off matrix for the key stakeholders to review.
- Cables should cross under roads and especially railways at right angles where possible so that the reinstatement and length of cable across the carriageway is minimal. This also applies when under boring.
- The designer will consider environmental constraints in terms of threatened species and associated permit requirements and environmental offsets as a potential cost factor
- Actual cable lengths will be slightly longer than lengths measured off plans due to vertical lengths at terminations, e.g. 1.5m to turn up into a turret or 8 to 12m to terminate on a pole. This also applies to non-horizontal ground or steep slopes where the true length is greater than the horizontal plan length.

2.2.3 Selection of equipment

2.2.3.1 Types and number of cables

The designer shall determine the number of feeders and cable types based on the following factors:

- Peak and fault current capacity
- Manufacturer's rating – for the purposes of derating (if required)
- Lengths for both HV and LV reticulations
- Laying configuration (horizontal, vertical)
- Cable enclosure (direct buried or conduit)
- Future load growth

TasNetworks' standard feeder sizes for both 11 and 22 kV is 185 mm^2 and 240 mm^2 3 core, XLPE insulated individual copper screened and HDPE sheath. For design purposes, the minimum permissible HV cable length including a cable joint is 200 m.

2.2.3.2 Underground furniture

The designer shall consider the appropriate UG furniture for the design and layout of the area which may include the following:

- Turrets available
- Cabinets available
- Public lighting
- Kiosk substations available

Where the last connection point (i.e. LV turret) is not located immediately adjacent to the subdivision boundary then a turret is to be installed. The installation of the turret must be immediately adjacent to the subdivision boundary to terminate the LV cable for future stage development and include a conduit for future termination.

2.2.4 Safety in Design

Designers must consider and comply with all safety requirements to exercise due diligence in assessing design work, including under the Work Health and Safety Act 2012. The elements to consider include:

- Early identification of hazards and assess risk associated in the design process, construction phase, operating and maintenance phase and the decommissioning and demolition phase
- Elimination of identified risks as so far as reasonably practicable or the minimisation of these risks throughout the entire lifecycle of the plant, substance or structure
- Consultation and communication of the assessment outcomes through formal documentation

The safety in design process integrates the above elements into an industry recognised framework, with the focus on early identification of risk. This approach often yields an easier and cheaper outcome to the design as it reduces the likelihood of a need to undertake future design changes as hazards become real risks. The designer shall complete a safety in design report for each new design, where the safety in design content detail shall be proportional to the complexity of the design.

2.2.5 Electrical design

The electrical design stage collates the information from the previous stages to develop a detailed design. Listed below are the minimum requirements for construction and operation of TasNetworks owned electrical infrastructure. These items should be negotiated with the site owner/s prior to any commitments being made by TasNetworks to supply electricity to the site. The designer shall incorporate the design in both drawing and reporting form where applicable and shall include the following elements listed below:

1. Obtain client construction requirement and TasNetworks planning team verification

- An easement is required over all TasNetworks owned equipment installed on, over or under private property, council land, schools, reserve roads, Crown land, or TasRail assets. Refer to the Connection Contract for further details.
- 24 hour access must be available to all TasNetworks owned equipment.

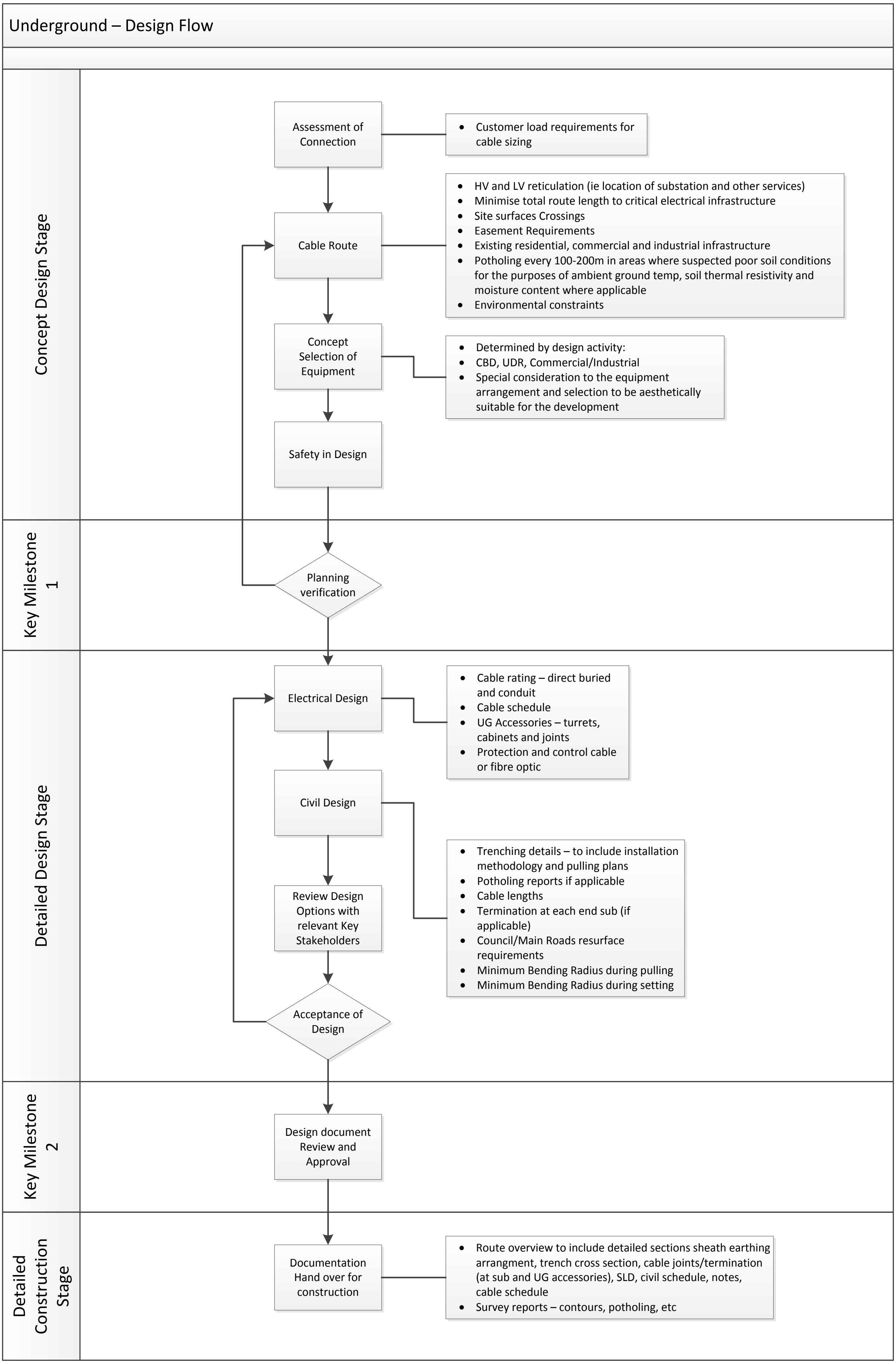
2. **Arrangement:**
    - Where not prescribed by the Distribution Planning Requirements, select the most appropriate HV/LV network extension arrangement based on the existing network available.
    - Location – the HV and LV reticulation interconnection can be dependent on TasNetworks' reliability area classification such as Critical Infrastructure (CBD), High Density Commercial, Urban, High Density Rural and Low Density Rural. Depending on the reliability requirements, additional feeders may be required for future capacity.
3. **Electrical specification**
    - Confirm voltage drop acceptability
    - Confirm cable rating - configuration in trench, conduit or direct buried
    - Confirm number of cables and spares
    - Confirm minimum bending radius
    - Confirm location and number of joints
    - Confirm cable schedule
    - Confirm minimum clearances to other underground services in accordance with AS/NZS 3000 and TasNetworks standard design requirements
    - Confirm turrets, cabinets and joints requirements
    - Protection and control cable or fibre optic
4. **Confirm cable bending radii**
5. **Develop detailed electrical design drawings and documentation (single line diagram, equipment general arrangement, etc)**

2.2.6 Civil Design

The civil design component shall comprise the following as a minimum:

- Confirm cable route
- Confirm trenching details – to include cable configuration, trench material, bending protection, mechanical and labelling location compliant with AS 3000, AS 2067 and TasNetworks standard design
- Confirm pulling cable calculations
- Complete potholing and soil thermal resistivity (if applicable)
- Reinstating of the surface should be completed to the original form
- Develop detailed electrical design drawings and documentation (single line diagram, equipment general arrangement, etc

2.3 Design methodology process flow



2.4 Detailed design requirements

2.4.1 Cable joints

Cable shall be laid in the longest length possible, subject to the maximum drum length and the pulling tension requirements, to ensure minimum number of joints. The designer shall keep HV joints to a minimum by considering alternative cable route arrangements, pulling specifications and cable derating. The designer shall ensure no HV Tee Joints are used on the HV network, with all HV termination locations to be either HV switchgear or UGO connections to suit the size and arrangement of the cable.

Where HV cable joints are necessary, the joints shall be positioned in accessible locations clear of any obstructions that have the potential to make jointing difficult or impossible. As a guide, a minimum clearance of 6 metres from trees and fixed structural material should be maintained around a HV joints. HV joint shall not be installed within 10 metres of waterways.

The designer shall not use LV joints on the LV reticulation. All terminations on the LV system shall be achieved by either a turret or cabinet to suit the size and arrangement of the cable.

2.4.2 Cable route

The designer shall ensure the appropriate level of locating/marking of existing underground services is completed prior to confirming cable routes. Existing underground services may include the following:

- Large sewer and high pressure water mains
- Large telecommunication cables and all fibre optical installations
- TasNetworks underground cables
- Gas mains
- Traffic signalling cables

In addition, the designer shall be notified of:

- Aboriginal heritage and historic cultural heritage
- Threatened species and threatened communities
- Land tenure e.g reserves and Crown land
- Land usage – assessment of the chosen cable route impact on current and future use
- Declared weeds and environmental weeds
- Contained sites
- Acid sulphate soils
- Waterways
- Parks, gardens with trees, landscaped areas etc.
- Areas with major pedestrian or vehicular traffic flow
- Native vegetation including grasslands

A thorough investigation must take place at the design stage for these potential problems which includes an Environment and Heritage Assessment as per TasNetworks' Environmental and Heritage Design and Construction Standard.

Excavation around sensitive services must be performed by hand for precise location before machinery is allowed in the vicinity. Appropriate levels of environmental planning shall be allowed if these sites have been clearly identified in the design phase.

Ground surface marks shall be made in accordance with AS 1345.

2.4.2.1 Surrounding features

Wherever possible, designers shall photograph and record any features of the property that are already in poor condition, including the following:

- Cracked ceilings and other plaster work.
- Cracked or damaged foundations.
- Collapsed retaining walls or fences.
- Broken or dislodged gateposts.
- Damaged plants and trees.

Where reinstatement work will be required on decorative surfaces, gardens, landscaped features etc, designers must photograph the area in order for before and after comparisonsto be made.

2.4.2.2 Environmental considerations

Designers must consider the following environmental aspects for any underground site work:

- Is suitable space available to store excavated soil onsite – if not, it may need to be transported for offsite storage.
- Control of excavated soil against erosion or runoff in the event of rain.
- Whether acid sulphate soils exist and its neutralisation when excavated. E.g. when exposed to air after being disturbed, soils containing iron sulphides produce sulphuric acid and often release toxic quantities of iron, aluminium and heavy metals.
- Dust and noise control.
- Disposal of waste, including unusable excavated spoil.
- Cleaning of paved surfaces.
- Reinstatement of pavements, grassed areas and vegetation.
- Protection of native and/or protected flora and fauna.
- Waterways and wetlands

Documenting this process is to be done in accordance with TasNetworks' Environmental and Heritage Design and Construction Standard.

2.4.3 Electrical Loads

Designers must understand the magnitude, nature, location and distribution of the electrical load. In an urban residential estate, the electrical loading may be relatively easy to predict, and more or less homogeneous across a given development.

In the case of commercial or industrial subdivisions, loads may vary widely in magnitude and nature depending upon the type and permanency of the businesses. In view of this, the reticulation should be designed with flexibility and future expansion in mind.

2.4.3.1 Loading in commercial/industrial areas

Smaller loads (<100 amps)
A small commercial or industrial subdivision will contain businesses ranging from storage warehouses, trade or retail sales establishments having modest maximum demands (<100 amps) to fabrication workshops, cool storage depots etc. that may require several hundred amps.

The loading in this type of subdivision will also be fairly static and can be serviced in a manner similar to a residential subdivision, with LV reticulation and residential type turrets or cabinets.

The initial supply may be from a LV cable fed from a kiosk or overhead system at the entrance to the subdivision with spare HV conduits and a proposed internal transformer site to cater for future load growth.

Large loads or a mixture of large and small loads
Large industrial subdivisions with sizeable individual lots indicate the potential of substantial loads. Service to large loads can be provided in a number of ways, from:

- cabinets with large capacity fuses or circuit breakers.
- a distribution substation, which is also feeding the LV reticulation.
- a dedicated distribution substation located on the property being supplied.

Where a subdivision contains a mixture of large and small loads, the designer will develop a reticulation system that may comprise all of the above.

In the absence of more precise information the designer should allow 50 kVA (70 amps) per small lot, 150 kVA (200 amps) per medium and the provision of a transformer of sufficient capacity to supply large lots.

2.4.3.2 Industrial and commercial loading characteristics

To provide adequate supply to industrial and commercial consumers, the designer must understand the magnitude and the characteristics of the load to be serviced. The design must account for the following load characteristics as applicable:

- Hours of operation – commercial and industrial loads will usually conform to business hours rather than the early morning and evening peaks of residential loads. The load usage is generally more constant so transformer overloading where the peak cyclic load exceeds the transformer nameplate rating for continuous loading will be more restricted, if allowed at all.
- Power Factor – power factor in residential estates is relatively close to unity. The planning requirements refers to 0.95 Power Factor for design. Note as of the 1st of January 2016, PV inverters will now have to be capable of and operate between 0.95-0.95 power factor lagging (absorbing VARS). The designer shall include these factors in the voltage drop calculations.
- Time of peak – each commercial and industrial estate will have its own characteristics depending on the type and size of business and whether they do shift work. Generally, an estate load will quickly ramp up in the morning to a plateau point for the day. This will then fall off in the afternoon till close of business.
- Sudden loads – large motors or plant that can stop and start suddenly require sufficiently large cabling and/or transformer capacity to cope with starting peaks to prevent voltage dips on the wider system.
- Unusual or disturbing loads – the load characteristics of motors with electronic variable speed drives, large spot or arc welders, arc furnaces, large air conditioners or similar devices can 'disturb' or distort the supply voltage sine wave through the production of harmonics (multiples of the standard supply frequency). This distortion can have serious effects on the business's own equipment or other external customers' equipment. There are a variety of solutions for this type of problem, some of which can be complex and may require specialist engineering analysis.
- Embedded generation sites – large solar or photo voltaic cell systems, bio energy generation sites, private hydro and wind generation sites that supply electricity back into the network grid can have an adverse effect on the system. This can range from localised voltage rise and disturbances (solar shear),fault level issues, altered protection grading of circuit breakers and fuses, to regulators being affected if the injection point is at end of line. For further details refer to IEC 61000 standard for distributing loads.

For electricity supply utility, there are restrictions in the starting current of motors, power factor limits or maximum levels of harmonic emission at a site. When designing a suitable system for a large or complex estate, the designer should consult with the enterprise asset owners to investigate these factors. A full system study may be required prior to connection of some specialised consumers.

2.4.4 Voltage drop calculations

The designer shall calculate the voltage drop for all design options and, where practical, the worst case transformer location. Voltage tolerance shall comply with TasNetworks' Distribution Planning Requirements document. The designer should complete an iterative process of changing the feeder routes or lengths, to meet the voltage drop and conductor thermal constraints.

For URD, the designer shall adhere to the following design rules:

- The permissible voltage range at the customer's terminal (located at TasNetworks turret or cabinet on adjacent property boundaries) is +10% to -6% of the nominal voltage 400/230 Volts.
- All voltage drop calculations shall be analysed using the software program "LV Drop" and the following inputs shall be applied to URD designs:
    - Transformer Type – Low Impedance
    - Unbalance Factor 1.8
    - Cable Confidence Factor 2.0
    - Volt Drop Confidence Factor 2.0
    - TXF Confidence Factor 1.65
    - Standard Deviation = ADMD
- TasNetworks preferred ADMD value is 6 kVA per residential lot. Alternative ADMD values will need approval from TasNetworks prior to detailed design. For further details on acceptable ADMD values, refer to the Distribution Planning Requirements directive.
- All voltage drop results shall be submitted as part of the design deliverables. The reports shall include current, voltage and voltage percentage.

The nominal voltage level may be changed at some future date to conform with Australian standards. For this reason voltage drops are considered for calculation purposes as a % change from nominal and ADMD's have been selected to accommodate associated demand changes.

2.4.5 Cable rating

TasNetworks' cable rating calculations are based on the following factors

- Continuous with correction factors
- Cyclic with cyclic rating factors
- Emergency with emergency rating factors
- Short circuit current rating (near the supply source)

Unless TasNetworks advises otherwise, cable derating will not apply for cable arrangements in conduit for runs less than 15 metres. For example road crossing and incoming conduits to HV and LV switchgear. For all other underground cable arrangements, the designer shall calculate derating factors.

2.4.5.1 Continuous current ratings

The continuous current rating is defined as the current per phase that a cable can carry continuously without exceeding its rated maximum conductor temperature.

The continuous current rating of a cable is given in this standard and in manufacturers' catalogues and is subject to several modifying factors which are set out below. Continuous ratings for cables used by TasNetworks are given within this section. In the case where neither of these sources provides a rating, it can be calculated using IEC Document 60287.

Always be certain that catalogue temperature and other correction factors are applied if using manufacturers' catalogues as catalogue ratings are based on mainland conditions which are different from those in Tasmania.

Whenever a continuous rating is quoted it must always be accompanied by the defined limiting conditions as defined below:

- Ambient soil temperature 15^{o}C
- Soil thermal resistivity 1.2 ^{o}C.m/watt.
- Depth of burial from finished surface level to the top of the cable or conduit:
  - 600 mm for LV cables
  - 900 mm for 11 & 22kV cables
  - 1200 mm for 33kV cables

All continuous ratings are for one isolated cable. The continuous ratings are used in the calculation of cyclic and emergency ratings.

2.4.5.2 Cyclic rating

Cables laid in the ground have a thermal inertia and consequently there is a thermal time constant associated with heating and cooling cycles.

The cyclic current rating is the maximum peak current per phase that a cable can carry during a specified load cycle so that the cable rated maximum conductor temperature is not exceeded at or near the time of the peak of the cycle.

The cyclic current rating is always quoted as the PEAK value of current during the loading cycle.

For particular applications where rating is critical a cyclic rating factor can be determined based on knowledge of the daily load curve. This information can be obtained from TasNetworks' Network Planning team.

2.4.5.3 Emergency current ratings

The emergency current rating is the current that a cable can carry for a specified limited time on a specified load cycle and at a specified clock time on that load cycle such that the cable rated maximum conductor temperature is not exceeded at the end of the application of the emergency load to the cable.

The usual time period for an emergency load to be applied is one hour. In the absence of specific requirements, the period is taken as the hour immediately following the normal peak loading on the cable.

2.4.5.4 Rating Factors

The correction rating factors for continuous current rating of a cable with respect to the critical cable inputs can be represented by the following formula:

Cable rating = Base rating x Depth of laying factor x Soil thermal resistivity factor x Ground temp factor

A range of correction rating factor critical inputs have been summarised in Table 3, Table 5, Table 6, Table 7 and Table 8 for the cable types used by TasNetworks distribution in different conditions of installation.

Ground temperatures (^{o}C)

The designer shall take into account the maximum conductor temperature as specified by manufacturer's guidelines and referenced with AS3008 and AS 1429 for cross-referencing. Rating factors for variation in ground temperatures for cables have been provided in Table 3 for reference only. The designer shall confirm by means of computational calculations the appropriate ground temperature factor for the specific conditions in the underground design.

Table 3 : Ground temperature factor

Max Conductor Temperature ^{o}C	Ground Temperature ^{o}C			
	10	**15**	**20**	**25**
90	1.04	1.00	0.97	0.93
80	1.04	1.00	0.96	0.92
70	1.04	1.00	0.95	0.90

2.4.5.4.1 Soil Thermal Resistivity (G)

The soil thermal resistivity is classified by association to the soil condition's texture, compaction and moisture content as summarised in Table 4. Designers shall use the value of 1.2 ^{o}C.m/watt for cable rating, except for the following soil conditions

- Ground with considerable stones
- Sandy soils subject to dry out

The designer shall also stipulate the bedding material to be included in the cable trench to be within the preferred soil resistivity range by using materials such as sand cement mix of 14:1. TasNetworks cable trenches shall not have bedding materials such as coarse dry sand or similarly structured materials.

