UNDERGROUND DISTRIBUTION DESIGN MANUAL

THIS MANUAL PROVIDES THE STANDARD APPROACH TO UNDERGROUND DISTRIBUTION DESIGN FOR THE EVOENERGY DISTRIBUTION NETWORK

This Design Manual sets out the requirements and must be applied to the design of an underground distribution in the ACT. It relates to the information necessary to assess various aspects of the development and its suitability for connection to Evoenergy's electricity system. The document does not include procedure for the street lighting design. This document also gives the information on installation requirements and procedures.

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1. SCOPE

This Design Manual sets out the requirements and must be applied to the design of underground distribution in the ACT. It relates to the information necessary to assess various aspects of the development and its suitability for connection to Evoenergy's electricity system.

The document does not include procedure for the street lighting, chamber substation, zone substation and transmission design.

This document also gives information on installation requirements and procedures. This information is considered as a guideline only. For further details on installation requirements and procedures refer to PO0792 & PO0793, "Civil Work Manual Volume 1 & 2".

This manual provides the standard approach to underground distribution design for the Evoenergy distribution network. If the standard design guidelines are not suitable for any particular situation, the designers may choose to depart from these standard design guidelines and develop a solution based on appropriate engineering analysis. Approval by the Asset Owner is required for departures from this manual.

2. PURPOSE

The purpose of this Design Manual is to outline the principles to be observed in designing the electrical reticulation for underground distribution in the ACT.

3. DESIGN PHILOSOPHY

An underground distribution system should have a long-expected life and have a low maintenance requirement. This sets particular requirements for the careful selection of materials and equipment for high standards of installation and construction.

The general methodology for the design for **Greenfield area** is as follows:

1. Obtain approved Estate Development Plan including the Electrical Master Plan (EMP) for the subdivision
2. Obtain Environmental Report and Tree Protection and Management Plans
3. Evaluate the number of blocks and size of the block in the area to be served
4. Estimate the demand per block with any specific information related to blocks
5. Determine the number and the type (i.e., OLTC or Non-OLTC) of padmount substations with capacity to be installed
6. Identify the location for the padmount substations to be installed
7. Determine the source of HV supply (i.e., zone substation or feeder)
8. Design the HV reticulation with route of the HV cable to be laid
9. Calculate the number of dwellings to be connected to each padmount substation/s.
10. Design LV reticulation with route of the LV cable to be laid
11. Identify location of underground submersible pit/s and installation of service cable requirements
12. Identify requirement and locations of link pillars
13. Calculate voltage regulation to check for compliance with requirements (i.e., voltage drop calculations)
14. Assess and manage effect of connected embedded generation (including any incentivised PVs) on supply parameters (voltage rise, power quality).
15. Consideration of EV chargers, gas reticulation, hot water system or any other special requirements.

<u>Design for Brownfield area</u> will broadly adopt the methodology outlined above and additionally include:

1. Details for the removal and disposal of existing assets as required. Of particular concern is management of hazards imposed by existing services and material handling (asbestos etc.)
2. Consideration of cost-effective solutions including the Least Cost Technically Acceptable Solution (LCTAS for customer-initiated projects) to modify or augment the existing network to supply the new development, such as maximising the utilisation of existing assets through network re-configuration and review of plant ratings where possible.
3. Assess and manage effect of connected embedded generation (including the PVs) on supply parameters (voltage rise, power quality).
4. Consideration of EV chargers, gas reticulation, hot water system or any other special requirements.
5. Investigation of the impact the proposed work will have on the existing network –for example, removal of certain assets could affect the underlying earthing arrangement in the local network
6. Investigation of opportunities to improve or address issues related to supply reliability, performance, operation, and safety of the connected local network.
7. Design details to address any access or constructability constraints imposed by assets and infrastructure that must be retained or preserved – street hardware, driveway crossings, buried services.
8. Network Alteration Proposal is to be prepared and submitted by relevant Project / Planning / Asset Engineer or Officer as per Evoenergy document PO07466 “Network Alteration Proposal Procedure”.

3.1 Design options analysis and selection

Design options analysis and selection will be guided by the over-arching principle that network designs minimise the installation of new assets. That is:

1. New loads and load increases are to be serviced through existing assets, where practical, to increase the overall network utilisation.
2. The extent of augmentation is to be minimised by switching existing loads to other LV or HV feeders, or substations, where practical, to provide available existing network capacity at the proposed connection points.
3. Current loads are to be understood through measurement of the actual network or through interrogation of an electronic system for fully occupied buildings and neighbourhoods. Additionally, the potential to maximise network usage during the winter period is to be understood and considered when determining available capacity in the existing network.
4. Any de-rating factors (e.g., connectors, LV boards) of LV and HV feeders are to be investigated and upgraded if this provides a low-cost solution in providing the capacity necessary to service a new load or load increase.
5. Neighbouring developments that are included in future load determination, require at a minimum, a request for Preliminary Network Advice; thereby providing the necessary confidence in the future connection of these loads.
6. If network capacity is “reserved” and an alternate project becomes available that could utilise this reserved capacity, the alternate project is to utilise this capacity unless the original project has (a) at a minimum progressed from the PNA to the application stage or (b) if an offer has been accepted and the project developer is constructing the development in accordance with the project milestones provided with the application.
7. When network augmentation is required, whole of life costs are to be considered when determining what assets are to be installed, thereby providing a preference to assets with the least overall whole of life cost. In the absence of a suitable systems integration functionality and a whole of life costs calculator this may be completed based on up-front capital costs only.
8. When a new load can be supplied by more than one connection point or supply point, preference is to be given to the Least Cost Technically Acceptable Solution (LCTAS).
9. The backyard overhead LV network is to be utilised where practical and cost effective, to remove the need to produce a duplicate underground network in the street verge.

4. GENERAL TECHNICAL/DESIGN PARAMETERS

4.1 Estate Development Plan

The information required to commence the design of the subdivision (Greenfield development) is:

- An electronic copy (dxf or dwg format) of the layout of the proposed subdivision with each block boundary shown and the size of each block.
- A copy of the proposed hydraulic (water and sewer) plans for the subdivision.
- The category and width of each road and the distance of boundary to boundary.
- Any public lighting supply requirements.
- The location of pathways and the alignment of the common (or dedicated) trench.
- Adequate space for supply and network distribution assets (such as, pits, pillar, substation etc)
- Maximum demand data based on number of proposed dwellings and any additional supplies required (e.g., BBQ's, toilets, irrigation, NBN, 5G etc.).
- A drawing or sketch indicating high voltage cables entering and leaving the estate (Electrical Master Plan 'EMP') and each stage of development (to be approved by Evoenergy Network Planning).
- Location, type, and available capacity of existing LV supply points (substations, pillars) to supply all or part of the new load.
- Details of proposed solar PVs (including incentivised) and/or batteries.
- Details/requirements of EV Chargers, Gas reticulation, Hot Water system and any special requirements.

Street names will also be required to be supplied early in the project but are not necessary at the project initiation stage.