Table 4 : Typical soil thermal resistivity based on soil conditions

Resistivity G ^{o}C.m/w	Soil conditions	Comment
0.9	Wet	Good ground; sand/cement mix typical.
1.2	Average	Good ground – used for normal ratings
2.0	Dry	Rubbishy ground, stones, bricks etc
3.0	Very dry	Rubbishy ground; sandy soils subject to dryout.

Rating Factors for variation in soil thermal resistivity for XLPE cables direct buried and in ducts are provided in Table 5 and Table 7.

Table 5 : Soil thermal resistivity rating factors - Direct buried

Conductor Size mm^2	Value of G* ^{o}C.m/watt			
	0.9	**1.2**	**2.0**	**3.0**
185	1.10	1.00	0.82	0.69
240	1.10	1.00	0.81	0.69
300	1.10	1.00	0.81	0.69
400	1.10	1.00	0.81	0.69

Table 6 : Soil thermal resistivity rating factors – Laid in duct

Conductor Size mm^2	Value of G* ^{o}C.m/watt			
	0.9	**1.2**	**2.0**	**3.0**
185	1.05	1.00	0.89	0.80
240	1.05	1.00	0.89	0.79
300	1.05	1.00	0.88	0.78
400	1.05	1.00	0.88	0.78

The following tables provide factors to be applied to the basic continuous ratings so that changes in the ambient conditions may be allowed for.

2.4.5.4.2 Depth of cable

TasNetworks cable depth has been carefully selected to achieve compliance with the relevant Australian Standard and for cable rating optimisation purposes. It is the designers responsibility to ensure the minimum cable depth complies with the relevant Australian Standards. The designer shall ensure the cable depth is clearly specified in the relevant design trench drawings and where trench depth varies from the uniform rating of the cable by more than 6 linear metres, the designer shall recalculate the cable sizing according to the new depth. Refer to Table 7 for cable rating factor guidance.

Table 7 : Cable depth of cover rating factors – Direct buried

Depth	Low voltage cables		High voltage cables	
	70 - 300 mm^2	**Above 300 mm^2**	**To 300 mm^2**	**Above 300 mm^2**
0.5	1.02	1.03	-	-
0.6	1.00	1.00	-	-
0.8	0.98	0.97	-	-
0.9	0.97	0.96	1.00	1.00
1.0	0.96	0.95	0.99	0.98
1.25	0.94	0.93	0.97	0.96
1.5	0.93	0.92	0.96	0.95
1.75	0.91	0.90	0.95	0.93
2.0	0.90	0.89	0.93	0.91

Table 8 : Cable depth of cover rating factors – Duct laid

Depth	Low voltage cables		High voltage cables	
	Single Core	Multi-core	Single Core	Multi-core
0.5	1.02	1.01	-	-
0.6	1.00	1.00	-	-
0.8	0.97	0.98	-	-
0.9	0.96	0.97	1.00	1.00
1.0	0.95	0.97	0.99	0.99
1.25	0.92	0.96	0.96	0.97
1.5	0.91	0.95	0.94	0.96
1.75	0.90	0.95	0.93	0.95
2.0	0.89	0.94	0.91	0.94

2.4.5.4.3 Mutual heating effects of cable

The designer shall account for the mutual heating effects where a number of cables are situated in the same trenching arrangement. As a guide, TasNetworks standard trench arrangement limits a maximum of 4 cables per trench.

2.4.6 Standard cable sizes

Designers shall use Crossed Linked Polyethylene cables (XLPE). XLPE is one of the main insulating materials for modern power cables. It is extruded, vulcanized and formed concentrically over the conductor in roughly the same way as rubber insulation. XLPE material is a thermosetting polymer that may be operated at temperatures as high as 90°C or even 130°C for emergency overloads.

XLPE insulation has a high mechanical strength and resistance to softening and distortion under high temperatures. It also has superior heat aging resistance, high resistance against stress cracking, excellent electrical insulation characteristics, light in weight, mechanically flexible and very low dielectric losses (power loss through the insulation). Table 9 provides as summary list of the cables currently available. Designers must use the cable sizes listed in Table 9 for design and construction purposes.

Table 9 XLPE cable standard sizes

Voltage kV	Phase configuration	Size (mm^2)	Core type	Core material
11	3 core	185	Stranded	Aluminium
11	3 core	240	Stranded	Aluminium
22	3 core	185	Stranded	Aluminium
22	3 core	240	Stranded	Aluminium
1	4 core	185	Solid	Aluminium
1	4 core	240	Stranded	Aluminium
1	4 core	300	Stranded	Aluminium
1	4 core	400	Stranded	Aluminium

The designer shall select the size and appropriateness of the customer underground mains in accordance with AS/NSZ 3000.

The use of all single core cables shall be approved by TasNetworks' engineering group prior to issuing for construction. Single core cables will require additional information such as but not limited to derating of cables, unbalanced assumptions, screen bonding arrangement, etc.

The designer shall ensure adherence to the cable core type minimum bending radius to ensure the insulation and core is not damaged during installation and final termination. Particular care shall be taken in relation to solid core cable due to its susceptibility to damage.

2.4.6.1 Historical installations

The designer shall accommodate the new cable installation, where required, to interface with TasNetworks historical installations. Since 1992 XLPE insulated cables have been the predominant cable type used on the underground distribution network. Prior to 1992 a number of different cables types were used on the network. These cables can be broadly divided into the following categories:

Table 10 Historical cable installations

Cable Type	Period of Installation
HV Cables – Oil-filled (33 kV feeders only)	1964-1971
HV Cables – Oil-draining	1920s-1960s
HV Cables – Mass Impregnated Non-Draining	1960-1991
HV Cables – Polymeric Insulated (Mainly XLPE)	1991-2007
HV Cables – Polymeric Insulated (Mainly XLPE-TR)	2008- Current
LV Cables – Oil-draining	Pre -1960
LV Cables – Mass Impregnated Non-Draining	1960 -1978
LV Cables – Polymeric Insulated (Mainly XLPE)	1978 – current
LV Cables - CONSAC	1971-1980

2.4.7 Underground furniture

The designer shall refer to TasNetworks approved product list for underground furniture for the purposes of underground system design. All cable entries shall terminate in parallel to the respective UG furniture.

2.4.7.1 Turrets

TasNetworks' turrets are either a Standard Turret or an Extra Large Turret enclosure as described in Table 11, Table 12, Table 13 and Table 14. The designer shall select turrets and cabinets that is suitable for the design activity. Table Abbreviations are as follow: P/L = Public light, C/B = Circuit breaker & SW= Switch.

Table 11 – Standard turret arrangement single cable set

Enclosure Type	**Standard Turret – preferred UG furniture for URD**			
Voltage	**Cable size (mm^2)**	**Cable size (mm^2)**	**Cable size (mm2)**	**Services fuses**
LV – XLPE 4c	185			3x100A+P/L
	240			3x100A+P/L
	300			3x100A+P/L
	400			3x100A+P/L

Table 12 – Standard turret arrangement dual cable set

Enclosure type	**Standard turret– preferred UG furniture for URD**			
Voltage	**Cable size (mm^2)**	**Cable size (mm^2)**	**Cable size (mm^2)**	**Services fuses**
LV – XLPE 4c	185	185		3x100A+P/L
	240	240		3x100A+P/L
	300	300		3x100A+P/L
	400	400		3x100A+P/L

Table 13 – Standard Turret arrangement triple cable set

Enclosure type	**Standard turret– preferred UG furniture for URD**			
Voltage	**Cable size (mm^2)**	**Cable size (mm^2)**	**Cable size (mm^2)**	**Services fuses**
LV – XLPE 4c	185	185	185	3x100A+P/L
	240	240	185	3x100A+P/L
	240	240	240	3x100A+P/L

Table 14 – Extra Large Turret arrangement triple cable set

Enclosure type	Extra Large turret– preferred UG furniture for URD			
Voltage	**Cable size (mm^2)**	**Cable size (mm^2)**	**Cable size (mm^2)**	**Services fuses**
LV – XLPE 4c	300	300	185	3x100A+P/L
	300	300	300	3x100A+P/L
	400	400	185	3x100A+P/L

2.4.7.2 Cabinets

The designer shall select cabinets that comply with TasNetworks' approved product list. The standard turrets are either a Standard Turret or an Extra Large Turret enclosure as described in

Table 15 – 200 A Cabinet single cable set

Enclosure type	200 A Cabinet – C/B to be used for Strata title blocks or large single loads			
Voltage	**Cable size (mm^2)**	**Cable size (mm^2)**	**Cable size (mm^2)**	**Services fuses and circuit breaker**
LV – XLPE 4c	240			3x100A+P/L and 250A C/B
	300			3x100A+P/L and 250A C/B
	400			3x100A+P/L and 250A C/B

Table 16 – 200 A Cabinet single cable set with larger C/B

Enclosure type	200 A Cabinet– C/B to be used for Strata title blocks or large single loads			
Voltage	**Cable size (mm^2)**	**Cable size (mm^2)**	**Cable size (mm^2)**	**Services fuses and circuit breaker**
LV – XLPE 4c	185			3x100A+P/L and 400 A C/B

Table 17 – 200 A Cabinet dual cable set

Enclosure type	200 A Cabinet– C/B to be used for Strata title blocks or large single loads			
Voltage	**Cable size (mm^2)**	**Cable size (mm^2)**	**Cable size (mm^2)**	**Services fuses and circuit breaker**
LV - XLPE	185	185		3x100A+P/L and 250A C/B
	240	240		3x100A+P/L and 250A C/B
	300	300		3x100A+P/L and 250A C/B

Table 18 – 200 A Cabinet dual cable set with larger C/B

Enclosure type	200 A Cabinet– C/B to be used for Strata title blocks or large single loads			
Voltage	**Cable size (mm^2)**	**Cable size (mm^2)**	**Cable size (mm^2)**	**Services fuses and circuit breaker**
LV - XLPE	185	185		3x100A+P/L and 400 A C/B

Table 19 – 200 A Cabinet dual cable set with S/W

Enclosure type	200 A Cabinet – SW used for Normally Open point			
Voltage	**Cable size (mm^2)**	**Cable size (mm^2)**	**Cable size (mm^2)**	**Services fuses and circuit breaker**
LV - XLPE	185	185		3x100A+P/L and SW
	240	240		3x100A+P/L and SW
	300	300		3x100A+P/L and SW

Table 20 – 200 A Cabinet triple cable set

Enclosure type	200 A Cabinet			
Voltage	**Cable size (mm^2)**	**Cable size (mm^2)**	**Cable size (mm2)**	**Services fuses and circuit breaker**
LV - XLPE	300	300	300	3x100A+P/L
	400	400	185	3x100A+P/L

Table 21 – 200 A Cabinet triple cable set with S/W

Enclosure type	200 A Cabinet - SW used for Normally Open point			
Voltage	**Cable size (mm^2)**	**Cable size (mm^2)**	**Cable size (mm^2)**	**Services fuses**
LV - XLPE	185	185	185	3x100A+P/L and SW
	240	240	185	3x100A+P/L and SW

Table 22 – 400 A Cabinet single cable set

Enclosure type	400 A Cabinet– C/B to be used for Strata title blocks or large single loads			
Voltage	**Cable size (mm^2)**	**Cable size (mm^2)**	**Cable size (mm^2)**	**Services fuses and circuit breaker**
LV - XLPE	240			3x100A+P/L and 400 A C/B
	300			3x100A+P/L and 400 A C/B
	400			3x100A+P/L and 400 A C/B

Table 23 – 400 A Cabinet dual cable set 250 A

Enclosure type	400 A Cabinet– C/B to be used for Strata title blocks or large single loads			
Voltage	**Cable size (mm^2)**	**Cable size (mm^2)**	**Cable size (mm^2)**	**Services fuses and circuit breaker**
LV - XLPE	400	400		3x100A+P/L and 250 A C/B

Table 24 – 400 A Cabinet dual cable set 400 A

Enclosure type	400 A Cabinet– C/B to be used for Strata title blocks or large single loads			
Voltage	**Cable size (mm^2)**	**Cable size (mm^2)**	**Cable size (mm^2)**	**Services fuses and circuit breaker**
LV - XLPE	240	240		3x100A+P/L and 400 A C/B
	300	300		3x100A+P/L and 400 A C/B

Table 25 – 400 A Cabinet dual cable set S/W

Enclosure type	400 A Cabinet– C/B to be used for Strata title blocks or large single loads			
Voltage	**Cable size (mm^2)**	**Cable size (mm^2)**	**Cable size (mm^2)**	**Services fuses and circuit breaker**
LV - XLPE	400	400		3x100A+P/L and SW or 400 A C/B

Table 26 – 400 A Cabinet triple cable set

Enclosure type	400 A Cabinet			
Voltage	**Cable size (mm^2)**	**Cable size (mm^2)**	**Cable size (mm^2)**	**Services**
LV - XLPE	400	400	400	3x100A+P/L

Table 27 – 400 A Cabinet triple cable set and S/W

Enclosure type	400 A Cabinet - SW used for Normally Open point			
Voltage	**Cable size (mm^2)**	**Cable size (mm^2)**	**Cable size (mm^2)**	**Services**
LV - XLPE	240	240	240	3x100A+P/L and SW
	300	300	185	3x100A+P/L and SW
	300	300	300	3x100A+P/L and SW
	400	400	185	3x100A+P/L and SW
	400	400	400	3x100A+P/L and SW

Designers shall use turrets over cabinets in URD areas due to the improved overall lifecycle maintenance for the turrets. The turrets will be located to supply to adjoining lots. The designer should consider cabinets in commercial or CBD areas where site availability is limited. Positioning of cabinets in commercial and CBD areas requires special attention to avoid the inadvertent damage to the asset due to vehicle or pedestrian access.

In URD area the designer shall locate the position of the turret or cabinet to run in parallel to the main access and as close as practical to an allotment. In a multistage development, a turret shall be installed as the last connection point immediately adjacent to the subdivision boundary. The installation of the turret will include conduit to the adjacent future subdivision stage to allow for future termination.

2.4.7.3 Public lighting

The underground design shall accommodate for public lighting infrastructure sourced from the UG LV reticulation. For additional information regarding the requirements for Public lighting, refer to TasNetworks Distribution Design Standard – Public Lighting.

2.4.7.4 Kiosk substation

The UG design shall consider for a Kiosk substation if applicable. For additional information regarding the requirements for Kiosk Substation, refer to TasNetworks Distribution Design Standard – Kiosk Substation.

2.4.7.5 Underground to overhead pole (UGO)

The designer shall consider UGO interconnection if applicable. These considerations include but are not limited to the following:

- Minimum offset to the pole foundation to prevent structural undermining
- End capping and coiling of cable
- Cable length allowance along the length of the pole for termination at the top of the pole– to be confirmed with TasNetworks
- Suitability of existing pole top structures clearances with relevant standards, age and sizing of pole

For additional information refer to the TasNetworks' Civil Construction Specification of Urban Residential Development.

2.4.8 Pulling cable

The designer shall ensure the cable pulling tension for the cable run is based on the manufacture's specification, with consideration to the:

- cable weight and diameter
- co-efficient of friction
- geometry of trench
- direction of pulling.

To assist the construction installation, the designer shall provide recommendations of pulling locations in the design to reduce stress on the cable by considering

- pulling down hill
- pulling around bends at the start of the pull versus at the end of the pull
- requirements of caterpillar/cable pusher, rollers, skid plates etc if applicable

The designer shall document the pulling requirements where the cable length exceeds 200 m in a continuous run.

2.4.9 Surface cutting and reinstatement

The designer shall review the Local Government Authority's requirements for reinstating surfaces and include these requirements in the underground design, including as but not limited to, the following:

- full width footpath to be resurfaced regardless of the cut width
- Road crossings only under boring permitted

As a minimum, reinstatement of surfaces shall be like for like such as lawn, concrete or bitumen.

2.4.10 Existing underground infrastructure

Installation of underground cabling and infrastructure creates ground disturbance and requires interaction with existing services. Depending on location and complexity of the project, it is essential that the designer liaise with the appropriate asset owners or authorities. Approval may be required from the relevant authority to locate infrastructure near the existing infrastructure.

Listed below are some of the foremost Authorities that maybe applicable:

- Telstra Australia (Telstra cables only).
- Transport Traffic Signals & Cabling (Department of State Growth).
- Main Classified Roads (Department of State Growth).
- Local Councils (drainage, street furniture including trees and all roads except Department of State Growth roads).
- Water Authorities (TasWater and TasIrrigation)
- Railways (TasRail).
- Gas Transmission and Reticulation. (TasGas)
- TasNetworks for transmission and distribution cables.
- Private property owners.
- Department of Primary Industries, Parks, Water and Environment

The dial before you dig (DBYD) service will cover most utility owned underground services at the site.

The minimum separation of electrical infrastructure from other infrastructure is provided in drawings UG-614.

2.4.11 Electrical and Magnetic Field (EMF)

Each design shall consider the effects of EMF and the associated limits for personnel in accordance with ICNIRP, Guidelines for limits exposure to magnetic and electric fields and AS 2067 Appendix D. For further details on EMF design considerations refer to the TasNetworks Kiosk Substation Design Standard.

2.4.12 Earthing

2.4.12.1 Introduction

The designer shall comply with ‘Section 8 - Earthing Systems’ of AS 2067 and Section 5 of AS/NSZ 3000; which are the minimum performance based standard. Additionally, ENA EG0 methodologies may be used as a reference for making risk based assessments using the ALARA (As Low As Reasonably Practicable - ALARP) principle.

Designers shall apply a standard HV cable earth screen arrangement by bonding both ends of the HV screen to the corresponding substations or HV assets (UGO pole) earthing arrangement. For single core cables, the designer shall prove the effects of double bond arrangement do not affect the derating of the cable.

The designer shall ensure the LV reticulation earth rods are positioned at least 15 m from the nearest Telstra equipment pits. If site conditions do not allow for minimum separation to the communication assets, a detailed assessment based on the earth potential rise at the site and applicable electrical potentials on neighbouring communication assets shall be undertaken in accordance with AS/NZS 3835.

The designer shall refer to TasNetworks’ Kiosk Substation Design Standard for a complete HV earthing design.

The design shall ensure acceptable safety for persons within the zone of influence of the substation's earthing performance, with legitimate access in accordance with the risk assessment principles outlined in ENA EG0. This is a minimum requirement and additional guidance on the design and installation of underground earthing systems can be gained from other published documents such as, but not limited to, AS 3835, AS 4853, ENA EG1, AS 60479.1 and IEEE 837, which can assist the designer in qualifying permanent connections used in underground earthing systems.

2.4.12.2 Earthing considerations

The earthing system design of an underground system installation needs to include many considerations to ensure fault currents can be safely dissipated to earth. Existing Australian Standards and best industry practice (in the form of guidelines) require a holistic prudent approach which is appropriate for the benefit versus cost for these types of installations. The following considerations must be taken into account.

Public and operator afety: the earthing design limits shall be developed using AS 60479.1 and provide a demonstrated methodology to derive the limits. Comparison of the limits developed with ENA EG-0 typical contact scenarios shall be provided and where deviation between the standard and the guide, the designer shall provide justification in supporting documentation.

ENA EG-0 may also be used, if determined suitable by the designer. The analysis should consider a risk cost benefit analysis using the principles of contact scenario assessment where there is the likelihood of personal contact with nearby infrastructure during the time of an earth fault at the site. The assessment of what is "nearby" will generally depend on the amount of earthing at a site, bonding arrangements, soil resistivity and the fall of potential profile of the soil. As a rule of thumb, infrastructure within 10m of an HV earth should be considered.

Two scenario categories are defined by EG0 which should be considered. These are:

- Individual risk assessment: Appropriate in situations where persons are likely to touch applied voltages individually (one at a time).
- Societal risk assessment: Required for situations where multiple persons are likely to touch an applied voltage at the same time.

When assessing a site, designers should identify any societal risks. These will exist in heavily populated areas where people congregate on objects such as hand railings or fences.

Crushed rock layer and bitumen shall not be used as the first measure to derive safety limit calculations. Surface layer alterations shall be incorporated in a detailed earth design to ensure the correct applicability of the risk mitigation measures.

If all contact scenarios at a given site are identified as remote, then the design shall focus on ensuring protection will operate effectively. In these cases, standard resistance referred to in Appendix B of AS 2067 should be referenced.

Where other contact scenarios are identified, a risk assessment shall be performed on the step and touch voltages that will be present, using the design tool or the EG0 process.