4.2 Environmental Considerations

Designers must contact the Environment Team through environment@evoenergy.com.au for a Preliminary Environmental Assessment or Desktop Review prior to design finalisation in line with PO06103 Manage Environmental Interactions. When requesting an assessment, the Designer must include a Project Number or Work Order, Block, Section and Suburb Section, Asset ID, and detailed information about the project.

An Evoenergy Environment Officer will assess the site for cultural sensitivity, significant trees, threatened species of flora and fauna, contaminated sites and any planning or development constraints which may require additional approval or engagement with Regulators. This assessment may require additional considerations to be incorporated into the design, depending on the unique characteristics of the proposed works, site constraints and regulatory obligations. Examples of mitigation may include:

- Revised construction methodologies for working near established trees or within tree protection zones (e.g., hydrovac, matting to reduce soil compaction)
- Revised ground asset designs to reduce potent for fauna to establish burrows or impact network operation (e.g., rock barriers around ground assets in nature reserves)

The designer to refer the Trees on private land - City Services (act.gov.au) and Trees on public land - City Services (act.gov.au) for more information on tree protection zones prior proposing the substation or under boring/conduit installations under the tree canopy. Typically, a Tree Protection Zone for a protected tree is:

- the area under the canopy of the tree
- the 2m wide area surrounding the vertical protection of the canopy; and
- the 4m wide area surrounding the trunk as measured at 1m above natural ground level

Depending on the project location, work proposed and environment and planning constraints, an Environment Officer will provide advice to the Designer to incorporate and consider within 3 working days. This advice may result in additional timeframes or consultation required with Regulators depending upon the work location and work proposed. Advice may also result in additional timeframes depending on required Development Approvals or Work Approvals which must be facilitated by the Environment Team (Network Initiated) or Designer (Customer Initiated).

4.2.1 Development Approval

Development Approvals may be required for works that are not exempt under the Planning and Development Regulation 2008. If works are network initiated, the Environment Team can facilitate this process, however, if customer initiated, the requirement for a Development Approval will be pushed on to the customer to provide. It is important to ensure that all Evoenergy works have the required approvals prior to construction to ensure Evoenergy satisfies its regulatory obligations.

4.2.2 Works Approval

Works Approval is required for any work that is conducted within areas covered by the National Capital Plan and administered by the National Capital Authority (NCA). If works are network initiated, the Environment Team can facilitate this process, however, if customer initiated, the requirement for Works Approval will be pushed on to the customer to provide.

Under the National Capital Plan Evoenergy must plan the installation of electricity infrastructure to minimise visual impact. This is of particular importance along major vistas, corridors, and major open space. Where the installation of overhead conductors is not suited due to the impact to significant vistas the installation of underground reticulation should be considered.

4.2.3 Network Resilience

Evoenergy maintains a long-term target in its Sustainability Strategy that it is resilient to climate change and continue to deliver and maintain a safe, reliable, and affordable electricity network for the ACT.

Efforts should be made where possible during the design process to account for considerations of future network capability and capacity as increased electrical load and electrification continues as the ACT moves towards net-zero by 2045. Examples of this may include considerations of network losses through conductor sizing, transformer sizing or local network configuration.

4.2.4 Supporting resources:

Evoenergy's Environment Team maintains a Grid Page with resources to support designer to consider environmental and planning constraints in their preliminary designs. Resources include information on:

- Planning and Development
- Contaminated Land and VENM
- Oils and Fuel
- Working in Nature Reserves
- Heritage
- Extreme Weather
- Waste Management

Additional resources include mapping services provided by the ACT Government through ACTmapi. This service includes mapping information on:

- Bushfire Prone Areas (BPA) and Bushfire Abatement Zones (BPA)
- Flood prone areas
- Aerial Imagery

- Land Custodianship
- Heritage and culturally significant areas
- Significant species and vegetation communities
- Soil and Hydro geological data
- Development constraints

4.3 Safety in Design

Designs must allow for optimal utilisation of readily available plant materials and equipment as well as standard work practices routinely employed in construction and maintenance activities including the application of live line working procedures where appropriate. Design also must consider the fire risk of locating asset in the vicinity of building.

Designs must allow for and adhere to the standard safety work practices routinely employed in the construction and maintenance activities within Evoenergy. Designs and must comply with the Utilities Act and its supporting documentation and the Safe Design of Structures Code of Practice under the ACT Work Health Safety Act and Evoenergy's corporate risk management procedures. For further detail refer to Evoenergy document PO0785 "Capital Works Design Checklist Procedure".

4.4 Non-Standard Design

For project specific reasons, designers may consider a non-standard or non-typical design which may include unfamiliar work practice or method of installation, unaccustomed material etc. Designer must review their non-standard or non-typical design with relevant parties as per following table:

TABLE 1. NON-STANDARD DESIGN REVIEW REQUIREMENT

TYPES OF NON-STANDARD DESIGNS	LV (PILLARS, POES, ETC) NEW MATERIAL	HV (PADMOUNT, SWITCHING ETC) NEW MATERIAL	LV OR HV (EARTHING, CIVILS, ETC) NEW WORK PRACTICE	SCADA / PROTECTION	PV / SOLAR / BATTERY
Asset Standards & Specification	✓	✓	✓		
Work Practices			✓		
PDL Construction	✓	✓	✓		
System Control/ Commissioning				✓	✓
Zones				✓	✓
Network Service	✓	✓			✓
Embedded Generation					✓

If designer is to implement something different from above mentioned types of non-standard design, then designer is to check with each section supervisor/manager if they would like to assess the non-standard or non-typical design.

4.5 Cable Installation

Cable (as identified in Chapter 5, 7 & 9) installation in **Greenfield development** must be direct buried in line with Evoenergy Drawing 393-010 “Underground Services in a Shared Trench”. However, in **Brownfield development** due to access and coordinating issues cables may be installed in conduit in line with Evoenergy Drawing 393-007 “Cable trench details for Cable Installations not covered by Shared Trench”. In both case the associated civil works must be conducted in accordance Evoenergy document PO0793 “Civil Works Manual Volume 2”. Where **adequate separation and cover** cannot be maintained, designers are required to produce alternative options and consult with related stakeholders in line with Safety in Design. For further details on cable installation refer to Appendix A.

As per Network Alteration Proposal Procedure, Secondary system from Zones Section will advise if there is any requirement of pilot & communication cables and/or fibres along with pits.

Light Rail Network property crossings must be designed in accordance with Transport Canberra and require prior approval before being agreed or committed to. Where new and/or additional assets are proposed to be installed within property owned/ managed by the Canberra Metro, the following documentation must be recorded in line with Safety in Design:

- A list of all alternative options considered.
- Justification that the rail property crossing is the only feasible/practical option.
- Underground bore profile of both new and existing assets.

Details of any future stages/propose use of the crossing. In the event that assets are permitted to be installed in the rail corridor, all poles, joints, and the ends of conduits are to be installed outside of the rail corridor to facilitate ease of future access.