Fault inputs - Fault study information shall be provided by TasNetworks for each specific site (assumed zero impedance fault) and shall include:

- Identification of HV fault locations (sources)
- Phase to earth fault level (zero sequence impedance) in amps;
- Two phase to earth fault level (zero-sequence impedance) in amps;
- Three phase fault level in amps;

- Fault clearing times, both primary and secondary protection for each fault level (in graphical form).

The designer shall allow for the fault current DC offset using TasNetworks fault information. The designer shall allow for fault iteration calculations to determine the actual fault level based on the site grid resistance.

The designer shall use the worst case ultimate earth fault level possible on the site to complete the earthing study.

Buried earth arrangement – TasNetworks' standard LV earthing connection is only applicable for a HV/LV combined substation earth grid upstream from the LV or localised MEN.

Earthing conductors– TasNetworks has standardised the LV earthing conductors as 35 mm^2 stranded Yellow/Green insulated copper conductor with suitable lug and 13 mm diameter solid copper rod.

Earthing connections – TasNetworks has standardised the LV earthing connections for turrets and cabinets as palm clamp (such as CABAC) to localised earth bar and rod clamp (such as Dulmison) for earth rods. Alternative earth connections shall be approved by TasNetworks prior to installation and type testing certificates to comply with the intent of IEEE 837 shall be provided.

As a minimum, each turret and cabinet shall have a dedicated earth electrode within the installation in accordance with AS/NSZ 3000. If metallic enclosure is used, the enclosure shall be earth to the main earth electrode.

HV Cable screens - The HV cable screen forms an integral part of TasNetworks' template earthing system design. The metallic screens of cables are designed to provide an effective earth return path for fault current resulting from failed equipment and cables. A minimum of one double bonded HV screen shall be used as part of the design, which will ensure an appropriate remote earth. The remote substation earth may be a distribution substation, underground to overhead earth electrodes, cabinets or Zone substation (source) assets. The earthing termination at the remote HV asset is dependant on the plant fitted to the corresponding HV asset. The designer shall communicate with TasNetworks relevant team for each asset to ensure bonding requirements of the HV screens have been adhered to.

CMEN – TasNetworks' template earth design shall be connected to a combined multiple earth system, where the MEN link shall be incorporated and be visible within the Kiosk substation LV board. For earthing system designs that extend beyond the template design scope, additional requirements such as separated LV and HV earthing may be incorporated and will require the MEN link to be isolated. An additional insulated dedicated earth cable along the LV cable trench may be utilised for LV contingency purposes. The designer shall clearly show the location and extent of the dedicated earth conductor on the associated earthing drawings. For further information regarding separated LV and HV requirements, refer to Section 8 of AS 20267 and liaise with the TasNetworks' Asset Engineering team.

Telecommunication assets – the earthing system design shall consider the interaction of telecommunications infrastructure, as both HV electrical installations and telecommunication assets must co-exist in the same environment as they provide services to the same customers. The proximity of the earthing system may give rise to Low Frequency Induction (LFI) and Earth Potential Rise (EPR) affecting telecommunication systems under high voltage fault conditions on the electricity network. These voltages are short duration but can reach dangerous levels. The voltage rise that will appear at the earth under fault conditions is dependent on the earthing design, fault levels and soil resistivity. The design shall determine if the applicable protection of telecommunication network users, personnel and plant external telecommunications assets isolation devices are required in accordance with AS 3835:2006, namely if the 430 and 1000 V contour locations are present. If isolation devices are required, the designer must ensure that relevant telecommunications companies are advised, with reasonable notice, of details of the protection requirements and the resolution of this matter is a joint responsibility of both parties.

Metallic pipe lines – the earthing system design shall consider the effects on metallic pipe lines such as, and not limited to water reticulation and gas pipelines. In the event there are metallic pipe line installations; the new installations are required to use non-conductive pipes in close proximity to the new HV installation. It is required the installation meets the requirements set out in AS 4853:2012 to develop the appropriate safety limits.

Documentation - The earthing system design shall be presented in a detailed package which is to include layout drawings indicating location of buried conductors, conductor size, insulation surface thickness (if applicable), grounding rods and earthing tails to metallic structures. The designer shall submit a design report detailing all inputs, assumptions, calculations, graphical model outputs and commission test program.

Commissioning testing – the testing shall be carried out by an appropriately qualified and accredited worker, who is compliant with TasNetworks' HSEQ Policies and Procedures for earthing system installations.

Where the design only extends the existing LV network, the design shall be verified by testing each underground furniture dedicated earth electrode only.

Where the underground reticulation design includes HV cables, the earthing system shall be verified in accordance with Section 2.4.6 of the TasNetworks Kiosk Substation Design Standard.

Stakeholder management - Due to the complexity presented by various parties involved through a project, it is strongly recommended that the project support members correctly distribute the earthing related design documentation to the following project stakeholders (where applicable):

- civil contractors
- electrical installers
- telecommunications installers
- plumbing installers
- earth grid installers
- gas installers.
- Electrical network utility

2.4.13 Protection and control

The designer shall consider the requirements of electrical protection and control for the distribution network. If protection control is required, the designer shall incorporate fibre optic within the cable trench design, in accordance with TasNetworks planning directive scope. For further details, refer to TasNetworks Protection and Control documentation.

2.4.14 Access and operational clearance

The designer shall ensure minimum clearances for underground systems comply with AS/NSZ 3000 for LV cables and AS 2067 for HV cables. The turret or cabinet's road facing side shall have a minimum 900 mm clearance from the centre of the foot path, unless easement restriction exists on site. Refer to Section 2.2.1.2.

In the absence of foot paths, the designer shall ensure the road facing side of all turret and cabinet shall have a minimum 1.5 m clearance from the road kerb or driveways.

The location of the turret or cabinet shall always run in parallel with the adjacent foot path/road and be positioned in a manner that avoids road vehicles inadvertently damaging the equipment. TasNetworks' turrets or cabinets shall not be positioned in between two adjoining driveways.

Additionally, underground designs must comply with the minimum clearances to gas and water services outlined in accordance with AS 5601, AS 3500 and AS/NSZ 3000. Where conflict between the standards existing, the most onerous shall be used.

All TasNetworks infrastructure requires unimpeded access for TasNetworks personnel and heavy vehicle, directly from a public street for 24 hours per day, 7 days a week.

2.4.15 Civil

Cables shall be installed below ground in one of the trench arrangements provided in drawings, UG-205, UG-206 or UG-207.

Where cable routes run under roadways, ground subject to vehicle traffic shall be installed in conduits. Refer drawing UG-209 for details.

Where cable routes cross water courses cables shall be installed in conduits. Refer drawing UG-344 for details.

2.4.15.1 Trenching

Cable bedding material shall be sand which is nominally free of soluble salts, free of organic material (eg twigs, leaves, bark, wood, shells etc) and of pebbles, stones and clay. Sand having such impurities may not be accepted at the point of delivery.

The bedding sand shall be graded with the particle distribution from approximately 0.05mm to 2mm, but consideration will be given to similar sand having additional particles up to 5mm making no more than ten percent of the total by weight. These particle sizes will be determined by a particle size distribution test to be carried out by TasNetworks using sieves to AS 1289. If offered, sandy loam will be considered as an alternative. The bedding sand shall comply with the following technical requirements.

Table 3: Bedding sand technical requirements

Test	Preferred value	Maximum permissible variation	Comments
Dry Density	Max	-10%	-
Thermal Resistivity	Min 1.2 OC .m/W	+10%	-
Particle Distribution		Range 0.05-2mm	Variation within range stated will be permitted at Engineer's discretion
Soluble Salts	Min 0	+0.5%	-
Organic content	Min 0	+1.0%	Value will refer to oily material. Sand is to be nominally free of solid organic material
Acidity (pH)	7.0	+0.5	-

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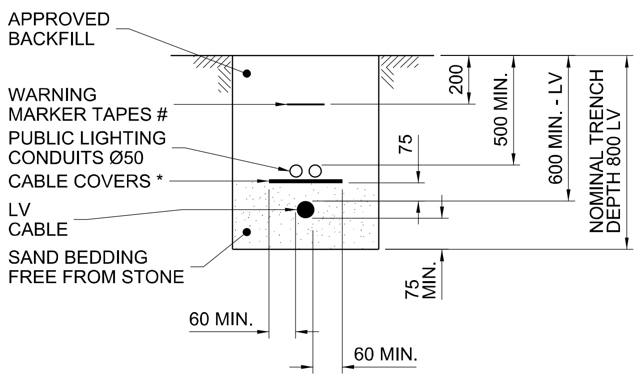
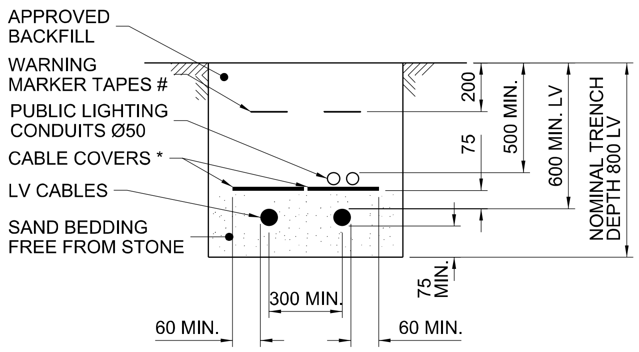
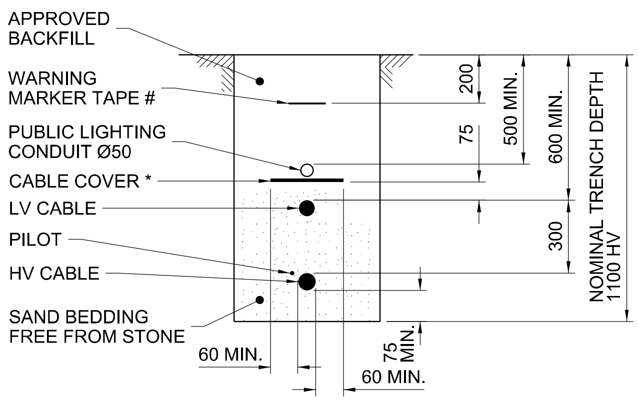


ARRANGEMENT No. 1 DIRECT BURIED SINGLE LV



ARRANGEMENT No. 2 - DIRECT BURIED DUAL LV



ARRANGEMENT No. 3 - DIRECT BURIED LV & HV

NOTES

1. TRENCH WIDTH MUST ALLOW FOR A MINIMUM CLEARANCE OF 75mm EACH SIDE OF CABLE.
2. REFER TO TASNETWORKS APPROVED SAND BEDDING MATERIAL SPECIFICATIONS.
3. FOR SEPARATION FROM OTHER SERVICES REFER TO DRAWING UG-614, OR RELEVANT AUTHORITY.

WARNING MARKER TAPE TO AS2698.1 S.I. No 348630

* POLYMERIC CABLE COVER 300 WIDE TO AS4702 S.I. No 077561

ALTERATIONS

TasNetworks

TasNetworks PTY. LTD.
ABN: 24 167 357 299

DIMENSIONS ARE IN MILLIMETRES. UNLESS OTHERWISE STATED.

DRAWN	C5 PRO-SOLUTIONS	TITLE: UNDERGROUND CABLE LV & HV CABLES DIRECT BURIED TRENCH ARRANGEMENT	SCALES 1:30
CHECKED	G. HALL		SIZE A4
APPROVED	DAVID ELLIS	UG-205	REVISION A
DATE	05/02/2016		

03/11/2015

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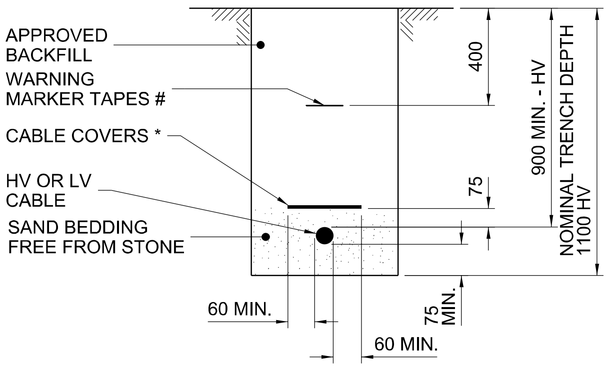
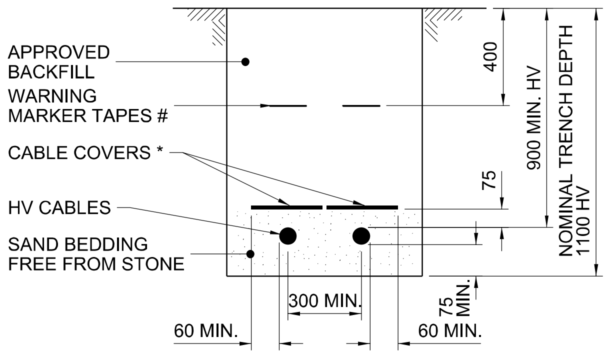


ARRANGEMENT No. 4 - SINGLE DIRECT BURIED HV



ARRANGEMENT No. 5 - DUAL DIRECT BURIED HV

NOTES

1. TRENCH WIDTH MUST ALLOW FOR A MINIMUM CLEARANCE OF 75mm EACH SIDE OF CABLE.
2. REFER TO TASNETWORKS APPROVED SAND BEDDING MATERIAL SPECIFICATIONS.
3. FOR SEPARATION FROM OTHER SERVICES REFER TO DRAWING UG-614, OR RELEVANT AUTHORITY.

\# WARNING MARKER TAPE TO AS2698.1 S.I. No 348630

* POLYMERIC CABLE COVER 300 WIDE TO AS4702 S.I. No 077561

ALTERATIONS

TasNetworks

TasNetworks PTY. LTD.
ABN: 24 167 357 299

DIMENSIONS ARE IN MILLIMETRES. UNLESS OTHERWISE STATED.

DRAWN	C5 PRO-SOLUTIONS	TITLE: UNDERGROUND CABLE HV CABLES DIRECT BURIED TRENCH ARRANGEMENT	SCALES	1:30
CHECKED	G. HALL		SIZE	A4
APPROVED	DAVID ELLIS	UG-206	REVISION	A
DATE	05/02/2016			

24/11/2015

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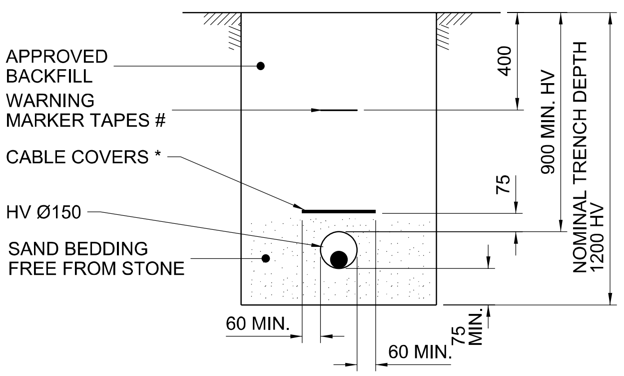
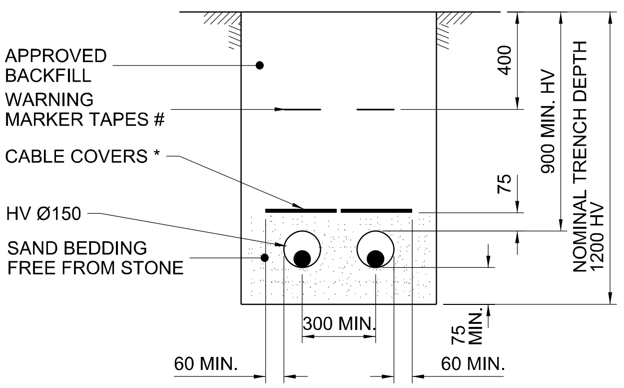
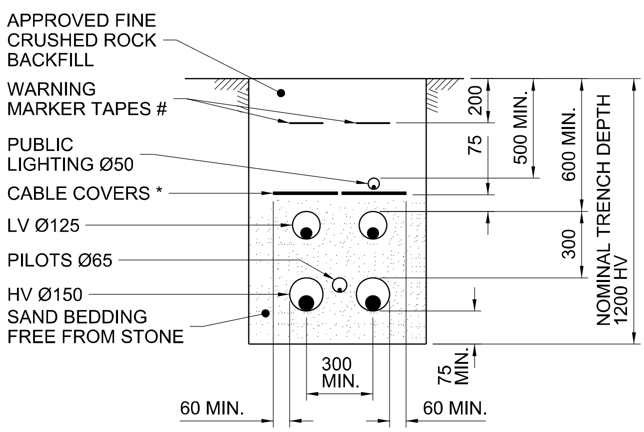


ARRANGEMENT No. 6 - SINGLE HV CONDUIT



ARRANGEMENT No. 7 - DUAL HV CONDUIT



ARRANGEMENT No. 8 - ROAD CROSSING WITH DUAL LV & HV CONDUIT

NOTES
1. TRENCH WIDTH MUST ALLOW FOR A MINIMUM CLEARANCE OF 75mm EACH SIDE OF CONDUIT.
2. REFER TO TASNETWORKS APPROVED SAND BEDDING MATERIAL SPECIFICATIONS.
3. FOR SEPARATION FROM OTHER SERVICES REFER TO DRAWING UG-614, OR RELEVANT AUTHORITY.

WARNING MARKER TAPE TO AS2698.1 S.I. No 348630
* POLYMERIC CABLE COVER 300 WIDE TO AS4702 S.I. No 077561

ALTERATIONS	TasNetworks	TasNetworks PTY. LTD. ABN: 24 167 357 299	
	DIMENSIONS ARE IN MILLIMETRES. UNLESS OTHERWISE STATED.	TITLE: UNDERGROUND CABLE LV & HV CABLES CONDUIT TRENCH ARRANGEMENT	SCALES 1:30
	DRAWN: C5 PRO-SOLUTIONS		SIZE A4
	CHECKED: G. HALL		
	APPROVED: DAVID ELLIS	UG-207	REVISION A
	DATE: 05/02/2016		

24/11/2015

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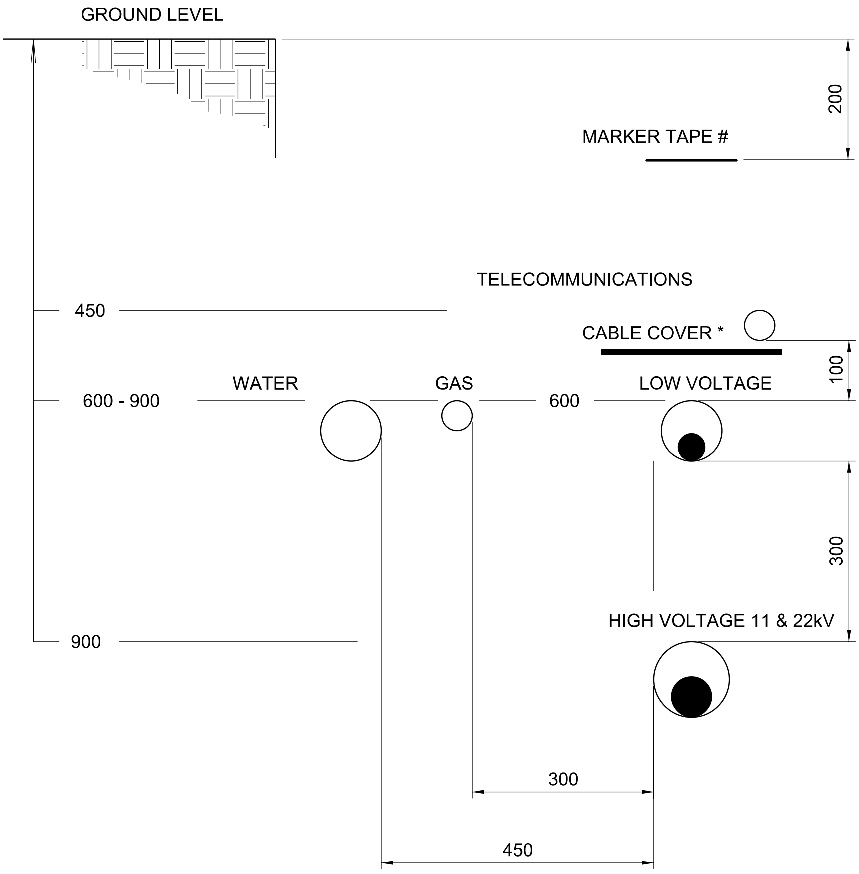

MINIMUM UTILITY SERVICE SEPARATIONS

NOTES
1. TRENCH WIDTH MUST ALLOW FOR A MINIMUM CLEARANCE OF 75mm EACH SIDE OF CABLE OR CONDUIT.
2. CONTACT TASNETWORKS TO CONFIRM THE LATEST APPROVED LAYOUT.
3. OTHER UTILITIES MAY SPECIFY GREATER MINIMUM CLEARANCES.