Cables proposed to be installed at existing **Bridge Crossings** must either be installed in conduits under the existing bridge using trenchless techniques (for example under boring the bridge) or within conduits in the bridge. The installation of new conduits within an existing bridge must only be proposed if the access to the cables is not negatively impacted, no maintenance of the conduits will be required, and the bridge is mechanically suitable for the installation of conduits. For concrete and steel bridges the degree of any expansion/contraction must be considered and included in safety in designs. The design must include a suitable provision to prevent damage to the cables. Under no circumstances must cables be installed on trays or in conduits suspended from the bridge or laid on railway bridges. The design must not allow joints within and in near vicinity of bridge.

The **Road reserve** is all the land between property/title boundaries (including footpaths, verges, driveways, and roadways). Cable must not be installed under **Footpaths**, **Driveways** and **Road** (carriageway); however, it is preferred to have cable crossing on 90° at footpaths, driveways, and roads. All joints, service ties and the ends of conduits are to be installed outside the footpaths, driveways, and roadways to facilitate ease of future access. Cable installed in verge must be in line with Evoenergy Drawing 3832-018 “Separation & Cover Requirements”. Cables in **Open Space** must be designed, approved, and installed in accordance with City Services Canberra. Open space is any open piece of land that is undeveloped (has no buildings or other built structures) and is accessible to the public. Open space provides recreational areas for residents and helps to enhance the beauty and environmental quality of neighbourhoods. But with this broad range of recreational sites comes an equally broad range of environmental issues. Just as in any other land uses, the way parks are managed can have good or bad environmental impacts, from pesticide runoff, siltation from overused hiking and logging trails, and destruction of habitat. Irrespective of cable being in road reserve or open space, it may require Development Application (DA) approval (depending upon the cable length/impact).

Depending upon the land custodian the approval is required from Transport Canberra City Services (TCCS) and/or, Environment Planning and Sustainable Development Directorate (EPSDD) and/or National Capital Authority (NCA).

4.6 Maximum Demand

The maximum demand of a proposed installation must be estimated by the Design Officer after obtaining relevant information from the client in accordance with PO07385 “Maximum Demand Estimates for Residential, Commercial and Industrial Installations”.

For Brownfield developments, it is recommended that at least two methods are used to estimate maximum demand. The choice of methods is subject to availability of data such as: load density and net floor area along with a list of connected loads and corresponding diversity factors.

When a number of consumers are connected to a three-phase electricity supply system, the total loading is normally not the sum of the individual consumer's maximum loads. In the particular case of URD projects in Greenfield areas, where the dominant types of consumers are domestic residences, load diversity and phase unbalance will affect the overall maximum demand seen by the supply system. The influence of these two effects must be taken into account when estimating the loading on cables and substations. Load diversity occurs because the maximum demand of a given group of consumers occurs at different times of the daily load cycle. For design purposes, the average demand for a very large number of consumers is the After Diversity Maximum Demand (ADMD).

For further details on types of method and ADMD values, refer to PO07385 "Maximum Demand Estimates for Residential, Commercial and Industrial Installations".

4.7 Use of the ADMS for LV network voltage analysis

Connection of Distributed Energy Resources (DER) to Evoenergy's LV network has now reached levels where it can adversely affect supply power quality if not managed satisfactorily. Of particular concern, for the purposes of this document, is voltage rise conditions due to reverse power flow.

Hence assessment of voltage at the various points of interest (service connection points and points of common coupling) must consider peak power flow in both directions based on the daily load/generation profile. This exercise is best carried out using load flow study software.

Evoenergy uses the load flow module in the ADMS to model and simulate power flow for the purposes of analysing voltage performance in an existing or modified network. The ADMS has provision for specifying different types of loads (e.g., residential, commercial) and embedded generating sources (e.g., Solar PV) to represent operating conditions more closely.

The designer makes the required changes in an offline model (simulation) of the real time network in the ADMS and runs load flow studies on this model to get feeder loading and voltages at nominated nodes or terminals.

Refer to the ADMS user guides for the procedure on simulating a load flow study for new development/connection within the distribution network in Greenfield or Brownfield areas.

As an alternative to using the ADMS other suitable methods may be adopted for analysing the LV network with the approval of relevant stakeholders.

4.8 Voltage Drop and Rise Limits

The design must ensure voltage at the customer's supply connection point is maintained within the range defined by PO070523 "Standard Supply Voltage for LV System", which is +10%, -6%. For a nominal 230V phase to neutral supply system this equates to the range 216V to 253V. Both voltage drop and voltage rise conditions need to be managed to ensure compliance with the above requirement.

To ensure voltage performance is satisfactory, voltage calculations must be done from the distribution transformer LV links to the last customer's point of entry on each LV distribution circuit for peak power flow in both directions. Therefore, two sets of calculations are required, one for voltage drop under peak demand/low generation conditions and one for (possible) voltage rise under low demand/peak generation conditions. For voltage drop the minimum voltage will be at the farthest connected load and for voltage rise the maximum voltage will be at the farthest connected generator. For further details refer to Evoenergy document PO070523 "Standard Supply Voltage for LV System".

The recommended allowance for voltage drops and rise across the various network elements is detailed in Table below.

TABLE 2. TABLE - RECOMMENDED MAXIMUM VOLTAGE DROP AND RISE

ELEMENT	VOLTAGE DROP	VOLTAGE RISE
HV Feeder	4.5%	-
Substation	2.5%	-
LV Feeder	4.5%	7%
Service Cable	1.5% for a total voltage drop of (4.5+1.5) = 6% of nominal	3% for a total voltage rise of (7+3) = 10% of nominal

The values in the table above assume that the tap-changer on the Padmount Substation transformer is set at 5% boost and the tap-changers on the Zone Substation transformers are set at 2% boost at high load. A load flow study reflecting power flow and actual transformer tap settings under peak load and generation conditions is required to reliably assess the voltage profile at the various points of relevance.

Voltage levels (drop/rise) are to be assessed using ADMS as per clause 4.3. For Brownfield development the existing low voltage network may need to be investigated and analysed (for voltage levels, existing loading, any solar PV resources causing reverse the power flow etc.) at the preliminary design stage.

4.9 LV Parallel Points

The design must include, where economical, provision for LV parallel points to allow LV ties between circuits and substations. This is achieved by extending LV circuits from different substations so that they meet at a normally open switch position. LV parallels provide limited capacity restoration of supply from an adjacent substation that is out of service and are not expected to cope with normal peak load conditions.

Two parallels points must be provided as a minimum for each substation, which means that some LV circuits will not have direct parallels but are kept energised by feeding through the Padmount Substation LV bus.

In Greenfield URD the installation of a normally open point between low voltage circuits must be installed where both the following conditions are met:

- The installation of less than 50m of additional cable would be required
- More than 20 blocks would otherwise have a radial supply

Each substation must have a low voltage tie to an adjacent substation subject to meeting the conditions above and this tie being economic to install. Installation of the tie is economic if the resulting increase in the cost of the project due to the installation is no more than 10%.

The decision to provide LV feeder ties and the selection of LV tie point locations must be supported by design calculations that consider transformer capacity and voltage drop under normal as well as single contingency conditions. For further details refer to Evoenergy document PO070523 "Standard Supply Voltage for LV System".