WARNING MARKER TAPE S.I. NO 348630 IN ACCORDANCE WITH AS 2698.1

* POLYMERIC CABLE COVER 300 WIDE S.I. NO 077561 IN ACCORDANCE WITH AS 4702

ALTERATIONS

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ABN: 24 167 357 299

DIMENSIONS ARE IN MILLIMETRES. UNLESS OTHERWISE STATED.

DRAWN	C5 PRO-SOLUTIONS
CHECKED	J. GOODGER
APPROVED	ANGUS KETLEY
DATE	10/02/2016

TITLE

UNDERGROUND CABLES
INSTALLATION DATA
MINIMUM UTILITY SERVICE SEPARATIONS

SCALES NTS

SIZE A4

UG-614

REVISION A

03/11/2015

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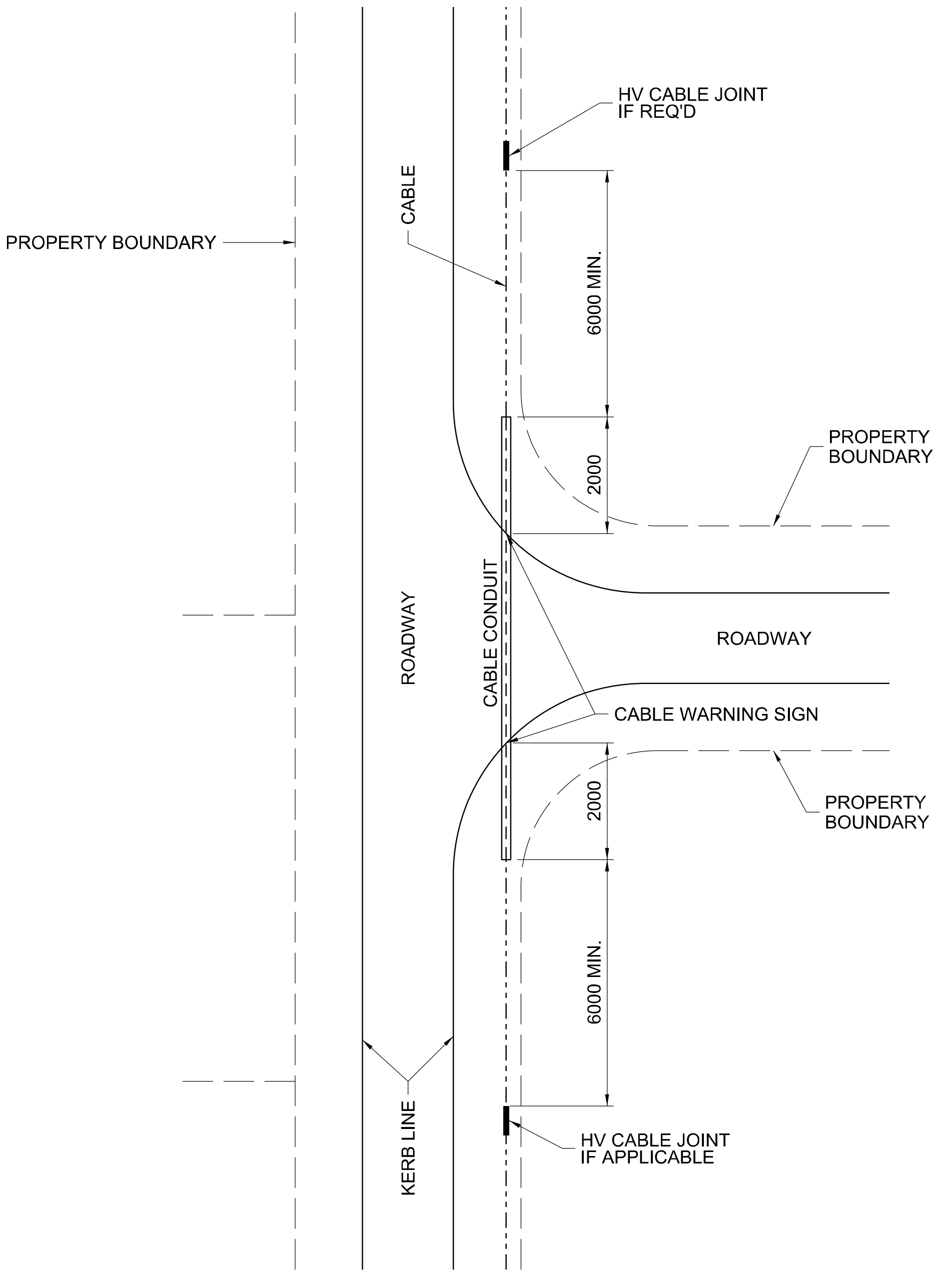

NOTES
1. FOR UNDERGROUND CABLE MARKER SIGN REFER TO DRAWING UG-604.
2. ENSURE WARNING SIGNS ARE SECURED TO KERB LINE.
3. DESIGNER SHOULD CONSIDER DERATING OF CABLE FOR CONDUIT INSTALLATION LENGTH.

ALTERATIONS	TasNetworks	TasNetworks PTY. LTD. ABN: 24 167 357 299	© COPYRIGHT - TASNETWORKS PTY. LTD. NO PART OF THIS DRAWING MAY BE REPRODUCED, STORED IN A RETRIEVAL SYSTEM IN ANY FORM, OR TRANSMITTED BY ANY MEANS WITHOUT PRIOR PERMISSION OF TASNETWORKS.
	DIMENSIONS ARE IN MILLIMETRES. UNLESS OTHERWISE STATED.	TITLE: UNDERGROUND CABLE CABLE & DUCT PLACEMENT ROAD CROSSINGS	SCALES: NTS
	DRAWN: C5 PRO-SOLUTIONS		
	CHECKED: G. HALL		SIZE: A4
	APPROVED: DAVID ELLIS		
	DATE: 05/02/2016	UG-209	REVISION: A

08/12/2015

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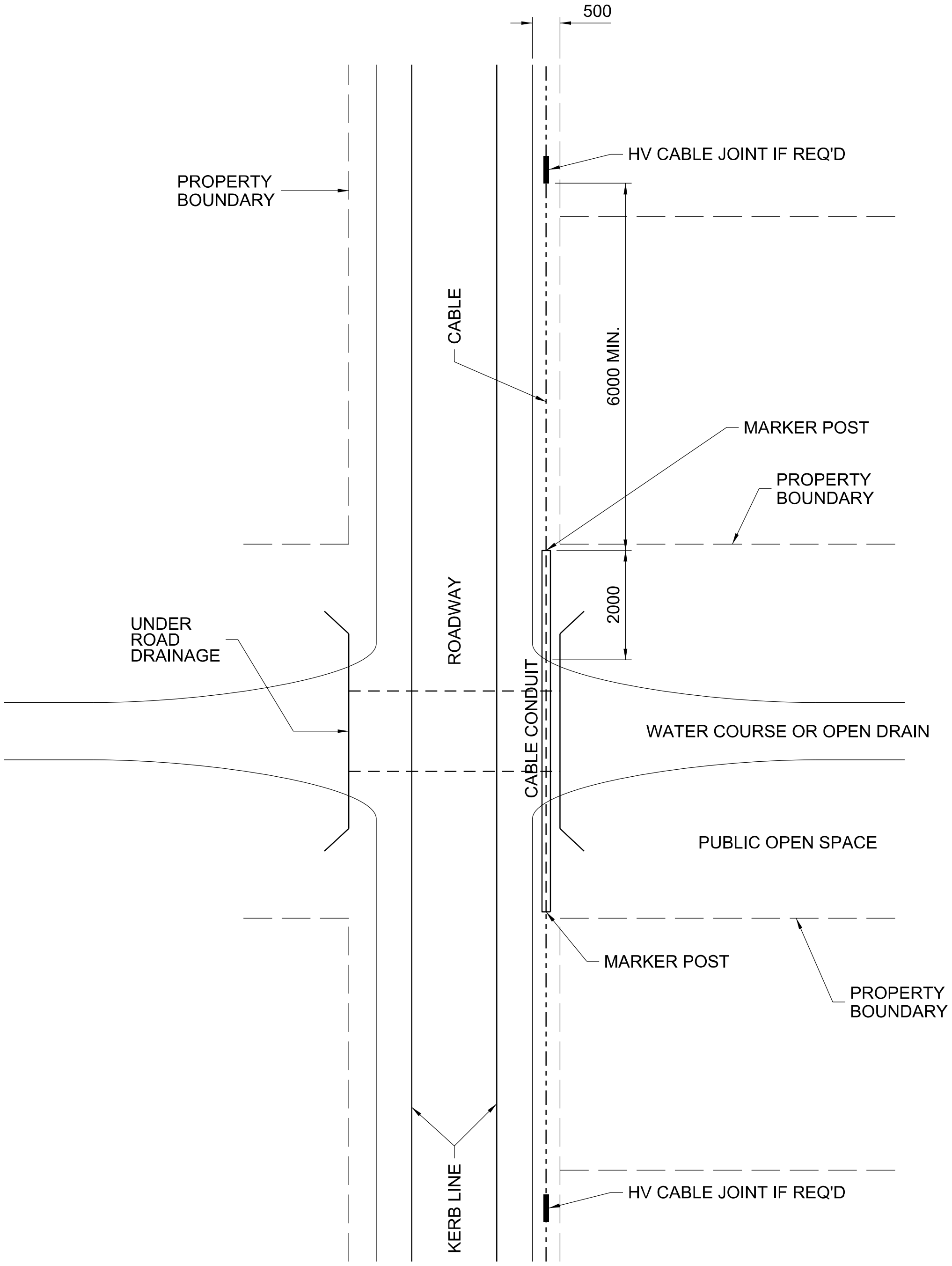

NOTES
1. CABLE CONDUIT SHALL BE INSTALLED ACROSS WATER COURSE OR DRAIN.
2. THE DESIGNER SHOULD CONSIDER CABLE DERATING TO ACCOUNT FOR DEPTH OF BURIED CONDUIT INSTALLATION.
3. MARKER POST DETAILS REFER TO DRAWING UG-603.
4. MARKER POST LOCATION MIN OFFSET TO CONDUIT END 2000mm.
5. CONDUIT SHALL EXTEND A MIN. OF 2000mm FROM EDGE OF WATER COURSE OR OPEN DRAIN.
6. CABLE DEPTH SHALL COMPLY AS A MIN. TO AS7067 OR AS3000, OR A MORE ONEROUS LOCAL GOVERNMENT STANDARD.

ALTERATIONS

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DRAWN	C5 PRO-SOLUTIONS
CHECKED	G. HALL
APPROVED	DAVID ELLIS
DATE	05/02/2016

TITLE
UNDERGROUND CABLE
CABLE & DUCT PLACEMENT
WATER COURSE OR OPEN DRAIN

SCALES NTS

SIZE A4

UG-210

REVISION A

08/12/2015

2.4.15.2 Boring

Guide boring or directional drilling is highly dependent on the ground conditions through which the bore is to be made as very hard and uneven rock may cause extensive deviations in the bored route. Deviations on the route result in excessive friction during cable pulling. The designer shall take into account the actual direction and depth of the bore in the design. The cable shall be pulled through conduit when boring and cable joints shall be installed minimum 6 m from the conduit ends.

The designer shall also account for sufficient space for the boring equipment including the pipes and environmental conditions such as noise.

2.4.15.3 Cable bending radius

The minimum bending radius requirement should be observed when:

- pulling cable through ducts
- bending cables around bends within trenches
- bending cables up to terminate in kiosk transformers, turrets, cabinets etc
- bending radius between cable core types – stranded or solid

The designer shall ensure the minimum bending radius is obtained from TasNetworks current periodic contract manufacture's details and included within the design where the cable bending radius is critical. The designer shall differentiate in the relevant design drawings between installation and setting bending radius in accordance with the manufacture's specifications.

2.4.16 Equipment labelling

It is critical for all TasNetworks assets to be clearly labelled to identify the presence of high voltage and low voltage equipment to warn of the dangers.

Cable and underground furniture identification/labelling shall comply with AS/NSZ 3000, AS2067 and TasNetworks labelling standards.

TasNetworks cables shall have early Warning Tape and Mechanical cover in accordance with AS/NSZ 3000. Refer to TasNetworks' typical trench drawings for further details.

TasNetworks cables and underground furniture shall be labelled. The following criteria apply to the various underground assets:

- Cables, both HV and LV shall have clear installation labels. The label shall identify both the source and destination at the respective ends of the cable.
- Underground furniture i.e. all turrets, cabinets and public lighting shall be labelled with a unique numeric order starting with the number 1. The numbering shall be sequential along each street with a prefix of 'T' for turrets, 'C' for cabinets, 'L' for pole lighting and 'S' for switch. Care shall be taken to ensure the labels are durable for future construction or augmentation.

2.5 Design deliverables

The designer shall ensure the following documents are delivered as a minimum:

- TasNetworks – Contractor Work Order or equivalent project scope/material/schedule
- TasNetworks – Order confirmation of supporting equipment or equivalent
- TasNetworks – Environmental Assessment for distribution lines or equivalent
- Drawings:
  - Project drawing register with reviewer and approval sign off
  - Proposed Plan drawing (showing easement locations and widths)
  - Detailed equipment reference drawings for Underground Systems
  - Detailed trenching arrangement
  - Dial Before You Dig asset information
  - Cable pulling plan (as required)
  - Single line diagram for HV and LV cables
  - Detailed Civil foundation and Earthing arrangement
- Detailed documents/reports:
  - Safety in Design report
  - Manufacturer equipment rating
  - Earthing compliance report
  - Infrastructure easement
  - Voltage drop calculations and software files
  - Project approval
  - Communication references such as emails and letters

The designer shall ensure the design deliverables are legible and submitted in electronic form to comply with TasNetworks' relevant standard (e.g. Design Drafting Standard).

2.5.1 Sample deliverables

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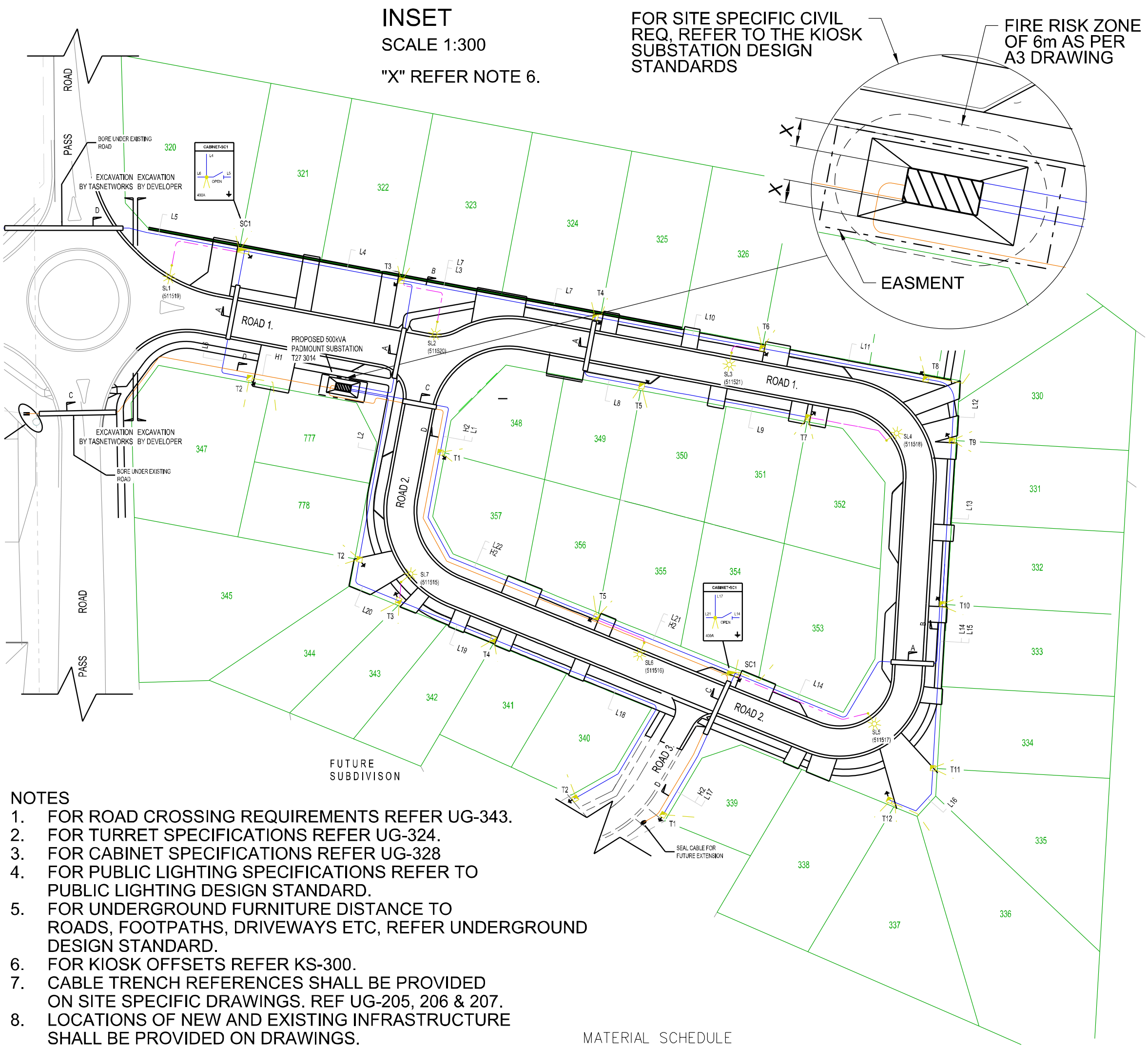

NOTES
1. FOR ROAD CROSSING REQUIREMENTS REFER UG-343.
2. FOR TURRET SPECIFICATIONS REFER UG-324.
3. FOR CABINET SPECIFICATIONS REFER UG-328
4. FOR PUBLIC LIGHTING SPECIFICATIONS REFER TO PUBLIC LIGHTING DESIGN STANDARD.
5. FOR UNDERGROUND FURNITURE DISTANCE TO ROADS, FOOTPATHS, DRIVEWAYS ETC, REFER UNDERGROUND DESIGN STANDARD.
6. FOR KIOSK OFFSETS REFER KS-300.
7. CABLE TRENCH REFERENCES SHALL BE PROVIDED ON SITE SPECIFIC DRAWINGS. REF UG-205, 206 & 207.
8. LOCATIONS OF NEW AND EXISTING INFRASTRUCTURE SHALL BE PROVIDED ON DRAWINGS.

LEGEND

- HV U/G CABLE - 11kV
- LV U/G CABLE
- PUBLIC LIGHTING U/G CABLE
- DUCT
- SUBSTATION ENCLOSURE
- TURRET
- CABINET
- STREETLIGHT

MATERIAL SCHEDULE

CABLE	95sqmm	185sqmm	240sqmm	300sqmm	400sqmm	CABLE TYPE
L1		90m				SA 4/c X PVC LV
L2		55m				SA 4/c X PVC LV
TOTAL		145m				

CABLE	95sqmm	185sqmm	240sqmm	300sqmm	400sqmm	CABLE TYPE
H1		395m				A 3/c XSHC PVC HDPE 11kV
TOTAL		395m				A 3/c XSHC PVC HDPE 11kV

STREETLIGHT CONDUITS	80m	50mm DIA. H.D. ORANGE ELECTRICAL
STREETLIGHT CABLES	110m	10sqmm 2/c • 4sqmm E ORANGE CIRCULAR
SERVICES CONDUITS	96m	50mm DIA H.D. ORANGE ELECTRICAL

TURRET	18	STANDARD
SERVICE CABINET	2	200A
PUBLIC LIGHTING COLUMNS	7	S.I. 32.49.71

INTENDED TO BE PRINTED IN COLOUR

ALTERATIONS

TasNetworks

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ABN: 24 167 357 299

DIMENSIONS ARE IN MILLIMETRES. UNLESS OTHERWISE STATED.