The low voltage neutral conductor must be earthed at all normally open points and must be connected to an earthing system. **The neutral conductor must be continuous through the normally open point and only the active conductors must be broken.**

5. HIGH VOLTAGE CABLES

5.1 Standard HV Cables

Following standard cables are to be used in the underground distribution design.

- 11kv 240mm² XLPE 3 core Aluminium cable
- 11kv 300mm² XLPE 3 core Aluminium cable

- 11kv 400mm² XLPE 3 core Aluminium cable

240mm² XLPE cable is the standard HV cable used by Evoenergy for all HV reticulation but for some exceptions 300 mm² XLPE and/or 400 mm² XLPE cables can also be used such as exit from the zone substation or bridge crossing where cable de-rating is considered to be higher as either the separation between cables are not enough or cables may be in conduits, or in the first leg of the feeder to cater for the maximum load on the feeder.

Due to site and connection size constraints, following cable can also be used for HV Supply and Feeder projects.

- 11kv 240mm² XLPE 3 core Copper cable
- 11kv 300mm² XLPE 3 core Copper cable
- 11kv 400mm² XLPE 3 core Copper cable

For project specific requirements and /or non-typical installations, other cables can be used with due consideration given to the impact on conduit size, pulling tension, terminations, joints, and installation method.

5.2 Technical Information

For technical information, refer to Evoenergy document:

- PO07454 "Electrical Data Manual"
- PO07395 "Technical Specification – Cables and Conductors"

5.3 HV Joints and Terminations

The most common joints and terminations used in underground distribution are:

- Straight through joint for standard XLPE cable
- Transition joint between XLPE cable and Paper Cable
- Termination in the Padmount substation and switching station
- UG/OH Connection

HV cables must be laid as complete cable sections between substations and switching stations. In Greenfield developments, conduits should be provided in the shared trench at stage boundaries, to avoid the need for a joint at the stage boundary. As future access to a cable in a joint trench is extremely difficult, should a HV cable be damaged during project construction, that whole section of cable must be replaced with a new cable.

Cable joints and terminations have a major impact on the reliability of underground cable networks. Joint and termination types specified in the approved material lists have been selected to ensure safe and reliable performance when installed correctly.

5.4 HV Supply configuration

The HV supply arrangement to the Padmount Substation is usually designed so that the substation has at least two cables in and out. However, for economic reasons on long circuits, up to 500kVA of load can be supplied from a radial feed as a long-term arrangement with approval sought through a Network Alteration Proposal as covered in the design philosophy for Brownfield development.

In Greenfield development the 500kVA load limit can be increased for short to medium terms to allow the progress of the staged development.

5.5 Application Note

Evoenergy requires cables to be installed on proper alignment within gazetted public road reserves. Alignment of the cable with respect to property boundary, road boundary and other details related to cable installation will be discussed and finalised with the developer during preparation of the estate development plan.

It is preferred to have 90° crossings at footpaths, driveways, and roadways. If the cable alignment on one side of the road is unable to accommodate the number of cables required, excess cables can be installed on the cable alignment on the opposite side of the road. Requirements such as spare conduits, cables under concrete footpaths and concrete pits will be addressed on an individual project basis.

Wherever possible, design must eliminate joints in the HV cable system. The option to use conduits for future HV cable routes must be taken into consideration to allow full cable drum runs, avoiding intermediate joints. During EDP negotiation, stages of development must be planned in a manner to avoid joints in the HV cable system. Where future development adjacent to the existing works is likely it is advisable to allow spare connection points for supply into the new estate in the present design (usually by way of 4-way switchgear in substations located on the development boundary).

5.6 Ferroresonance

Ferroresonance is a phenomenon which may occur when a capacitance is either in series or in parallel with a nonlinear inductance. It can cause over voltages and over currents that can pose a risk to transmission and distribution equipment and to operational personnel.

In power distribution systems, the most common place to find ferroresonance is when a three-phase distribution transformer is energised through an underground cable. Under no load, or very light load conditions, the cable parameters (length, type) may result in the capacitance being sufficient to create ferroresonance under single phase switching conditions. Single phase switching conditions occur when operating single phase HV switches or HV drop-out fuse units.

Whilst there are other methods of controlling ferroresonance, the use of ganged 3-phase HV switching is one of the most effective and commonly used methods of avoiding it. This is why 3-phase HV switching is the standard adopted by Evoenergy. For further detail refer to Evoenergy document PO07177 – "Ferroresonance Causes and Mitigation".

5.7 Communication

Building a smart grid involves transforming the traditional electricity network by adding new, smart technology. It includes field installed smart sensors, field automation, new back-end IT systems, and a communications network. Smart grids provide instant information (data) about the network to make it more efficient through faster fault location and preventive maintenance and to help reduce interruptions, support more renewable energy and give Evoenergy greater control over its Network. For further details refer to PO07401 "Network Design Standard for Telecommunications Pits including Specification and Installation".

6. PADMOUNT SUBSTATIONS & SWITCHING STATIONS

Distribution substations in underground distribution areas are the Padmount type with integrated HV and LV switchgear. All Padmount Substation transformers have a nominal voltage ratio of 11/0.4kV.

Switching Stations with integrated HV switchgear for HV network switching are also used to meet project specific requirements.

6.1 Capacity (Padmount Substations)

The standard padmount substation capacity ratings used in Greenfield residential developments is 500kVA (with or without OLTC). In some cases, a 750kVA (with or without OLTC) Padmount Substation may offer the optimal solution, particularly for larger multi-unit development sites in Greenfield areas.

In cases where there is a high level of EG penetration solutions such as enabling PV inverter demand response modes, battery storage and or installation of suitable voltage regulation devices may have to be considered to mitigate bi-directional power flow voltage fluctuations in consultation with and the approval of Strategy & Operations.

For Brownfield developments, the padmount substation capacity ratings should be based on the load after considering load transfers through network re-configuration to maximise the utilisation of existing assets. The standard padmount substation capacity ratings in Brownfield developments ranges from 500kVA to 2 x 1500kVA.

The capacity of the padmount substation should be based on maximum demand of a proposed installation, which must be estimated by the Design Officer after obtaining relevant information from the client in accordance with PO07385 “Maximum Demand Estimates for Residential, Commercial and Industrial Installations”.

6.2 Technical Information

6.2.1 High Voltage Switch Configuration

Typically, high voltage configuration of 3/4 way arrangements with 2/3 ring switches and a switch-fuse combination are the most common in underground distribution design; however, a 3/4 way switching station can also be used for feeder inter-tie connections.

LV supply assets (LV switchgear, transformer) are not installed in switching stations. However, switching stations fitted with SCADA will require separate LV supply sourced through local VTs or external connection via an isolating transformer. Approval of Strategy & Operations is required.

6.2.2 Low Voltage Switch Configuration

The LV switch configuration in each substation is optimised to suit project specific requirements. Refer to the documents and drawing in the reference chapter for further details on each substations LV switch configuration.

6.2.3 SCADA Configuration

Typically, there are two SCADA configurations available with Padmount substations that must be considered during the selection of Padmount substation: -

Major SCADA – For remote monitoring and control of LV and HV

Minor SCDA – For remote monitoring of LV only

The Project/Design Engineer must review and understand the Safety, Network Operation and Reliability considerations while considering a Padmount substation with Major or Minor SCADA configuration. The substation with Minor or Major SCADA to be proposed as part of the Network Alteration Proposal (NAP) for review and approval by other stakeholders as part of NAP process.

Major SCADA must be considered in the following circumstances:

6.2.3.1 Safety

- High risk Geographical Areas with Safety Risks associated with monitoring and operation e.g., remote areas for lone workers
- High arc flash risk that identified in ADMS

6.2.3.2 Network Operations

- When substation capacity is >=1.5 MVA
- Restricted access to substation or limitations to access the substation
- Any P1 or P2 high priority customers as per PO07273 Network Emergency Response section 2.1.2
- Historically highly utilised switchgear in brownfield setting

6.2.3.3 Reliability

- First substation on a feeder or within the first three points if no SCADA substation is already installed up to that point
- When substation location is a HV tie to another feeder or within 1 or 2 substations away from a Normally Open point
- 3 feeder cables are connected at the substation

- Near known unreliable part of the network and/or worst performing HV feeders
- Any feeder that is targeted for FLISR (Fault Location, Isolation and Service Restoration)
- Aim to sectionalise the feeder – install a major SCADA substation for every ~500 customers in a residential area or every 2-3 MVA installed capacity in a commercial / industrial area

The Project/Design Engineer must liaise with the Planning team to identify remote operability requirements, information on unreliable network and/or worst performing HV feeders during preparation of Electrical Master Plan (EMP) for Greenfield staged developments or preparing Network Alteration Proposal for Brownfield Development.

6.2.4 On-Load Tap Changing (OLTC) Requirement

OLTC must be used in the following circumstances.

- In new residential suburb (Greenfield) where PV is mandated by the ACT government or developer, or generally included within the build package.
- In an existing area with residential profile (Brownfield) where installed PV capacity is >=80% of the padmount transformer capacity, however OLTC must be considered when the installed PV capacity is >60%.

6.3 Siting Arrangement, Preparation, and Installation

Padmount substation locations in Greenfield developments are to be resolved during the EDP stage in master planning and should be at the central point of load geography. For Brownfield development areas, the location should be as close to the load as possible and voltage regulation on existing circuits assessed using ADMS. These locations must also meet the requirements of Evoenergy document PO07373 “Padmount Substation and Switching Station Guide”. During the Installation of the Padmount and/or Switching Station, provision must be made to support cables to ensure that there is no stress applied to switchgear bushings or terminals. HV and LV cabling from the substation must be installed all the way to the final connection locations, avoiding stripping and capping cable ends for future jointing. Wherever this is not possible conduits must be provided for future cabling. For further details on excavation required for padmount substations and switching stations, refer to the documents and drawing in the reference chapter.

6.4 Padmount Substation and Switching Station Earthing

The preferred option for padmount substation earthing is a combined (CMEN) arrangement, provided several conditions can be met. For further details refer to Evoenergy document PO07127 “Distribution Earthing Design and Construction Manual”. Detailed designs must be undertaken by the Design Officer using PO07127 “Distribution Earthing Design and Construction Manual”.

A new greenfield development is not expected to deliver the required MEN resistance reduction due to the limited number of residential lots i.e., interconnected MEN earths. Hence substations installed during the early stages of greenfield development should be configured as separately earthed. These substations must be converted to CMEN when the opportunity presents itself, namely when sufficient lots have been established and connected to the MEN system.

It is recommended that all separately earthed substations that are candidates for future conversion to CMEN by the reasoning outlined above be assessed periodically for conversion to CMEN. Earthing system design must include checking the configuration of upstream and downstream connected substations (to a reasonable extent) and including, if appropriate and justifiable, work to convert separately earthed substations to CMEN.

The HV earthing system is located adjacent to the Padmount Substation or Switching Station includes a grading ring around the substation. When the Padmount Substation or Switching Station is installed on a reinforced concrete slab, the reinforcing in the slab is bonded to the HV earthing system. All care must be taken to ensure that future works do not disturb or damage the earthing system. Location of the earthing systems must be recorded for BYDA (Before You Dig Australia) purposes.

7. LOW VOLTAGE CABLES

7.1 Standard Cables

The standard LV Cable used for supplying underground developments in ACT is typically 240mm² 4c Aluminium XLPE cable and 35mm² 4c Copper XLPE Cable. For project specific requirement and /or non-typical installations, additional cables can be used but due consideration must be given on conduit size, pulling tension, terminations, joints, and installation.

7.2 Technical Information

For technical information, refer to Evoenergy document:

- PO07454 "Electrical Data Manual"
- PO07395 "Technical Specification – Cables and Conductors"

7.3 LV Joints

LV cables must be laid as complete cable sections between link pillars. Straight through joints are to be avoided wherever possible. In Greenfield developments, conduits should be provided in the shared trench at stage boundaries, to avoid the need for a joint at the stage boundary.

As future access to a cable in a joint trench is extremely difficult, should an LV cable be damaged during project construction, that whole section of cable must be replaced with a new cable.

Following methodology should be adopted for LV cable jointing.

- Joints connecting LV Distributions Mains cables to each other should be avoided where possible. These joints will be made in a Link Pillar.
- Joints connecting LV Branch Cables to LV Service Cables must be installed in Service Pits.
- Joints connecting LV Distribution Mains Cables to LV Branch Cables will be installed underground and these joints (branch joint) must be direct buried.

Cable joints and terminations have a major impact on the reliability of underground cable networks. Particular types of joints and terminations are specified in the approved material lists to ensure that the network equipment has the potential to provide high reliability.

7.4 Application Note

Evoenergy requires cables to be installed on proper alignment within gazetted public road reserves. Alignment of the cable with respect to property boundary, road boundary and other details related to cable installation will be discussed and finalised with the developer during preparation of the estate development plan.

It is preferred to have 90° crossings at footpaths, driveways and roadways. If the cable alignment on one side of the road is unable to accommodate the number of cables required, excess cables can be installed on the cable alignment on the opposite side of the road. Requirements such as spare conduits, cables under concrete footpaths and concrete pits will be addressed on an individual project basis.

Wherever possible, design must eliminate joints in the LV cable system. The option to use conduits for future LV cable routes must be taken in to consideration to allow full cable drum runs, avoiding intermediate joints. During EDP negotiation, stages of development must be planned in a manner to avoid joints in the LV cable system. Where future development adjacent to the existing works is likely it is advisable to allow spare connection points for supply into the new estate in the present design (usually by way of spare circuit in link pillar and/or in substations).

7.5 Earthing of the LV Neutral

The low voltage neutral conductor must be earthed at all pillars and normally open points. The neutral conductor must be continuous through the normally open point and only the active conductors must be broken.

8. PITS, PILLARS, AND POE

The LV network within Evoenergy network is a combination of pits, pillars and point of entry (PoE) cubicles. The pits and pillars are the interface to provide three phase fused supply to each block in the subdivision and to distribute the supply. PoE cubicles are mainly used for three phase fused supply to commercial and multiunit developments depending on their maximum demand.