DRAWN	C5 PRO-SOLUTIONS
CHECKED	G. HALL
APPROVED	DAVID ELLIS
DATE	05/02/2016

TITLE
UNDERGROUND CABLE
TYPICAL URD CABLE LAYOUT

SCALES 1:1500

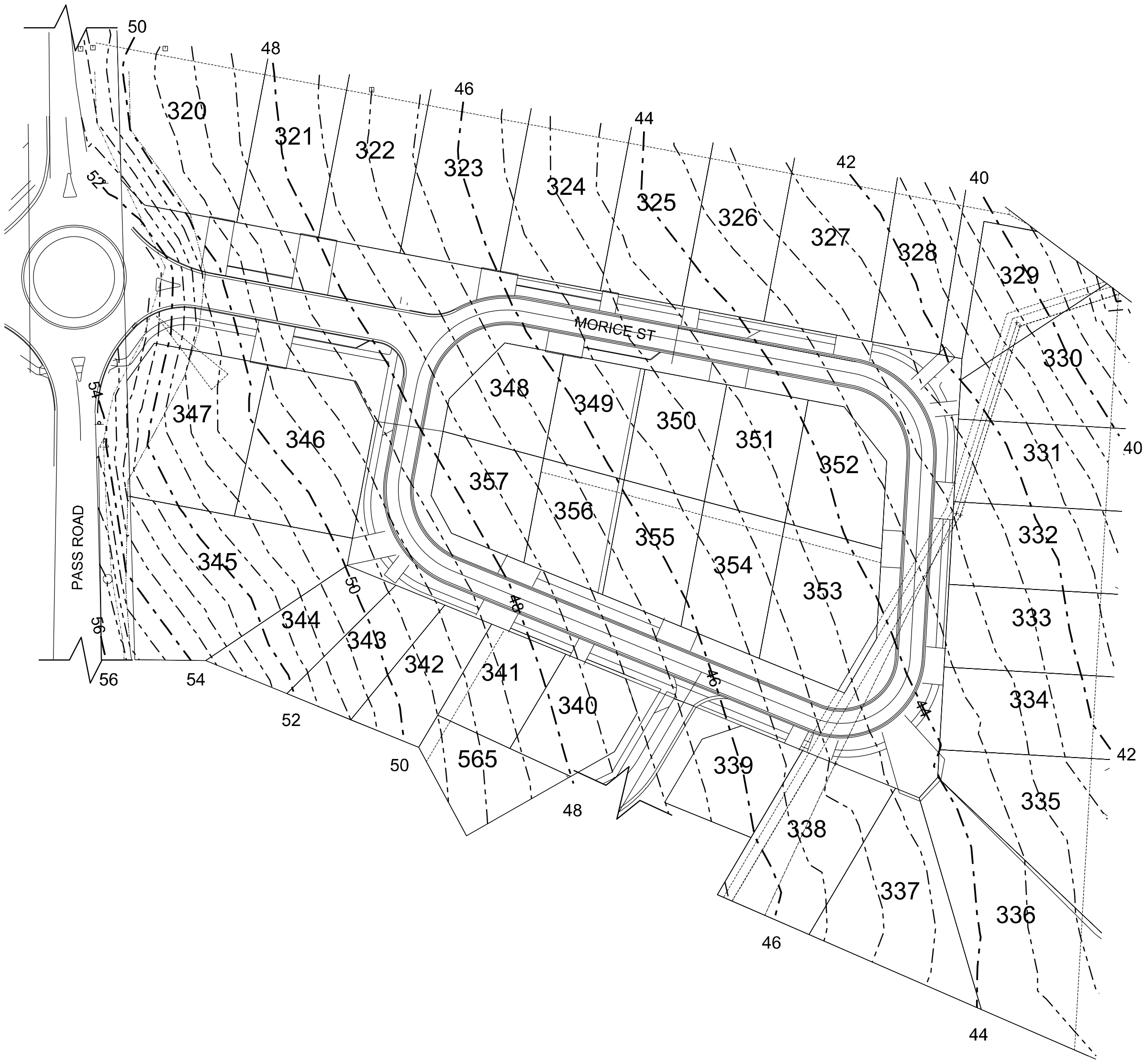
SIZE A4

UG-200

REVISION A

16/12/2015

CAUTION : Printed document is uncontrolled.



LEGEND:

MINOR CONTOUR

MAJOR CONTOUR ##

NOTES:

AS A MINIMUM SURVEYS SHALL INCLUDE:
1. MINOR CONTOURS AT 0.5 METRE INTERVALS.
2. MAJOR CONTOURS AT 2 METRE INTERVALS.
3. IDENTIFICATION OF ROADS.
4. LOT NUMBERS.

ALTERATIONS

TasNetworks

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DRAWN	C5 PRO-SOLUTIONS
CHECKED	G. HALL
APPROVED	DAVID ELLIS
DATE	05/02/2016

TITLE

UNDERGROUND CABLE
TYPICAL SURVEY SAMPLE

SCALES: NTS

SIZE: A4

UG-201

REVISION: A

17/12/2015

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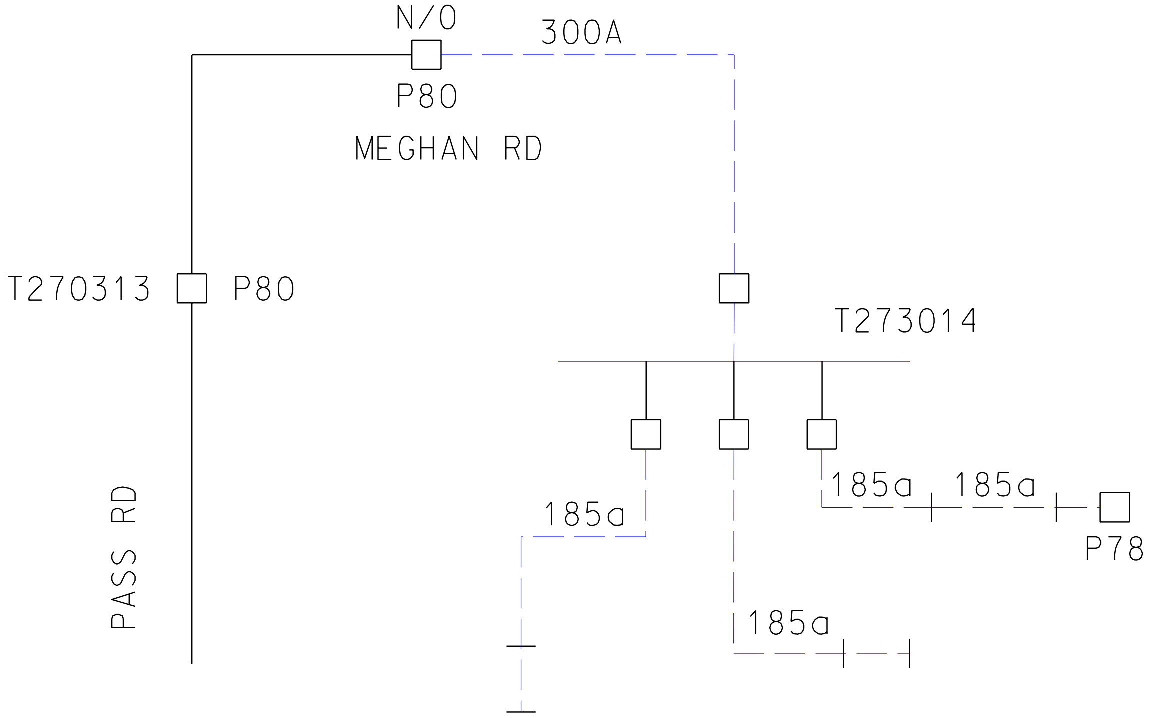

LEGEND:

P#	POLE NUMBER
☐ P#	POLE SWITCH
— —	UNDERGROUND LV
———	OVERHEAD LV
– –|– –	TURRET OR CABINET
	LV BUS & CIRCUIT BREAKER
N/O	NORMALLY OPEN POINT
T#	TRANSFORMER NUMBER

NOTES:

1. CABLE INFORMATION IS DENOTED BY CONDUCTOR SIZE + CONDUCTOR CORE MATERIAL EG 185a

ALTERATIONS

TasNetworks

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ABN: 24 167 357 299

DIMENSIONS ARE IN MILLIMETRES. UNLESS OTHERWISE STATED.

DRAWN	C5 PRO-SOLUTIONS
CHECKED	G. HALL
APPROVED	DAVID ELLIS
DATE	05/02/2016

TITLE: UNDERGROUND CABLE LV SLD

SCALES: NTS

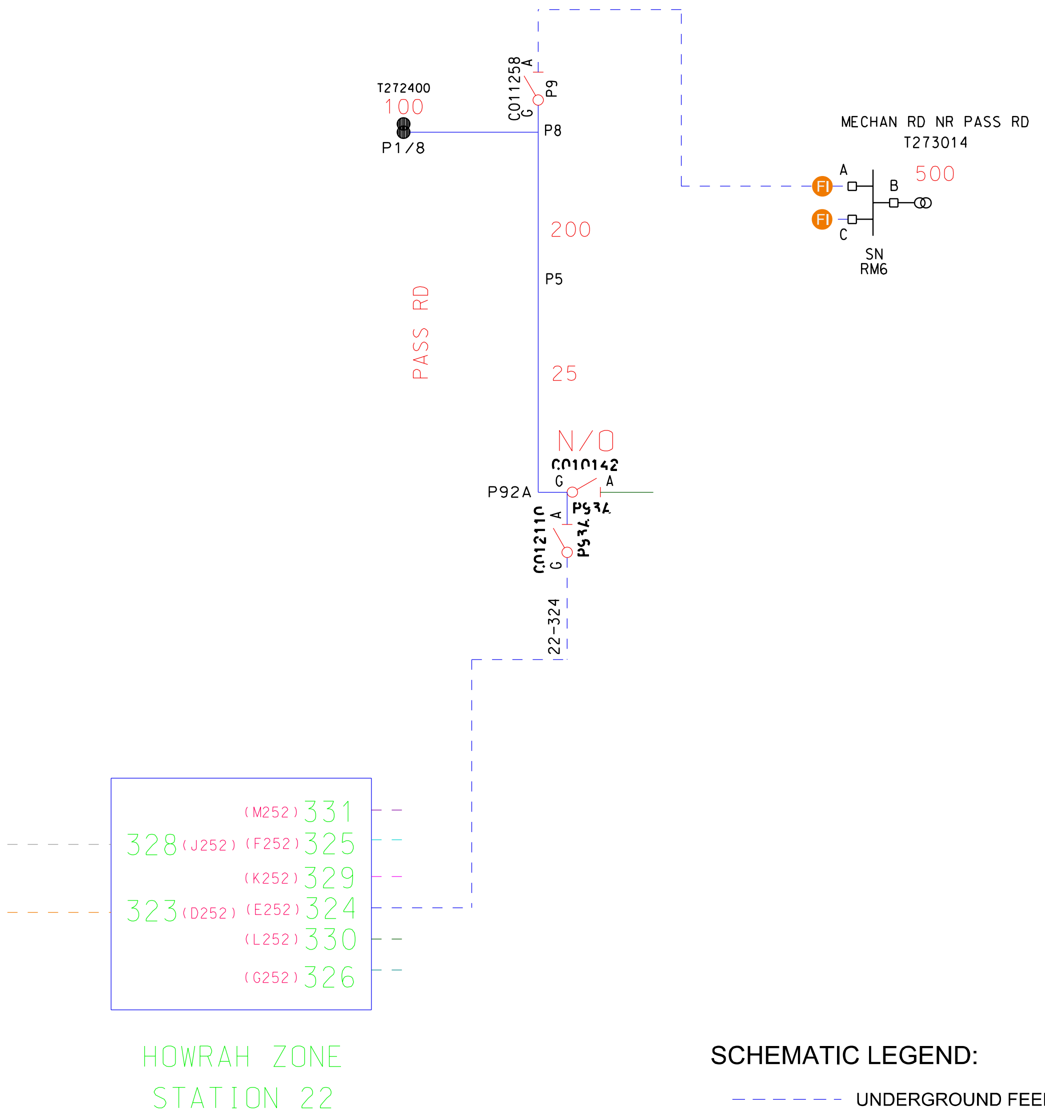
SIZE: A4

UG-202

REVISION: A

17/12/2015

CAUTION : Printed document is uncontrolled.



SCHEMATIC LEGEND:

– – – – – –	UNDERGROUND FEEDER
———	OVERHEAD FEEDER
P#	POLE NUMBER
	SW
C#	SWITCH NUMBER
T#	TRANSFORMER NUMBER
	CIRCUIT BREAKER
	TRANSFORMER SYMBOL
FI	FAULT INDICATOR

NOTES:
1. FEEDERS CONTINUES TO THE DOWN STREAM DISTRIBUTION NETWORK.
2. INTENDED TO BE PRINTED IN COLOUR

ALTERATIONS

TasNetworks

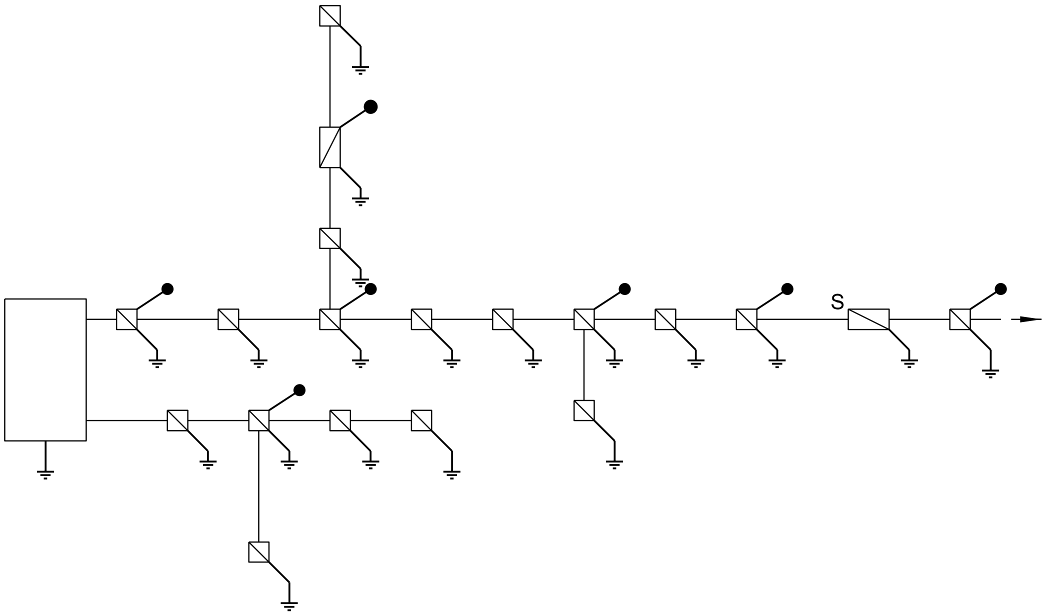
DIMENSIONS ARE IN MILLIMETRES. UNLESS OTHERWISE STATED.

TasNetworks PTY. LTD.
ABN: 24 167 357 299

DRAWN	C5 PRO-SOLUTIONS
CHECKED	G. HALL
APPROVED	DAVID ELLIS
DATE	05/02/2016

TITLE
UNDERGROUND CABLE
HV SLD

SCALES: NTS
SIZE: A4
UG-203
REVISION: A



LEGEND:

S SWITCH

STREET LIGHT

CABINET

TURRET

GROUND TYPE SUBSTATION WITH AS PER DESIGN EARTH

SINGLE ELECTRODE POINT - At Every Cabinet
- At Every Tee - off
- At Every Street Light
- At Every Switch
- At Every Turret or Exception refer note 1.
- At Every End Point

NOTES
1. WHERE A TURRET HAS NO SERVICE OR PUBLIC LIGHTING CONNECTION, AN EARTH ELECTRODE IS NOT REQUIRED

ALTERATIONS

TasNetworks

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ABN: 24 167 357 299

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DRAWN	C5 PRO-SOLUTIONS
CHECKED	G.HALL
APPROVED	DAVID ELLIS
DATE	05/02/2016

TITLE
UNDERGROUND CABLE
LV EARTHING SCHEMATIC

SCALES NTS

SIZE A4

UG-204

REVISION A

02/11/2015

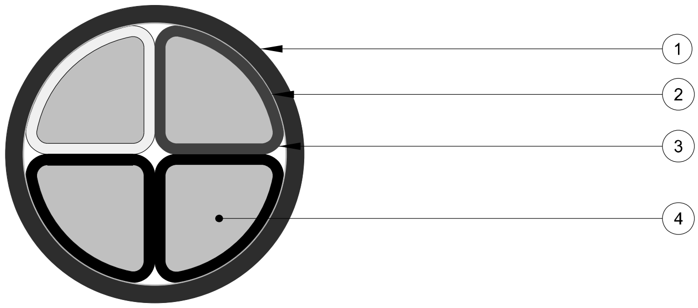
2.6 Design check list

Design component	**TasNetworks relevant Standards Clause**	**Australian Standards/Guide referenced**	**Drawing/Report reference**	**Completed /Actioned** **Yes/No/NA**	**Additional Comments**
New Asset considerations	Ref section 2.2.1				
Cable Selection	Ref section ?, 2.2.5 and 2.4.3				
Cable routes	Ref section 2.2.2, 2.2.5 and 2.4.2				
Location of UG furniture	Ref section 2.4.7				
Electrical Design	Ref section 2.2.5				
Civil Design	Ref section 2.2.6				
Safety in Design sign off	Ref section 2.2.4				
Detailed Electrical Design review/approval	Ref section 2.4				
Detailed Civil Design review/approval	Ref section 2.4.15				
Design options Cost versus Benefit sign off					
Design documentation complete	Ref section 2.5 and section 4.				

3 Underground design drawings

3.1 Low voltage cable

CAUTION : Printed document is uncontrolled.



NOTES:

1. CONDUCTOR C.S.A. - 185mm² NOMINAL
2. CONDUCTOR DC RESISTANCE (MAXIMUM) - 0.164 Ω/km @20°C
3. INSULATION MINIMUM AVERAGE RADIAL (MIN. AVE) - 3.4mm NOMINAL
4. INSULATION MINIMUM AT ANY POINT (MAP) - 1.34mm
5. OUTER SHEATH NOMINAL RADIAL - 2.6mm
6. OUTER SHEATH MINIMUM AT ANY POINT (MAP) - 2.11mm
7. DIAMETER OVER LAY-UP (APPROX.) - 38.5mm
8. OVERALL CABLE DIAMETER (APPROX.) - ø 44mm
9. MAXIMUM PULLING TENSION (PULLING EYE ON CODUCTOR) - 22.2kN
10. MAXIMUM PULLING TENSION (STOCKING GRIP) - 6.78kN
11. MINIMUM BENDING RADIUS:
    - DURING INSTALLATION - 530mm
    - SET IN POSITION - 350mm
12. CABLE WEIGHT PER METRE (APPROX) - 2.85kg/m

PHYSICAL CHARACTERISTICS - 0.6/1kV 4 CORE SOLID SECTOR 185mm²

ITEM No.	DESCRIPTION	DETAILS
1	PVC SHEATH	5V-90 (UV) PVC SHEATH
2	BINDER TAPE	POLYPROPYELENE
3	INSULATION	XLPE
4	CONDUCTOR	SOLID 4-CORE ALUMINIUM SECTOR SHAPE

ALTERATIONS

TasNetworks

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ABN: 24 167 357 299

DIMENSIONS ARE IN MILLIMETRES. UNLESS OTHERWISE STATED.