8.1 Pillars

The Greenfield design must include provision for Link-pillars to allow LV cable ties between circuits and substations. Link pillar can also be installed for supply to large multi-unit sites. Link pillars must be used with underground service pits for ease in isolation and fault finding on LV mains cable. Where the Link pillar is required for an open point between circuits the fuse switch must be loaded with a solid link and left disconnected. Where Link pillars have been specified for a multi-unit site the fuse must be selected in line with Evoenergy Document PO07134 “Fuse Application Guide”. Mini pillars can also be used for providing three phase supply in Greenfield development where there isn’t adequate space for supply through pits with approval through NAP process.

For multiunit development blocks, the design must provide for a suitable arrangement of LV supply cabling and connection points to meet the ultimate demand of the multiunit block. This arrangement must be recorded in single line diagrams for future works either on the cable or Linkpillar with block number and multiunit numbers. If the multiunit supply is to be done through separate substation (due to size/load of development), then substation location must be finalised, and plinth established as part of Greenfield development. Link pillars (with spare circuit) can be installed where sufficient space is available in the verge for future supply to the multiunit sites.

In Brownfield design, link pillars are to be used for LV ties between circuits and substations. The service fuse in link pillar and minipilar are to be used for 100A supply to both residential and commercial blocks. Link pillars can also be installed for supplies to large multi-unit sites or commercial development (depending on load requirement) along with PoEs.

All drawings for works that involve installation of a new pillar or modification / reconfiguration of cable connection at an existing pillar must include an LV schematic diagram that clearly identifies the following:

- All relevant cable connections: specifically which cable to be switched (i.e., connected to the link pillar FSD)
- Whether a Solid link or Fuse is to be installed in the link pillar; and if a fuse is to be installed it must also clearly identify the fuse rating.

8.2 Point of Entry cubicles (PoE)

In Brownfield developments the supply to non-domestic commercial, multi-residential or industrial developments must be supplied through low voltage point of entry cubicles (PoE’s). The cubicles will be installed by the developer inside the block and serviced by Evoenergy. For further details on PoE’s, refer to the documents and drawing in the reference chapter.

8.3 Pits

A three-phase supply is provided using submersible service pits (SSPs) to the front boundary of each block in the subdivision. Submersible service pits are installed adjacent to property boundary of blocks in greenfield subdivisions. The submersible service pit centre line may be set-off from the property boundary by a maximum of 50mm. Service Pits must be used to provide fused connections to LV service cables and other minor loads.

Please note that Submersible Service Pits are not permitted to be installed in trafficable areas (roadways, Pedestrian paths, or driveways) and branch joints must be installed opposite to pits. A short length (approx. 1m) of 50mm PVC lead-in conduit is provided from the Service pit into each property to which a service is to be connected. This is to allow the subsequent installation of a service cable without disturbing the foundation of the Submersible Service Pit. The lead-in conduit is to be temporarily capped. The Developer must install a conduit from the meter position to the end of the lead-in conduit. For further details on pits, refer to the documents and drawing in the reference.

8.4 Siting Arrangement

An excavation with adequate separation to other assets is required at each pit, pillar and PoE in accordance with documents and drawing in the reference chapter.

8.5 Earthing

All service pits, pillar and PoE's are to be earthed. This earth must consist of a copper clad electrode driven into the bottom of the cable trench, as close as possible to the aperture where the earth conductor exits the pit, pillar or PoE's and then connected to the neutral link. For further details on earthing refer to the documents and drawing in the reference chapter.

The location of these earths must meet the requirements as stipulated in Evoenergy document PO07127 "Distribution Earthing Design and Construction Manual".

9. SERVICE CABLES

9.1 Standard Cables (Sizes)

The standard LV Service Cable used for supplying underground developments in ACT is typically 16mm² 4c Copper XLPE cable for three phase connections and 16mm² 2c Copper XLPE Cable for single phase connections

For multiunit sites, commercial and industrial development the standard 240mm² 4c Aluminium XLPE LV cable can be used in single or parallel configuration to meet the higher load.

For loads more than 450kVA (capacity of 2 x 240mm² 4c Al XLPE LV cables), padmount substation and/or switching station must be installed within the block boundary and service must be connected through the consumer mains

For project specific requirements and /or non-typical installations, other cables can be used with due consideration given to the impact on conduit size, pulling tension, terminations, joints, and installation method.

9.2 Technical Information

For technical information, refer to Evoenergy document:

- PO07454 "Electrical Data Manual"
- PO07395 "Technical Specification – Cables and Conductors"

9.3 Servicing Arrangements

A three-phase electricity supply must be provided to the front boundary of each block in the Greenfield subdivision. The service cable entry point to each property must be shown on construction plans with the dimension from the side boundary specified if altered from standard design. Supply to these Service pits and pillar must be provided from low voltage cables laid in the verge on the designated alignment. For further details on servicing, refer to Evoenergy document "Service and Installation rules for connection to the Electricity Distribution Network."

The LV supply to multiunit sites, commercial and industrial development based on the load demand must be arranged through PoEs (either through an in and out arrangement or a radial arrangement). However, if the supply is requested at high voltage (HV) then supply should be arranged through a switching station.

Following guidelines should be adhered to for service phasing:

- The total number of services on each phase should be equal
- The sum of load currents on each phase should be equal

Responsibilities for the installation and connection of LV Services and current harmonics (voltage waveform) distortion limits compliance must be in accordance with the latest revision of Evoenergy document PO07173 "Service and Installation Rules for Connection to the Electricity Distribution Network".

10. UNDERGROUND DISTRIBUTION DESIGN ARRANGEMENTS

Although underground distribution design is project specific and is to be completed by the Design Officer some of the options available are discussed in Appendix "B".

11. REFERENCES AND STANDARDS

DOCUMENT ID	DOCUMENT TITLE
PO07201	Chamber Type Substation Design And Construction Standard
PO07452	Technical Specification - Pad Mounted substations
PO07395	Technical Specification - Cables and Conductors
PO07127	Distribution Earthing Design and Construction Manual
PO07173	Evoenergy Distribution Service and Installation Rules
PO07177	Ferroresonance - Causes and Mitigation Requirements
PO0792	Civil Works Manual Volume 1 (internal use only)
PO0793	Civil Works Manual Volume 2
PO07335	Technical Specification – Electrical Conduit and Fittings
PO07454	Electrical Data Manual
PO07373	Siting Requirements for Padmount Substations
PO070523	Standard Supply Voltage for LV System
PO0785	Capital Works Design Checklist
PO07114	A Guide for LV Mains and Service Cable Connections to new SSP
PO06103	Manage Environmental Interactions
DRAWING NUMBER	**DRAWING TITLE**
8911-321	Service Equipment Permissible Locations Domestic Installations
8911-326	Dual Tenancy Switchboard Layout for 600 x 600 POE / Meter Box
8912-03	Typical U/G & O/H Service Cable Conduit Requirement for Single Domestic or Commercial Installation
8912-04	Typical U/G Service Cable Conduit Requirement for installations Exceeding 100Amps per Phase
8912-05	Typical U/G Service Arrangement for POE / Meter Box in Boundary Fence / Wall
8914-202	Temporary Service Installation, Residential Blocks with U/G Supply Connection
	UNDERGROUND 11kV & INTERFACE ASSEMBLIES
D301-0003	11kV Cable UG/OH, With Surge Diverters
D301-0004	11kV Cable UG/OH, Without Gas Switch on A 12.5m Concrete Pole