DRAWN	SMEEKS DRAFTING
CHECKED	G. HALL
APPROVED	DAVID ELLIS
DATE	05/02/2016

TITLE
UNDERGROUND CABLE
1kV LV 4-CORE SOLID SECTION
CABLE DETAILS

SCALES NTS

SIZE A4

UG-319

REVISION A

15/12/2015

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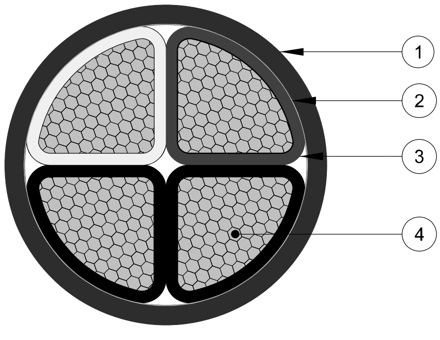

NOTES:

1. CONDUCTOR C.S.A. - 240mm² NOMINAL
2. CONDUCTOR DC RESISTANCE (MAXIMUM) - 0.125 Ω/km @20°C
3. INSULATION MINIMUM AVERAGE RADIAL (MIN. AVE) - 1.7mm NOMINAL
4. INSULATION MINIMUM AT ANY POINT (MAP) - 1.43mm
5. OUTER SHEATH NOMINAL RADIAL - 2.8mm
6. OUTER SHEATH MINIMUM AT ANY POINT (MAP) - 2.28mm
7. DIAMETER OVER LAY-UP (APPROX.) - 50.5mm
8. OVERALL CABLE DIAMETER (APPROX.) - ø 56.4mm
9. MAXIMUM PULLING TENSION (PULLING EYE ON CODUCTOR) - 25.0kN
10. MAXIMUM PULLING TENSION (STOCKING GRIP) - 11.1kN
11. MINIMUM BENDING RADIUS DURING INSTALLATION - 675mm, SET IN POSITION - 450mm
12. CABLE WEIGHT PER METRE (APPROX) - 3.77kg/m

PHYSICAL CHARACTERISTICS - 0.6/1kV 4 CORE SOLID SECTOR 240mm²

ITEM No.	DESCRIPTION	DETAILS
1	PVC SHEATH	5V-90 (UV) PVC SHEATH
2	BINDER TAPE	POLYPROPYELENE
3	INSULATION	XLPE
4	CONDUCTOR	4-CORE STRANDED ALUMINIUM SECTOR SHAPE

NOTES:

1. CONDUCTOR C.S.A. - 300mm² NOMINAL
2. CONDUCTOR DC RESISTANCE (MAXIMUM) - 0.100 Ω/km @20°C
3. INSULATION MINIMUM AVERAGE RADIAL (MIN. AVE) - 1.8mm NOMINAL
4. INSULATION MINIMUM AT ANY POINT (MAP) - 1.52mm
5. OUTER SHEATH NOMINAL RADIAL - 3.0mm
6. OUTER SHEATH MINIMUM AT ANY POINT (MAP) - 2.45mm
7. DIAMETER OVER LAY-UP (APPROX.) - 55.9mm
8. OVERALL CABLE DIAMETER (APPROX.) - ø 62.2mm
9. MAXIMUM PULLING TENSION (PULLING EYE ON CONDUCTOR) - 25.0kN
10. MAXIMUM PULLING TENSION (STOCKING GRIP) - 13.5kN
11. MINIMUM BENDING RADIUS DURING INSTALLATION - 745mm, SET IN POSITION - 500mm
12. CABLE WEIGHT PER METRE (APPROX) - 4.64kg/m

PHYSICAL CHARACTERISTICS - 0.6/1kV 4 CORE SOLID SECTOR 300mm²

ITEM No.	DESCRIPTION	DETAILS
1	PVC SHEATH	5V-90 (UV) PVC SHEATH
2	BINDER TAPE	POLYPROPYELENE
3	INSULATION	XLPE
4	CONDUCTOR	4-CORE STRANDED ALUMINIUM SECTOR SHAPE

NOTES:

1. CONDUCTOR C.S.A. - 400mm² NOMINAL
2. CONDUCTOR DC RESISTANCE (MAXIMUM) - 0.0779 Ω/km @20°C
3. INSULATION MINIMUM AVERAGE RADIAL (MIN. AVE) - 2.0mm NOMINAL
4. INSULATION MINIMUM AT ANY POINT (MAP) - 1.70mm
5. OUTER SHEATH NOMINAL RADIAL - 3.3mm
6. OUTER SHEATH MINIMUM AT ANY POINT (MAP) - 2.71mm
7. DIAMETER OVER LAY-UP (APPROX.) - 64.1mm
8. OVERALL CABLE DIAMETER (APPROX.) - ø 71mm
9. MAXIMUM PULLING TENSION (PULLING EYE ON CONDUCTOR) - 25kN
10. MAXIMUM PULLING TENSION (STOCKING GRIP) - 17.6kN
11. MINIMUM BENDING RADIUS DURING INSTALLATION - 850mm, SET IN POSITION - 570mm
12. CABLE WEIGHT PER METRE (APPROX) - 5.84kg/m

PHYSICAL CHARACTERISTICS - 0.6/1kV 4 CORE SOLID SECTOR 400mm²

ITEM No.	DESCRIPTION	DETAILS
1	PVC SHEATH	5V-90 (UV) PVC SHEATH
2	BINDER TAPE	POLYPROPYELENE
3	INSULATION	XLPE
4	CONDUCTOR	4-CORE STRANDED ALUMINIUM SECTOR SHAPE

ALTERATIONS

TasNetworks

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ABN: 24 167 357 299

DIMENSIONS ARE IN MILLIMETRES. UNLESS OTHERWISE STATED.

DRAWN	SMEEKS DRAFTING
CHECKED	G. HALL
APPROVED	DAVID ELLIS
DATE	05/02/2016

TITLE

UNDERGROUND CABLE
1kV LV 4-CORE STRANDED
CABLE DETAILS

SCALES NTS

SIZE A4

UG-323

REVISION A

04/12/2015

3.2 Low voltage furniture

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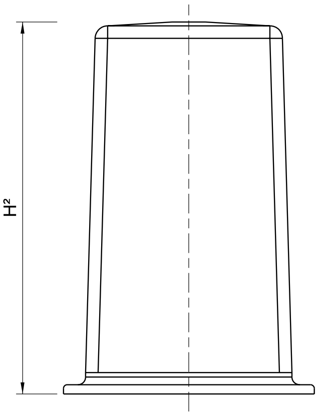
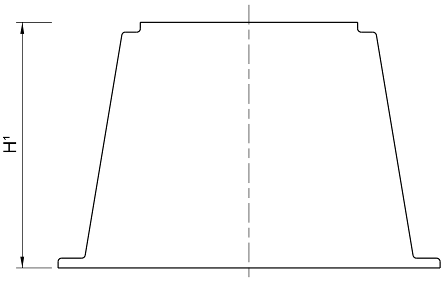
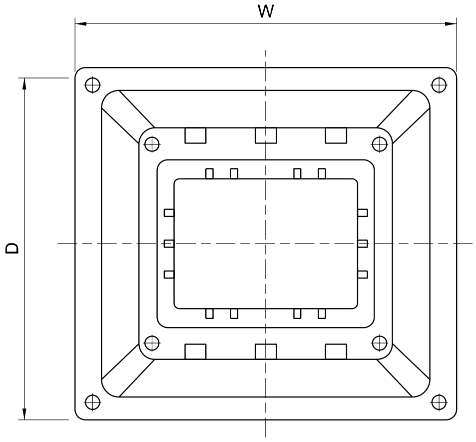


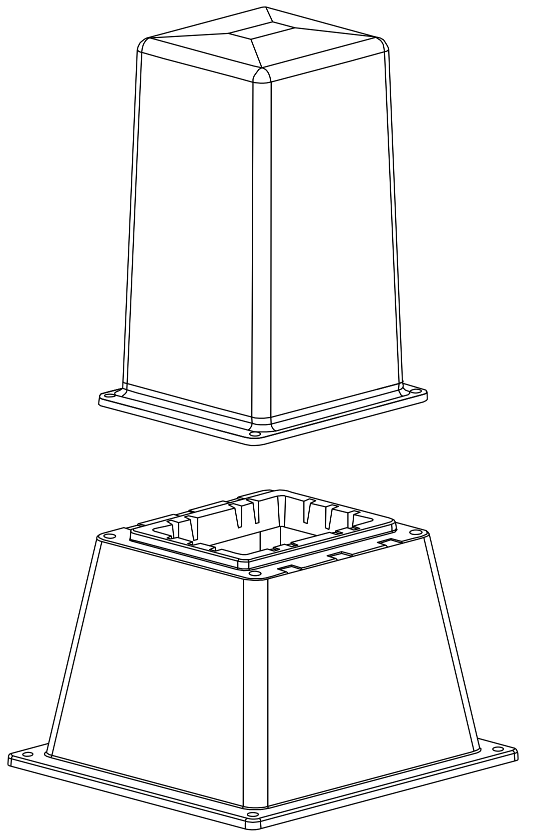
SIDE VIEW
TURRET TOP
1:10



SIDE VIEW
TURRET BASE
1:10



TOP VIEW
TURRET BASE
1:10



ISOMETRIC VIEW
1:10

	DIMENSIONS			
SIZE	W	D	H¹	H²
STANDARD	543	503	350	530
X LARGE	550	550	359	650

ALTERATIONS

TasNetworks

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ABN: 24 167 357 299

DIMENSIONS ARE IN MILLIMETRES. UNLESS OTHERWISE STATED.

DRAWN	C5 PRO-SOLUTIONS
CHECKED	G. HALL
APPROVED	DAVID ELLIS
DATE	05/02/2016

TITLE
UNDERGROUND FURNITURE
TURRET
DETAIL

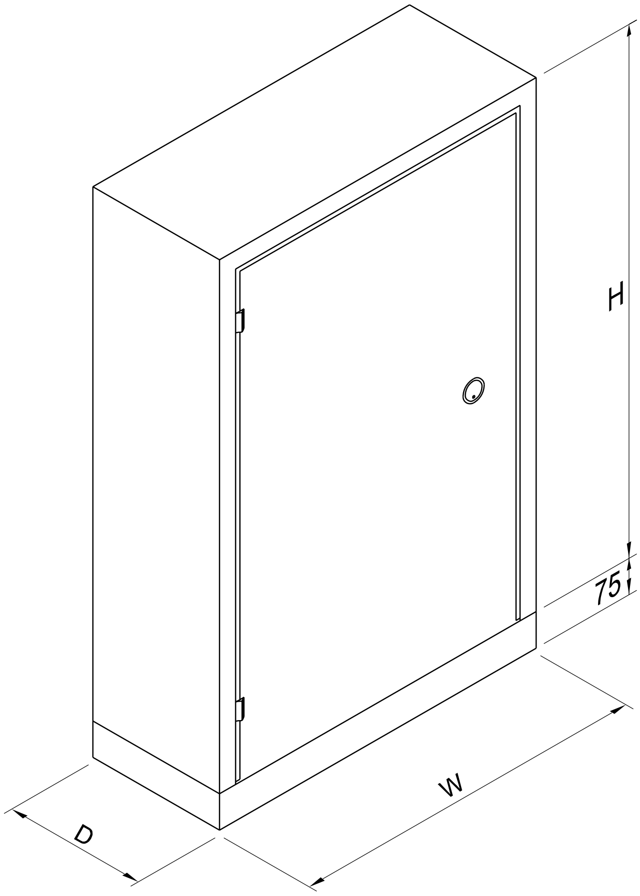
SCALES 1:10

SIZE A4

UG-324

REVISION A

16/12/2015



	DIMENSIONS		
SIZE	H	W	D
200 AMP	700	500	250
400 AMP	1000	500	250
XLGE 400 AMP	1100	750	300

NOTES:
1. CABINETS SHALL BE INSTALLED WITH THE DOOR FACING THE ROAD/FOOTPATH.
2. CABINETS SHALL BE INSTALLED IN LOCATIONS THAT PROVIDE UNRESTRICTED ACCESS.

ALTERATIONS

TasNetworks

TasNetworks PTY. LTD.
ABN: 24 167 357 299

DIMENSIONS ARE IN MILLIMETRES. UNLESS OTHERWISE STATED.

DRAWN	C5 PRO-SOLUTIONS	TITLE: UNDERGROUND FURNITURE CABINET DIMENSIONS	SCALES: 1:15
CHECKED	G.HALL		SIZE: A4
APPROVED	DAVID ELLIS	UG-328	REVISION: A
DATE	05/02/2016		

17/12/2015

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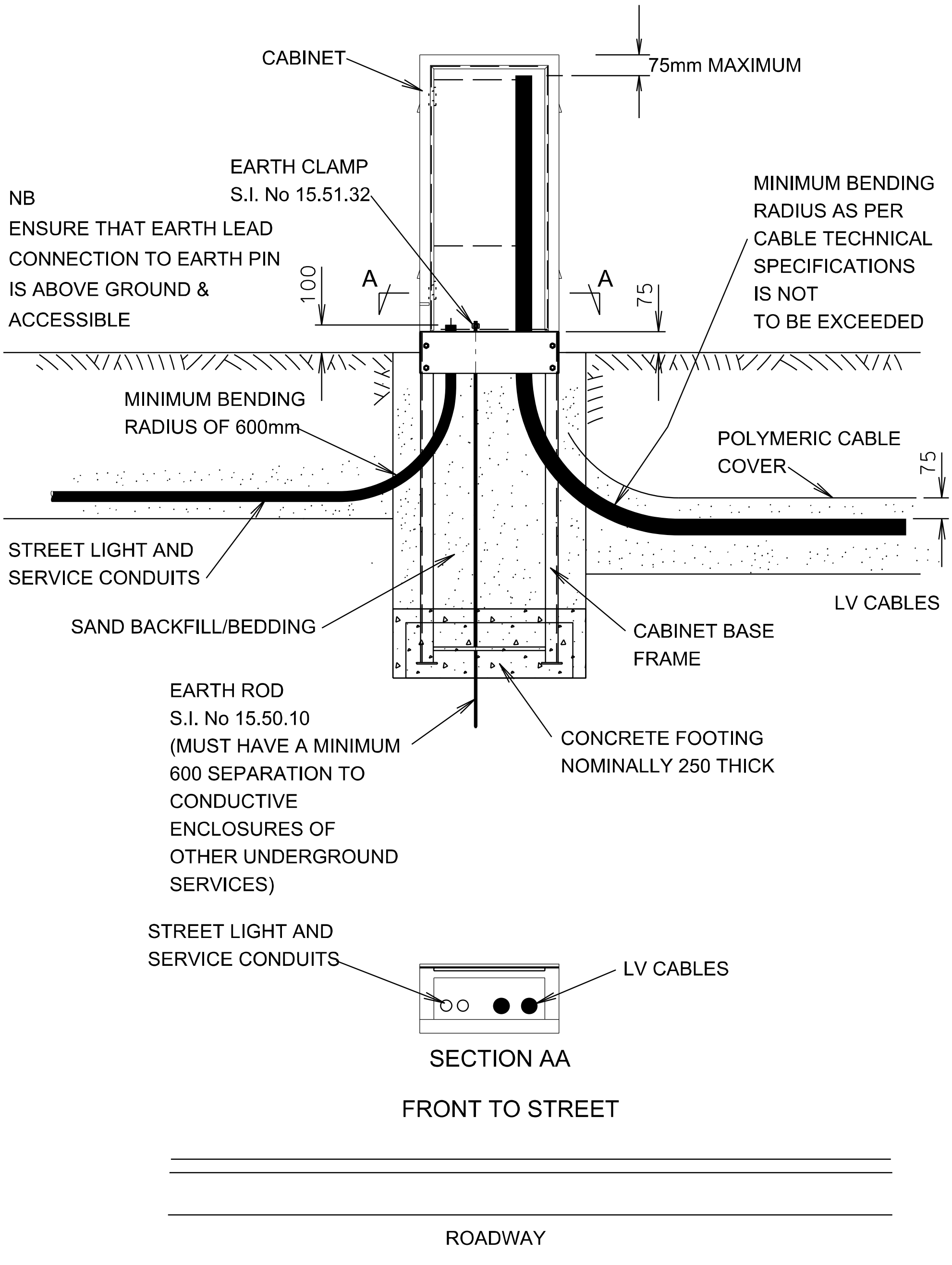

NOTES

1. SEE UG-619 & UG-627 FOR TERMINATION ARRANGEMENT AND UG-628 & UG-629 FOR EXAMPLE CABINET ARRANGEMENTS.

REFERENCES
SERVICE CABINET MOUNTING FRAME DETAILS - UG-601
SERVICE CABINET STEELWORK DETAILS - UG-602
SERVICE CABINET TERMINATION & EXAMPLE ARRANGEMENT - UG-619, UG-627, UG-628 & UG-629

ALTERATIONS

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ABN: 24 167 357 299

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DRAWN	C5 PRO-SOLUTIONS	TITLE: UNDERGROUND FURNITURE CABINET CABLE AND CONDUIT ENTRY POSITIONS	SCALES: NTS
CHECKED	J. GOODGER		SIZE: A4
APPROVED	ANGUS KETLEY	UG-620	REVISION: A
DATE	10/02/2016		

04/11/2015

3.3 High voltage cable

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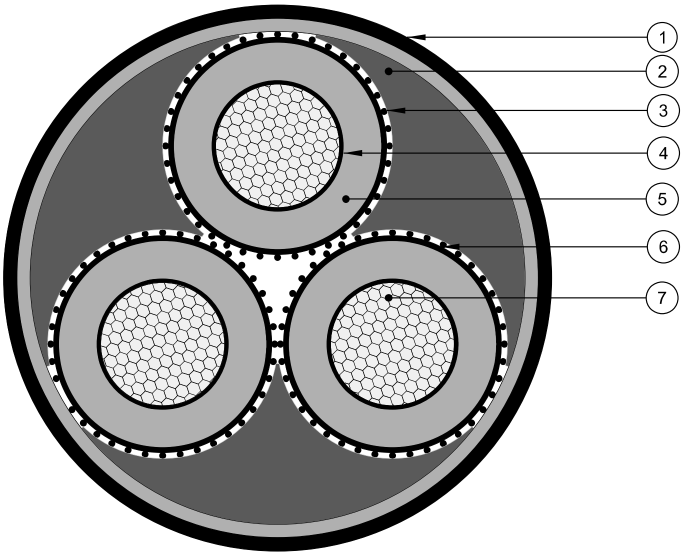

NOTES:
1. CONDUCTOR DIAMETER - ø 16mm NOMINAL
2. INSULATION THICKNESS - 3.4mm NOMINAL
3. DIAMATER OVER INSULATION - ø 24mm NOMINAL
4. OVERALL CABLE DIAMETER - ø 65.7mm NOMINAL
5. CABLE MASS (APPROX.) - 4140kg/km
6. MINIMUM BENDING RADIUS:
   - DURING INSTALLATION - 1640mm
   - INSTALLED - 985mm
6. MAX. PULLING TENSION:
   - STOCKING - 15.1kN
   - CONDUCTOR - 25kN

PHYSICAL CHARACTERISTICS - 6.35/11 (12)kV 3 CORE 185mm²

ITEM No.	DESCRIPTION	DETAILS
1	PVC SHEATH	5V 90 PVC SHEATH
2	FILLERS	POLYPROPYLENE FILL AND TAPE
3	COPPER WIRE SCREEN	40/0.85mm HEAVY DUTY PLAIN ANNEALED COPPER WIRE SCREEN
4	SEMI-CONDUCTIVE INSULATION SCREEN	XLPE
5	INSULATION	TREE-RETARDANT XLPE INSULATED
6	SEMI-CONDUCTIVE CONDUCTOR SCREEN	XLPE
7	STRANDED CONDUCTOR	Ø16mm COMPACTED ALUMINIUM

NOTES:
1. CONDUCTOR DIAMETER - ø 16mm NOMINAL
2. INSULATION THICKNESS - 5.5mm NOMINAL
3. DIAMATER OVER INSULATION - ø 28.2mm NOMINAL
4. OVERALL CABLE DIAMETER - ø 75.1mm NOMINAL
5. CABLE MASS (APPROX.) - 4960kg/km
6. MINIMUM BENDING RADIUS:
   - DURING INSTALLATION - 1180mm
   - INSTALLED - 1130mm
6. MAX. PULLING TENSION:
   - STOCKING - 19.7kN
   - CONDUCTOR - 25kN

PHYSICAL CHARACTERISTICS - 6.35/11 (12)kV 3 CORE 240mm²

ITEM No.	DESCRIPTION	DETAILS
1	PVC SHEATH	5V 90 PVC SHEATH
2	FILLERS	POLYPROPYLENE FILL AND TAPE
3	COPPER WIRE SCREEN	40/0.85mm HEAVY DUTY PLAIN ANNEALED COPPER WIRE SCREEN
4	SEMI-CONDUCTIVE INSULATION SCREEN	XLPE
5	INSULATION	TREE-RETARDANT XLPE INSULATED
6	SEMI-CONDUCTIVE CONDUCTOR SCREEN	XLPE
7	STRANDED CONDUCTOR	Ø16mm COMPACTED ALUMINIUM

ALTERATIONS

TasNetworks

TasNetworks PTY. LTD.
ABN: 24 167 357 299

DIMENSIONS ARE IN MILLIMETRES. UNLESS OTHERWISE STATED.

DRAWN	SMEEKS DRAFTING
CHECKED	G. HALL
APPROVED	DAVID ELLIS
DATE	05/02/2016

TITLE
UNDERGROUND CABLE
11kV HV CABLE DETAILS

SCALES NTS
SIZE A4
UG-309
REVISION A

04/12/2015

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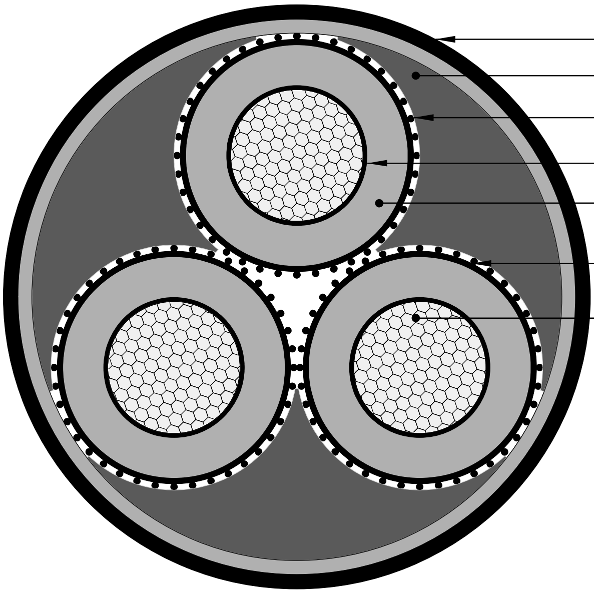

NOTES - 12.7/22 (24kV) 3 CORE 185mm² CABLE:
1. CONDUCTOR DIAMETER - ø 16mm NOMINAL
2. INSULATION THICKNESS - 5.5mm NOMINAL
3. DIAMATER OVER INSULATION - ø 28.2mm NOMINAL
4. OVERALL CABLE DIAMETER - ø 75.1mm NOMINAL
5. CABLE MASS (APPROX.) - 4960kg/km
6. MINIMUM BENDING RADIUS:
   - DURING INSTALLATION - 1180mm
   - INSTALLED - 1130mm
6. MAX. PULLING TENSION:
   - STOCKING - 19.7kN
   - CONDUCTOR - 25kN

PHYSICAL CHARACTERISTICS - 12.7/22 (24kV) 3 CORE 185mm² CABLE

ITEM No.	DESCRIPTION	DETAILS
1	PVC SHEATH	5V 90 PVC SHEATH
2	FILLERS	POLYPROPYLENE FILL AND TAPE
3	COPPER WIRE SCREEN	40/0.85mm HEAVY DUTY PLAIN ANNEALED COPPER WIRE SCREEN
4	SEMI-CONDUCTIVE INSULATION SCREEN	XLPE
5	INSULATION	TREE-RETARDANT XLPE INSULATED
6	SEMI-CONDUCTIVE CONDUCTOR SCREEN	XLPE
7	STRANDED CONDUCTOR	Ø16mm COMPACTED ALUMINIUM

NOTES - 12.7/22 (24kV) 3 CORE 240mm² CABLE:
1. CONDUCTOR DIAMETER - ø 18.1mm NOMINAL
2. INSULATION THICKNESS - 5.5mm NOMINAL
3. DIAMATER OVER INSULATION - ø 30.3mm NOMINAL
4. OVERALL CABLE DIAMETER - ø 80.2mm NOMINAL
5. CABLE MASS (APPROX.) - 5740kg/km
6. MINIMUM BENDING RADIUS:
   - DURING INSTALLATION - 2000mm
   - INSTALLED - 1200mm
6. MAX. PULLING TENSION:
   - STOCKING - 22.5kN
   - CONDUCTOR - 25kN

PHYSICAL CHARACTERISTICS - 12.7/22 (24kV) 3 CORE 240mm² CABLE

ITEM No.	DESCRIPTION	DETAILS
1	PVC SHEATH	5V 90 PVC SHEATH
2	FILLERS	POLYPROPYLENE FILL AND TAPE
3	COPPER WIRE SCREEN	40/0.85mm HEAVY DUTY PLAIN ANNEALED COPPER WIRE SCREEN
4	SEMI-CONDUCTIVE INSULATION SCREEN	XLPE
5	INSULATION	TREE-RETARDANT XLPE INSULATED
6	SEMI-CONDUCTIVE CONDUCTOR SCREEN	XLPE
7	STRANDED CONDUCTOR	Ø18.1mm COMPACTED ALUMINIUM

ALTERATIONS

TasNetworks

TasNetworks PTY. LTD.
ABN: 24 167 357 299

DIMENSIONS ARE IN MILLIMETRES. UNLESS OTHERWISE STATED.

DRAWN	SMEEKS DRAFTING
CHECKED	G. HALL
APPROVED	DAVID ELLIS
DATE	05/02/2016

TITLE
UNDERGROUND CABLE
22kV HV CABLE DETAILS

SCALES NTS

SIZE A4

UG-301

REVISION A

05/12/2015

3.4 High voltage termination arrangements

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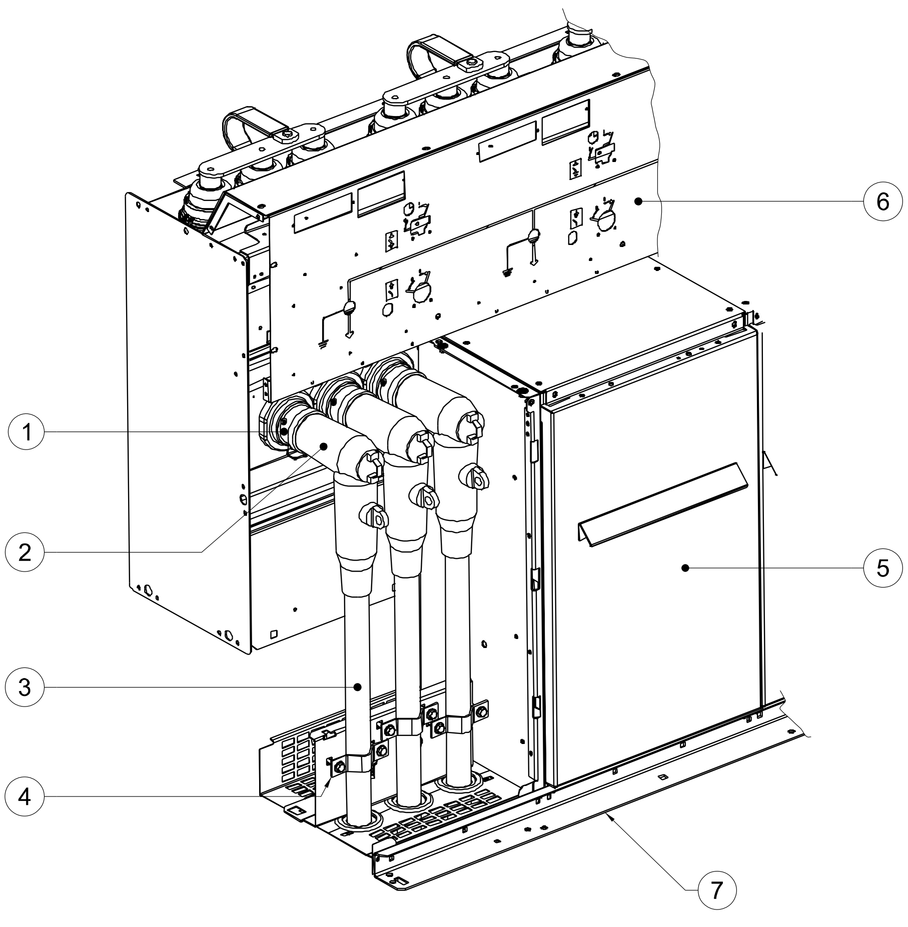


ITEM	DESCRIPTION
1	HV BUSHING
2	HV CABLE ELBOW CONNECTOR
3	HV CABLE
4	CABLE CLAMPS
5	HV SWITCHGEAR CABLE ENCLOSURE
6	HV SWITCHGEAR CONTROL PANEL
7	HV SWITCHGEAR SUPPORT STRUCTURE

NOTES

1. CABLE CLAMPS SHALL BE SUITABLE FOR CABLE SIZE.

2. CABLE CLAMPS SHALL BE FITTED IN ACCORDANCE WITH MANUFACTURERS INSTRUCTIONS.

3. HV CABLE ENCLOSURE REMOVED IN THIS DRAWING TO SHOW CABLE TERMINATIONS.

ALTERATIONS

TasNetworks

TasNetworks PTY. LTD.

ABN: 24 167 357 299

DIMENSIONS ARE IN MILLIMETRES. UNLESS OTHERWISE STATED.

DRAWN	C5 PRO-SOLUTIONS
CHECKED	J. HUGHES
APPROVED	ANGUS KETLEY
DATE	10/02/2016

TITLE

UNDERGROUND CABLE
HV SCHNEIDER SW CABLE TERMINATION

SCALES NTS

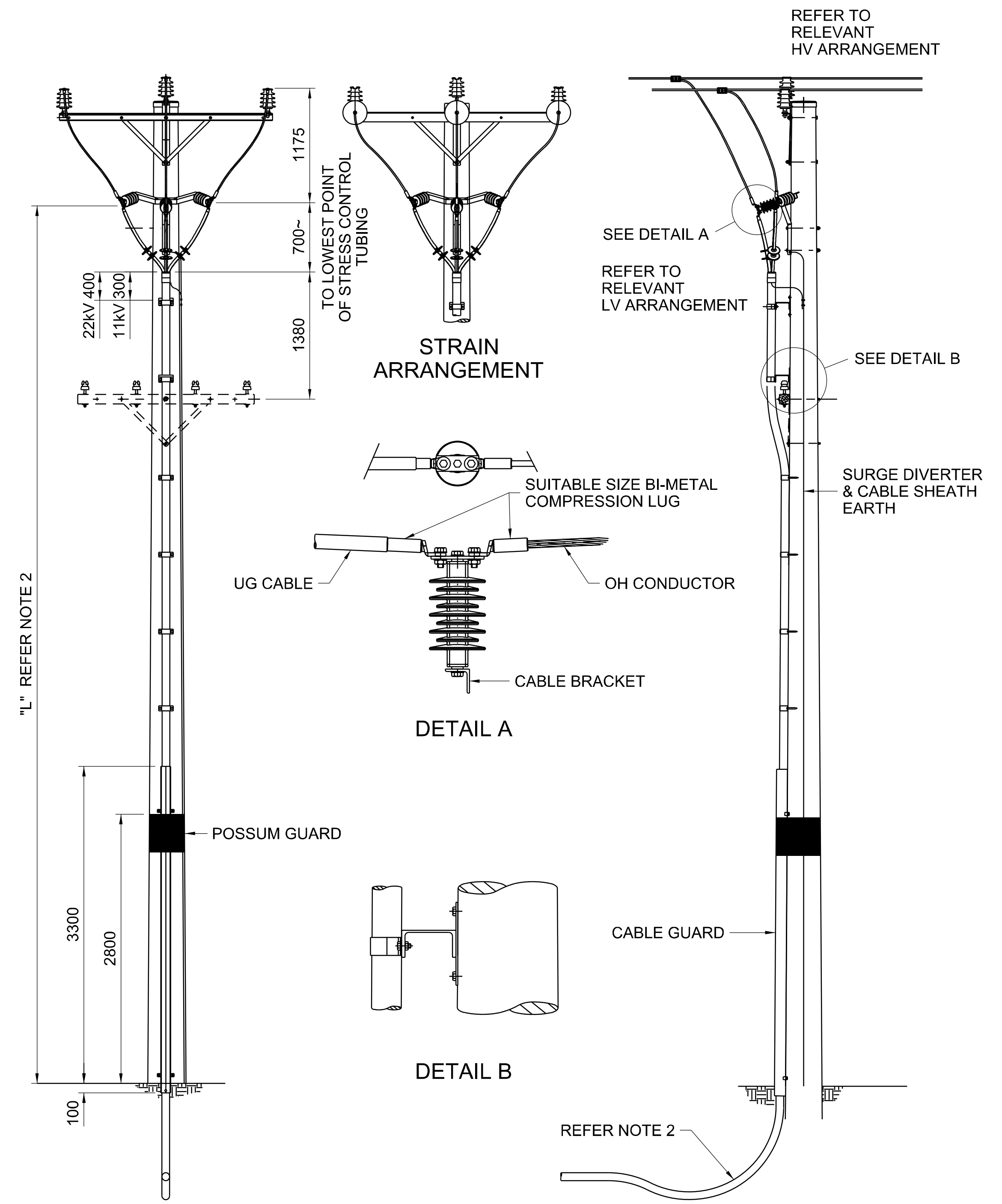
SIZE A4

UG-334

REVISION A

24/11/2015

CAUTION : Printed document is uncontrolled.

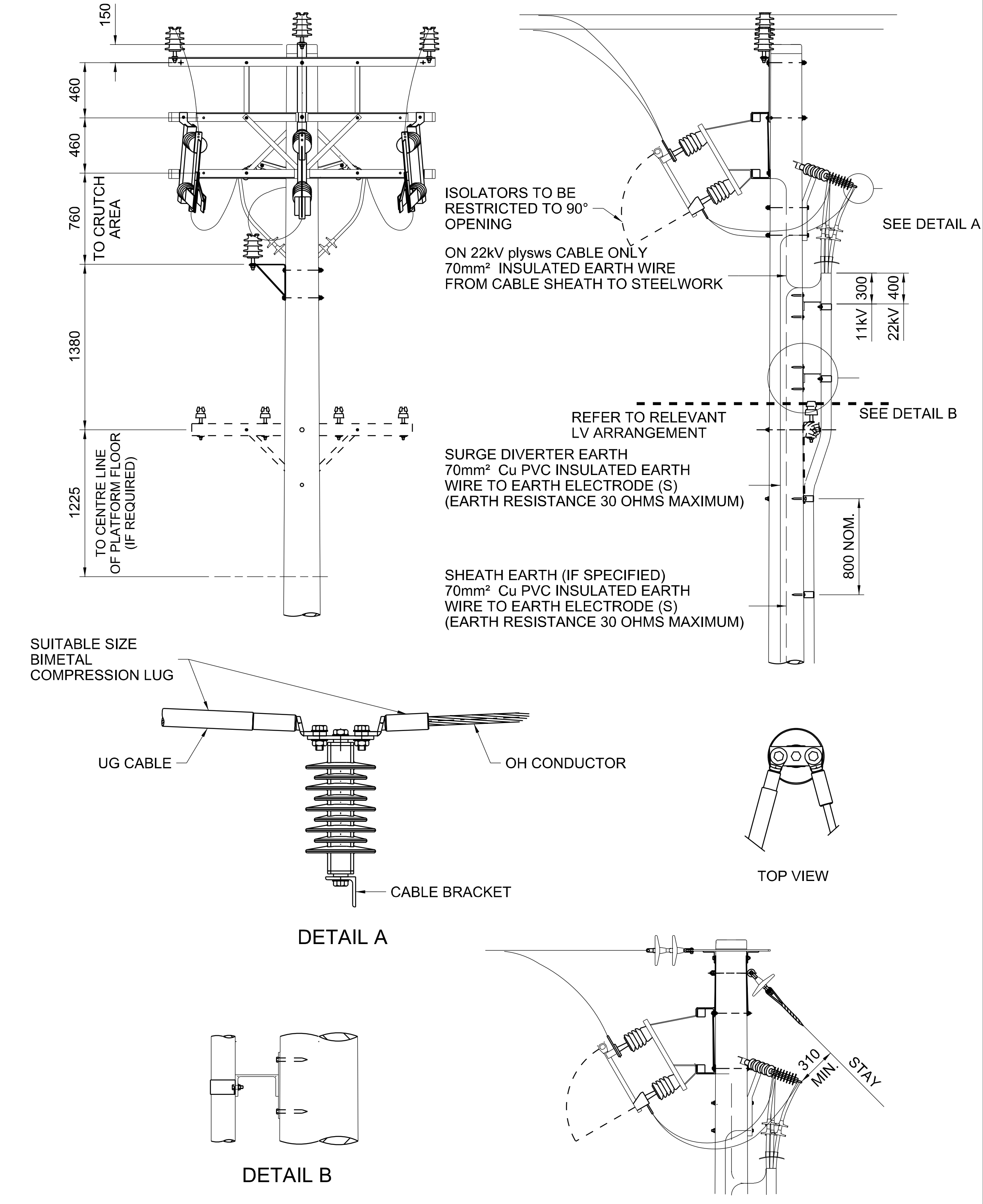


NOTES
1. FOR DETAILS REFER OVERHEAD DESIGN STANDARD D-OH1.
2. HEIGHT "L" WILL VARY. CABLE LENGTH TO ALLOW FOR LENGTH "L" INCLUDING LENGTH REQUIRED FOR TERMINATION, AND ANY ADDITIONAL LENGTH IMPOSED BY COMPLYING WITH MIN. BEND RADIUS REQUIREMENTS.

ALTERATIONS	TasNetworks	TasNetworks PTY. LTD. ABN: 24 167 357 299	
	DIMENSIONS ARE IN MILLIMETRES. UNLESS OTHERWISE STATED.	TITLE: UNDERGROUND CABLE UGO POLE INTERMEDIATE/STRAIN 11 kV or 22 kV	SCALES: NTS
	DRAWN: C5 PRO-SOLUTIONS		SIZE: A4
	CHECKED: G.HALL		
	APPROVED: DAVID ELLIS	UG-339	REVISION: A
	DATE: 05/02/2016		

4/12/2015

CAUTION : Printed document is uncontrolled.



NOTE
1. FOR DETAILS REFER OVERHEAD DESIGN STANDARD D-OH1.

ALTERATIONS	TasNetworks	TasNetworks PTY. LTD. ABN: 24 167 357 299	
	DIMENSIONS ARE IN MILLIMETRES. UNLESS OTHERWISE STATED.	TITLE: UNDERGROUND CABLE UGO POLE RAYCHEM TERMINATION 11 kV OR 22 kV	SCALES: NTS
	DRAWN: C5 PRO-SOLUTIONS		
	CHECKED: G.HALL		SIZE: A4
	APPROVED: DAVID ELLIS	UG-340	REVISION: A
	DATE: 05/02/2016		