D301-0005	11kV Cable UG/OH, With Gas Switch on A 12.5m Concrete Pole
D199-0008	Underground, IA, 11kV Standard HV Cables
D199-0010	Underground, IA, 11kV Cable Joints
D199-0011	Underground, IA, 11kV Cable Indoor Terminations
D199-0012	Underground, IA, 11kV Cable Underground/Overhead (UG/OH) Termination
	UNDERGROUND LV MAINS, SERVICES & INTERFACE ASSEMBLIES
D302-0005	UG/OH, 2 Core 16mm² Cu Fused UG/OH Termination
D302-0006	UG/OH, 4 Core 16mm² Cu Fused UG/OH Termination
D302-0007	UG/OH, 240mm² LV Cable Hard Bolted UG/OH Termination
D302-0008	UG/OH, 240mm² LV Cable Fused UG/OH Termination
D302-0009	UG/OH, 240mm² LV Cable UG/OH with Links Termination
D302-0037	UG/OH, 4 Core 35mm² Cu Fused UG/OH Termination
D302-0010	Terminations, 16mm² Cu 2 Core Indoor Termination
D302-0011	Terminations, 16mm² Cu 4 Core Indoor Termination
D302-0012	Terminations, 16mm² Cu 2 Core Outdoor Termination
D302-0013	Terminations, 16mm² Cu 4 Core Outdoor Termination
D302-0014	Terminations, 240mm² Al 4 Core Indoor Termination
D302-0015	Terminations, 240mm² Al 4 Core Outdoor Termination
D302-0022	Pillar, Minipillar - 9 x 100A and 1 x 32A
D302-0023	Pillar, Minipillar - 15 x 100A and 2 x 32A
D302-0024	Pillar, Linkpillar - 3 Way, 9 x 100A and 1 x 32A
D302-0025	Pillar, Standard Pillar Footing
D302-0047	Pillar, Linkpillar, Covered Busbar Linkpillar
D302-0048	Pillar, Minipillar, Covered Busbar Minipillar
D302-0049	Pillar, Mini & Linkpillar, Alternate (Strip) Earthing Arrangement
D302-0040	Pits, URD Submersible Service Pit and Footing
D302-0042	Pits, URD Submersible Service Pit, Footing and Earth Connection.
D302-0043	Pits, URD Submersible Service Pit, Footing, Earth Connection, Branch Joint & Pit Termination
D302-0044	Pits, URD Submersible Service Pit, Footing, Earth Connection, Branch Joint, Pit Termination and House Service Connections
D302-0045	Pits, URD Submersible Service Pit - Alternate Earthing Arrangement.
D302-0046	Pits, Fused URD Pit, Spare Individual Stocked Components and Parts
D199-0014	Underground, IA, LV Cables, Single Core Cables
D199-0015	Underground, IA, LV Cable Terminations
D199-0016	Underground, IA, Standard LV Mains and Service Cables

D199-0017	Underground, IA, LV Cable Straight Through and Branch Joints
AUSTRALIAN STANDARDS	
AS 2067	Substations And High Voltage Installations Exceeding 1 KV A.C.
AS/NZS 3000	Electrical Installations
AS/NZS 4026	Electric Cables – For underground residential distribution systems
AS/NZS 7000	Overhead line design
ENA EG1-2006	Substation Earthing Guide
OTHER DOCUMENTS	
Safe Work Australia	Model Code of Practice: Safe design of structures
National Construction Code	National Construction Code Volume One
National Construction Code	National Construction Code Volume two
Transport Canberra and City Services	Standard Specification for Urban Infrastructure Works
Work Health and Safety Act 2011 (ACT)	Section 22 - Duties of persons conducting businesses or undertakings that design plant, substances or structures
Work Health and Safety Regulation 2011 (ACT)	Part 4.1 Noise - Section 59 Duties of designers, manufacturers, importers and suppliers of plant; and Part 4.2 Hazardous manual tasks – Section 61 Duties of designers, manufacturers, importers and suppliers of plant or structures

12. DEFINITIONS AND ABBREVIATIONS

In the interpretation of this document the following definitions must apply.

ADMD: After Diversity Maximum Demand.

ADMS: Advanced Distribution Management System – Schneider's suite of applications to monitor, analyse and control Evoenergy's network

AS/NZS 3000 Wiring Rules: The current version of the Wiring Rules published by Standards Australia.

Branch Joint: Joint made between LV distribution cable and LV branch cable to energise pit

CMEN: Common Multiple Earthed Neutral.

Connection Point: The connection point to a distribution network. For the purpose of this document connection point also has the same meaning as Point of Supply as defined in AS/NZS 3000.

Customer: An entity or individual who is an end-user of electricity.

BYDA – Before You Dig Australia

Developer: Developer, Customer or Contractor working on behalf of the developer, other than Evoenergy.

Direct Buried Cables: Cables installed underground whose outer surface is in direct contact with the general mass of the earth and not installed in conduits.

Distributor: means a person who holds a Distribution Licence. A "Distributor" is also known as the Distribution Network Service Provider (DNSP). For the purpose of this document Evoenergy is the Distributor.

Earthed: Connected to the general mass of earth by a conductor to ensure and maintain the effective dissipation of electrical energy.

HV - High Voltage: Nominally 11,000V (for the purposes of this document).

HV Distribution Cable: HV Cable installed to padmount substations in underground distribution.

Link-Pillar: A Pillar in which one of the LV Distribution Mains cables is connected to a disconnector.

LV - Low Voltage: Nominally 400/230V (for the purposes of this document).

LV Distribution Cable: Cable installed from the LV board of a distribution substation.

LV branch Cable: Cable installed from Distribution Mains Cable branch joint to Service Pit.

LV Service Cable: Cable connecting the Customer's first point of supply to the Connection Point.

MEN: Multiple Earthed Neutral.

Padmount Substation: A self-contained distribution substation which sits on a concrete plinth or pad.

Pillar: An above ground cubicle for jointing and/or connecting cables.

Point of Supply: Refer to Connection Point.

Service Pit: A below ground cubicle for jointing and/or connecting cables.

Shared Trench: A trench provided by the developer's contractor and shared by electricity cables, gas pipes and telecommunication cables.

URD: Underground Residential Distribution.