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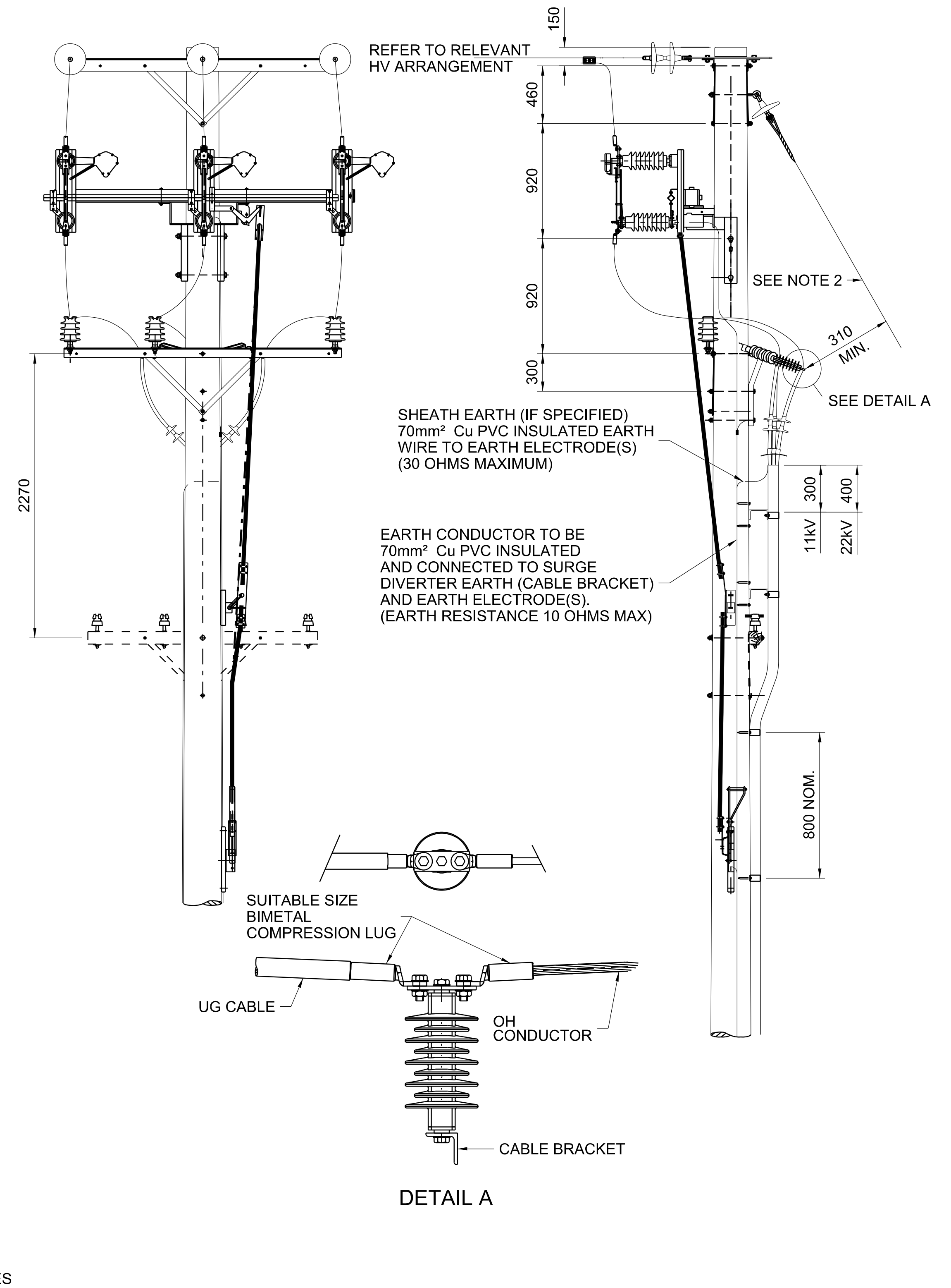
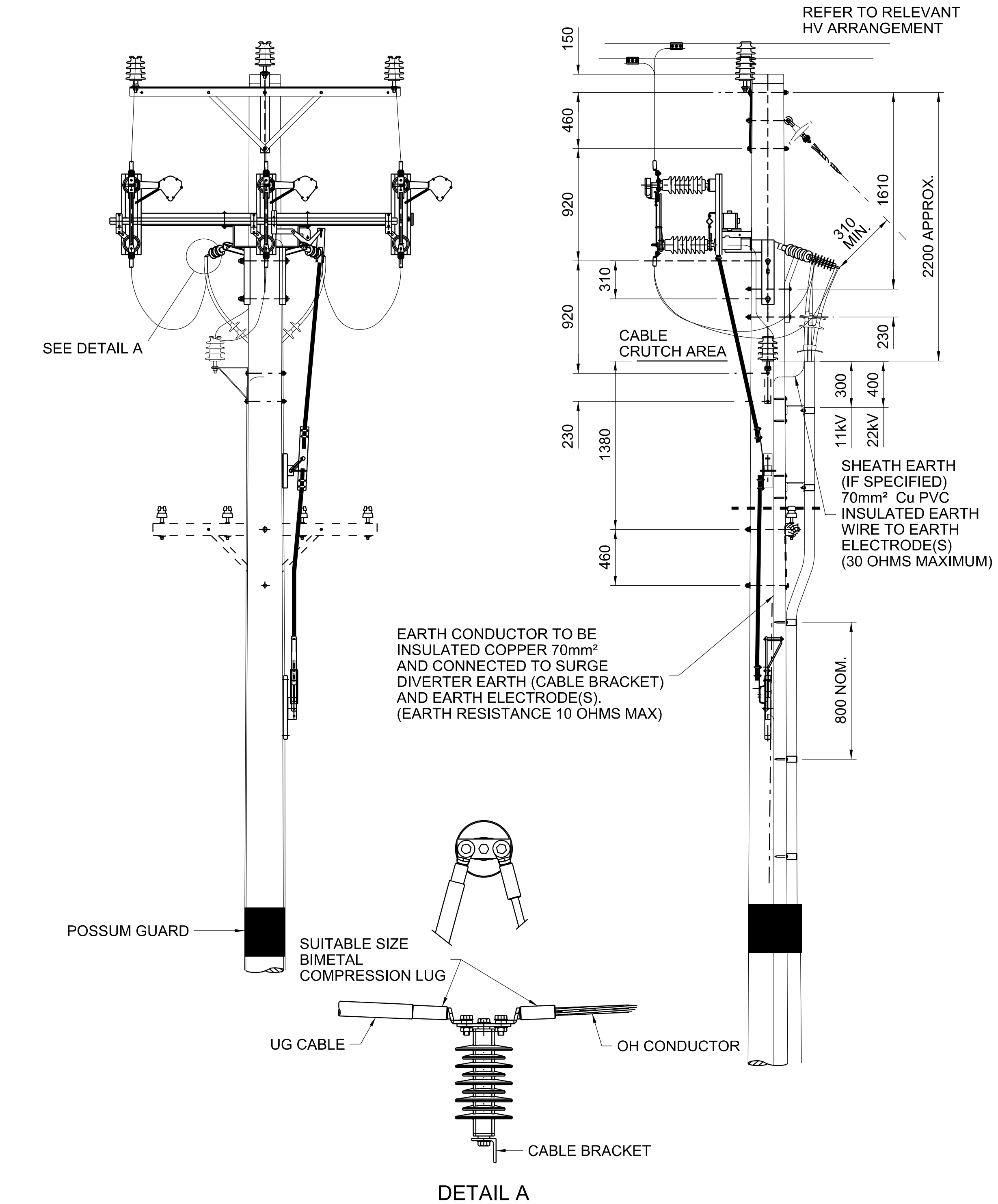


NOTES

1. FOR DETAILS REFER OVERHEAD DESIGN STANDARD D-OH1.

ALTERATIONS	TasNetworks	TasNetworks PTY. LTD. ABN: 24 167 357 299	
	DIMENSIONS ARE IN MILLIMETRES. UNLESS OTHERWISE STATED.	TITLE: UNDERGROUND CABLE UGO POLE RAYCHEM TERMINATION 11 kV OR 22 kV VERT ABS - ABB	SCALES: NTS
	DRAWN: C5 PRO-SOLUTIONS		SIZE: A4
	CHECKED: G.HALL		
	APPROVED: DAVID ELLIS	UG-341	REVISION: A
	DATE: 05/02/2016		

CAUTION : Printed document is uncontrolled.



DETAIL A

NOTES
1.FOR DETAILS REFER OVERHEAD DESIGN STANDARD D-OH1.

ALTERATIONS		
TasNetworks PTY. LTD. ABN: 24 167 357 299		
DIMENSIONS ARE IN MILLIMETRES. UNLESS OTHERWISE STATED.	TITLE: UNDERGROUND CABLE UGO POLE RAYCHEM TERMINATION 11 kV OR 22 kV MK5 CROSSARM - VER ABS - ABB	SCALES: NTS
DRAWN: C5 PRO-SOLUTIONS		
CHECKED: G.HALL		SIZE: A4
APPROVED: DAVID ELLIS	UG - 342	REVISION: A
DATE: 05/02/2016		

4/12/2015

4 Drawing Standards

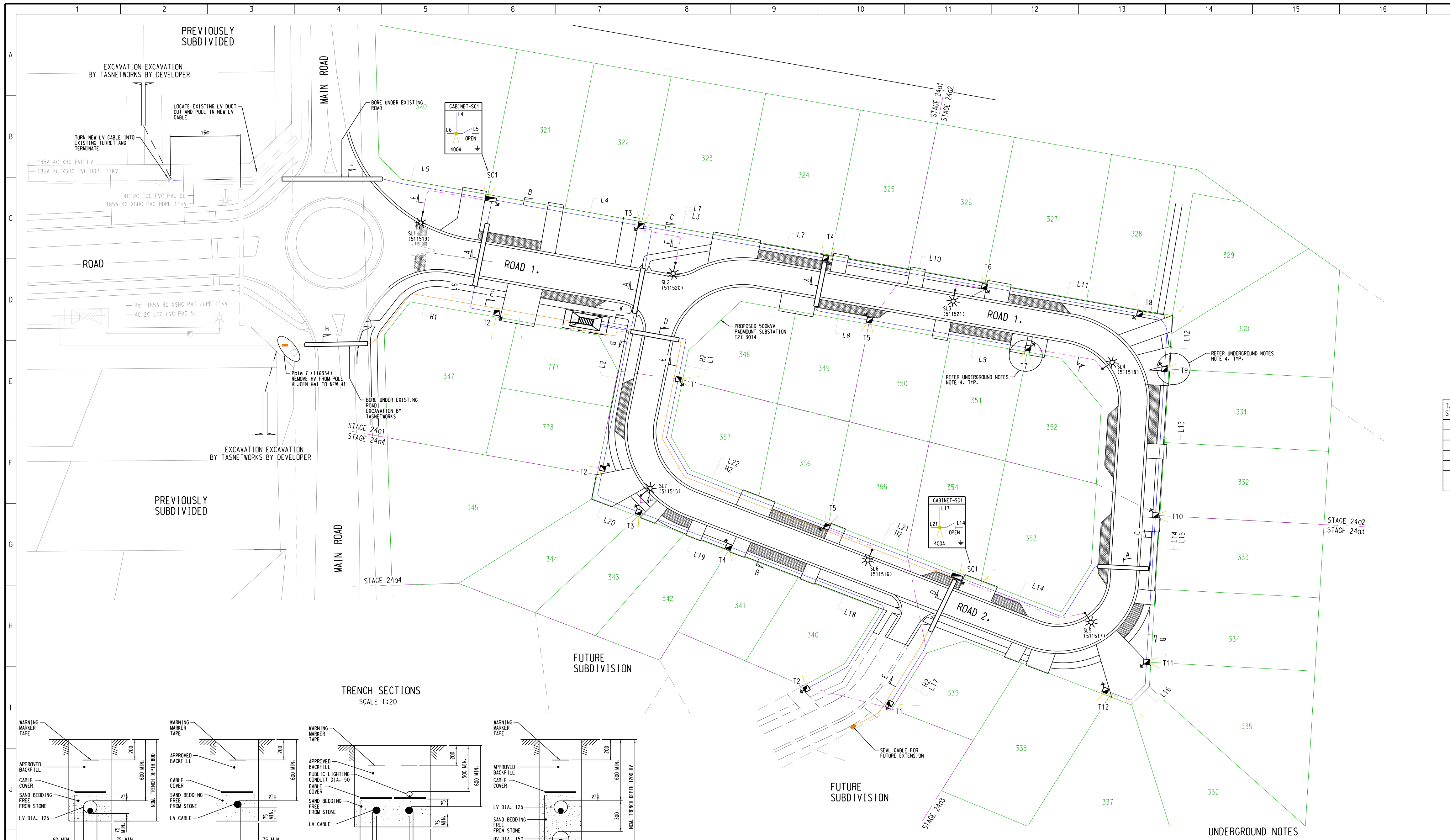
The designer shall ensure all design drawings reflect the format requirements outlined in TasNetworks' Design Drafting Standard. In addition the designer shall ensure the content and the number (including titles) of drawings reflect the minimum level of detail summarised below:

- Underground System plan drawing to include:
  - development staging (if applicable)
  - location of roads and footpaths
  - lot boundaries
  - lot drive ways
  - location for new and existing assets with offsets to existing infrastructure e.g. roads, fences, buildings, etc
  - specific site contours
  - easement locations
  - cable routes with easement locations
- Cable drawings
  - HV and LV cable single line diagram
  - Cable type (schedule list). The cable schedule shall be itemised for each cable run
  - Cable legend
  - cable detailed trenching arrangement
  - cable joint locations (with GPS locations)
  - existing underground services e.g. gas, water and telecommunications
  - underground furniture including GPS locations e.g. turret location/type, cabinet location/type, public lighting location/type)
  - Underground furniture such as public lighting, turrets and cabinets shall detail offsets to the surrounding new or existing infrastructure (ie roads, fences, building, etc).
- Critical Design Information drawings to include :
  - full list of drawings referenced in the cable drawings

A underground residential design sample has been provided in Appendix A –URD sample design

Appendix A –URD sample design

CAUTION : Printed document is uncontrolled.



CABLE SCHEDULE

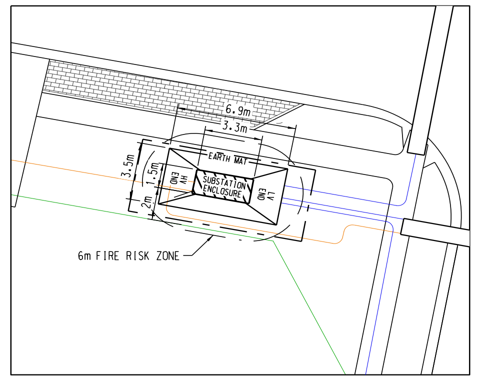
CABLE	95mmSQ	185mmSQ	240mmSQ	300mmSQ	400mmSQ	CABLE TYPE
L1				30m		a 4/c x pvc LV
L2				65m		a 4/c x pvc LV
L3				35m		a 4/c x pvc LV
L4				40m		a 4/c x pvc LV
L5				80m		a 4/c x pvc LV
L6		35m				sa 4/c x pvc LV
L7				45m		a 4/c x pvc LV
L8		30m				sa 4/c x pvc LV
L9		40m				sa 4/c x pvc LV
L10				40m		a 4/c x pvc LV
L11				40m		a 4/c x pvc LV
L12				25m		a 4/c x pvc LV
L13				40m		a 4/c x pvc LV
L14				70m		sa 4/c x pvc LV
L15		40m				a 4/c x pvc LV
L16		20m				a 4/c x pvc LV
L17				40m		a 4/c x pvc LV
L18				70m		a 4/c x pvc LV
L19				25m		sa 4/c x pvc LV
L20				20m		a 4/c x pvc LV
L21				35m		a 4/c x pvc LV
L22				65m		a 4/c x pvc LV
TOTAL		165m		765m		a / sa 4/c x pvc LV

CABLE	95mmSQ	185mmSQ	240mmSQ	300mmSQ	400mmSQ	CABLE TYPE
H1		110m				a 3/c xshc pvc hdpe 11 kV
H2		150m				a 3/c xshc pvc hdpe 11 kV
TOTAL		260m				a 3/c xshc pvc HDPE 11 kV

PUBLIC LIGHTING CONDUITS	84m	50mm Dia. H.D. ORANGE ELECTRICAL
PUBLIC LIGHTING CABLES	120m	10sq-mm 2-c + 4sq-mm E ORANGE CIRCULAR
SERVICES CONDUITS	BY LICENSED ELECTRICIAN	50mm Dia. H.D. ORANGE ELECTRICAL

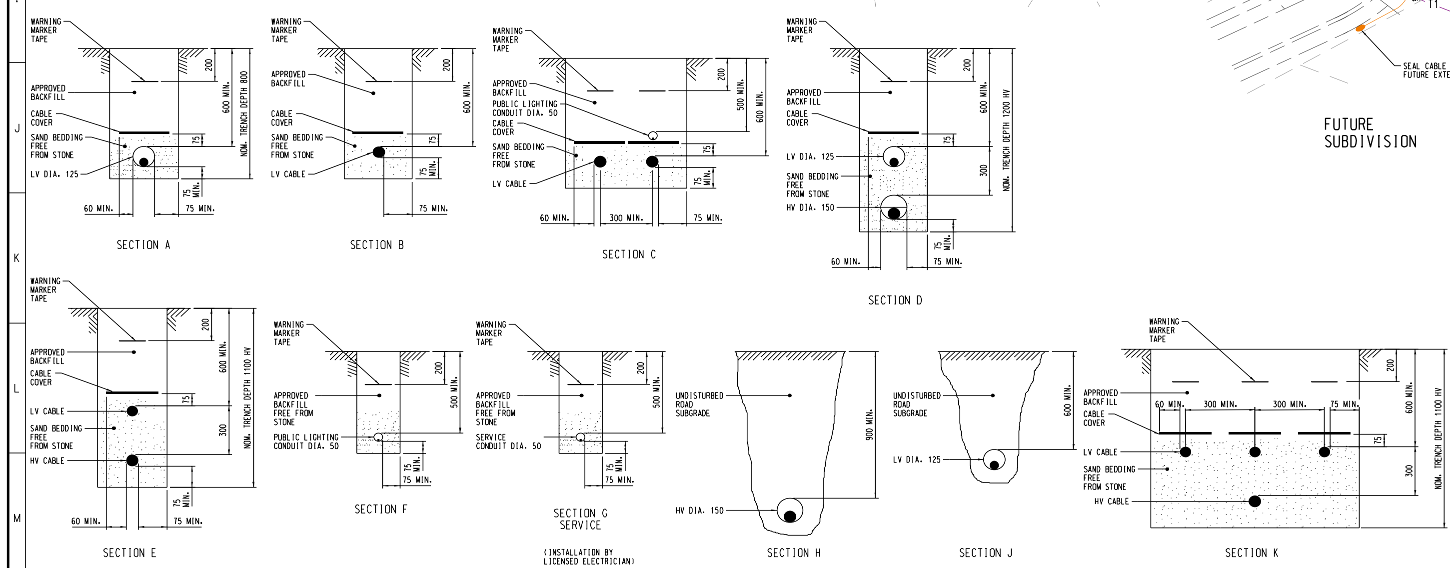
UNDERGROUND FURNITURE

TASNETWORKS STOCK ITEM NO.	DESCRIPTION	QTY
S.I.325742	TURRET STANDARD - BASE	18
S.I.325745	TURRET STANDARD - TOP	18
S.I.161481	SERVICE CABINET 400A	2
S.I.324993	PUBLIC LIGHTING COLUMN 5.5m ARTCRAFT BOULEVARD TOP ENTRY	7
S.I.161456	PUBLIC LIGHTING LUMINAIRE, BOURKE HILL LED, D2 PE CELL, TOP ENTRY	7
	KIOSK SUBSTATION 500kVA ENCLOSURE TYPE 3/05 REFER DRAWING KS-301	1
S.I.xxxxxx	HV CABLE END SEAL	1



SUBSTATION OFFSET DETAILS
SCALE 1:200

TRENCH SECTIONS
SCALE 1:20



EXCAVATION NEAR TASNETWORKS CABLES AND EQUIPMENT

1. ALL UNDERGROUND SERVICES TO BE LOCATED PRIOR TO ANY EXCAVATIONS DIAL 1100 "DIAL BEFORE YOU DIG" TO ARRANGE LOCATIONS.
2. ALL EXCAVATION WORK ON EXISTING UNDERGROUND CABLE AND EQUIPMENT SHALL COMPLY WITH TASNETWORKS SAFETY CLEARANCES.
3. ADVICE MUST BE SOUGHT FROM TASNETWORKS FOR ANY EXCAVATIONS WITHIN 3.0m OF POLES OR STAYS.

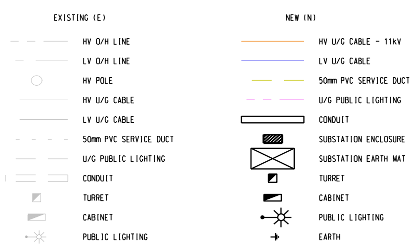
CONDUITS

1. CONDUITS SHALL BE EITHER:
UPVC PRESSURE PIPE CLASS 4.5 ORANGE TO AS/NZS 1477 BEDDED IN SAND AND PROTECTED BY PVC COVERING OR RIGID UPVC HEAVY DUTY ELECTRICAL CONDUIT TO AS/NZS 2053 BEDDED IN SAND ONLY.
2. UNDERGROUND CABLE ROAD CROSSING CONDUITS ARE TO EXTEND 2m BEYOND THE ROAD EDGE(WHERE POSSIBLE).

UNDERGROUND NOTES

1. ALL ROAD CROSSINGS, EXCAVATION, BACKFILLING AND RE-INSTATEMENT SHALL BE COMPLIANT WITH TASNETWORKS UNDERGROUND DESIGN STANDARD & CONSTRUCTION/ELECTRICAL SPECIFICATIONS.
2. CABLE WARNING SIGNS ARE TO BE INSTALLED AS PER UG-209.
3. PUBLIC LIGTHING COLUMNS ADJACENT TO ROADS ARE TO BE INSTALLED IN THE ROAD RESERVE.
FOR DETAILED LOCATION REFER TO PUBLIC LIGHTING REPORT BY THE DESIGNER.
4. FOR PUBLIC LIGHTING COLUMN FOUNDATIONS REFER DRAWINGS PL339, PL605 & PL606
5. ALL TURRETS, CABINETS & UNDERGROUND CABLE TO BE INSTALLED IN THE ROAD RESERVE, WITH A MIN. DISTANCE OF 0.5m TO PROPERTY BOUNDARIES AND DRIVEWAYS, AND A MIN. OF 1m FROM FOOT PATHS.
THE TURRET OR CABINET SHALL BE INSTALLED AS CLOSE AS PRACTICAL BETWEEN SUPPLIED LOTS. SPECIAL CARE SHALL BE TAKEN ON LOCATING T7 & T9 TO AVOID INADVERTANT VEHICLE DAMAGE.
6. FOR KIOSK SUBSTATION FIRE PROTECTION GUIDE REFER DRAWING KS-200.
7. FOR KIOSK SUBSTATION STANDARD DESIGNS -
CIVIL FOUNDATIONS REFER DRAWING KS-317
BATTERS & DRAINAGE REFER DRAWING KS-206
PLINTH DETAILS REFER DRAWING KS-302
EARTH GRID & FITTINGS REFER DRAWING KS-309
CONDUIT DETAIL REFER DRAWING KS-313
8. FOR SITE SPECIFIC DETAILED KIOSK SUBSTATION DESIGN REFER TO D-T27-3014-0100-002.

LEGEND



ALTERATIONS
ORIGINAL ISSUE

SCALE 1 : 500

REFERENCE

TasNetworks PTY. LTD.
ABN: 24 167 357 299

TITLE
SAMPLE DESIGN
URBAN RESIDENTIAL DEVELOPMENT

DRAWN	C5 Pro-Solutions
DRAFTING CHECK	C5 Pro-Solutions
DESIGNED BY	C5 Pro-Solutions
CHECKED BY	G.HALL
APPROVED BY	
DATE APPROVED	05/02/2016

SCALE 1:500
A1
D - T27 - 3014 - 0100 - 001
REVISION 0

DATE
DOCUMENT PHASE
DWG NO
Rev. 0