VERSION CONTROL

VERSION	DETAIL	APPROVED
1.0	Initial Document	Asset Standards and Acceptance Manager
2.0	ADMD, Voltage Drop Parameters and Design Options reviewed	Wayne Cleland
3.0	Document Re-Drafted	Santanu Chaudhuri and Wayne Cleland
4.0	Design Options updated	Wayne Cleland
5.0	Formatting of the whole document	Wahid Ibrahim
6.0	Document updated for Rebranding to 'Evoenergy'	Chirag Desai
7.0	Inputted into new template	
8.0	Reference added for Embedded Generation, Reverse Power Flow, and Brownfield development.	Brama Bramanathan; Nadeem Azizi; Wayne Cleland; 3/08/2020
8.1	Minor Updates at various locations	N. Azizi; 6/10/2020
9.0	Section 4.2 & 11 Updated and Minor Updates at various locations	K.Vedanti, N. Azizi; 23/09/2022

9.1	Section 4.4 added for Non-Standard Design	N. Azizi; 19/05/2023
9.2	Updated on new template; Clause 6.2.3 revised and clause 6.2.4 added	N. Azizi 22/02/2024

DOCUMENT CONTROL

DOCUMENT OWNER	DOCUMENT CUSTODIAN	PUBLISH DATE	REVIEW DATE
Group Manager Strategy and Operations	Principal Engineer Standards and Specifications	23/02/2024	23/02/2027

APPENDIX A – INSTALLATION INFORMATION

Please refer to Evoenergy document PO0793 “Civil Works Manual Volume 2”, for comprehensive field guide on the correct civil works activities for the installation of Evoenergy asset.

1. TRENCHES AND CONDUITS

1.1 Conduits

The requirement for conduits is to avoid disturbances to the road ground surfaces when cable systems are installed; In Greenfield development spare conduit must be considered avoid future disturbances to the road ground surfaces when cable systems are maintained and extended.

As part of the installation works of the project, spare conduits must be installed for all road crossings and adjacent to substations where appropriate. They may also be required for some pathway and driveway crossings, and this should be discussed with the developer. Installation of conduits at 90° with footpath, driveways and roadways is preferred option.

Spare Conduits must also be installed for future service cabling to multi-unit blocks and HV and LV ties to future substations where applicable as per the master reticulation plan.

Evoenergy reserves the right to specify additional conduits requirements as “spares” for future use and these requirements will be advised prior to final design approval. The full cost of any additional conduits and their installation in Greenfield must be the responsibility of the Developer. In Brownfield development, the full cost of any additional conduits and their installation inside the block boundary must be the responsibility of the Developer.

The maximum deviation in a single run must be 180°. Where the total deviation exceeds this figure either concrete or sand pits must be provided to provide pulling points which will ensure that the installation of cables does not require excessive pulling tensions.

1.2 Trenches

Trenches must be provided for cables as required by the design. Trenches must be as straight as possible except at street junctions where intersecting trenches must be widened or curved so that cables can be laid to meet the bending radius requirements.

The trench depth must allow the specified cover to be obtained when the ground surface is finished to its final levels. Changes in direction or level should be gradual and allow for an appropriate bending radius for both cables and conduits. Under no circumstance should a trench be provided that is more than 1.5m deep as it will need to be treated as a confined space in accordance with AS 2865.

Spoil from trenches may be temporarily stored adjacent to the trench as long as this arrangement complies with the various safety and anti-pollution requirements and the spoil cannot fall or be inadvertently knocked back into the trench or an adjacent waterway or stormwater system.

1.3 Shared Trenching

Details of shared trench arrangements, including the minimum separation between the various utilities’ equipment, are included in the Telstra, AGL, Transact and Evoenergy drawing: 393-010 “Underground Services in a Shared Trench”

The cable trench must be free from impediments such as trees, stumps, constructions, and other services. Where constructions such as bridges are unavoidable, suitable provision must be made for the installation of cabling and other electricity assets. These provisions must be subject to Evoenergy approval.

1.4 Cable Bedding

Cables must be laid in trenches on a layer of bedding material. The bedding material must consist of granular material of low plasticity such as quarry fines or coarse river sand free from organic matter and free from stones and other hard or sharp objects in line with Evoenergy document PO0793 “Civil Works Manual Volume 2” & PO07330 “Technical Specification Quarry Products & Raw Materials”.

Where multiple cables are laid in a trench the relative arrangement must comply with the detail shown on the approved design drawings.

1.5 Cable Laying

Where the installation method involves pulling in the cable, the procedure must utilise suitable cable rollers so placed that the cable is smoothly guided into place without scuffing or damaging the cable sheath and without subjecting the cable to a bending radius of less than that indicated in the technical data for the cable. The pulling tension placed on the cable sheath must not exceed the figures listed in the technical data for the cable.

Once commenced, cable laying and back filling should proceed continuously as far as possible so that cables are laid, bedded, and backfilled in a series of operations that will not leave the cable exposed in or above the trenches for longer than is necessary.

1.6 Backfilling

1.6.1 Backfilling around Direct Buried Cable

Following the installation of the cables, backfilling of the trench in the vicinity of the cables is required in line with Evoenergy document PO0793 “Civil Works Manual Volume 2”.

A mechanical protective strip is to be installed in accordance with Evoenergy drawings. The strip(s) must be installed so as to cover all cables by at least 40 mm from their outer edges.

Once the cables have been fully sand backfilled, compaction must take place using equipment purpose built for compacting as detailed in Evoenergy document PO0793 “Civil Works Manual Volume 2”.

1.6.2 Backfilling around Conduits

Where there are no cables, and conduits only are installed, the requirement for a sand backfilling material can be relaxed and all of the trench backfilled in accordance with following section of backfilling the reminder of the trench. For further details refer to Evoenergy document PO0793 “Civil Works Manual Volume 2”.

1.6.3 Backfilling the Reminder of the Trench

Spoil from trenches may be used for backfilling providing it complies with the requirements for backfill with Evoenergy document PO0793 “Civil Works Manual Volume 2”.

Special consideration is required when backfilling areas where earthing conductors have been installed to ensure that the earthing system performance with regard to step and touch potentials has not been compromised. High resistivity materials such as sand or crusher dust or blue metal must not be used as backfill around bare earthing conductors or electrodes as they could compromise the earthing system.

2. TESTING

2.1 HV cable tests

At completion, the HV cable system and associated switch gear (excluding transformers) must be tested using to at least 2.5kV to ensure that the cables and switchgear are safe to energize. All high voltage cable testing must be in accordance with Evoenergy Document PO07113 “HV Cable and Apparatus Testing.”

Tests must be carried out on each conductor in turn with the other conductors bonded together and earthed to the screen wires. That is:

- Test 1 - Red to White+Blue+Earth
- Test 2 - White to Red+Blue+Earth
- Test 3 - Blue to Red+White+Earth

The circuit will be deemed to have passed this test if the insulation resistance after 10 minutes is stable and is greater than 500MΩ. HV Cables and switchgear within one kilometre (circuit length) of a zone substation will also require a high voltage withstand test.

Phasing and phase rotation checks are also required on HV Cables.

Visual checks of phase colours must be performed at HV switchgear and during the energisation process Evoenergy staff will perform phasing checks across open points where appropriate.

2.2 Distribution Substation Tests

The following series of tests must be carried out on the completed padmount substation:

- A thorough Visual Inspection of the completed substation
- An Insulation Resistance Test on the HV and LV sides
- An Earthing System test
- Visual inspection of the completed substation must ensure that:
- The substation installation is completed and ready to be tested.
- All terminations are complete, and fasteners torqued.
- HV fuses are correctly installed and are of the specified rating.
- The LV switchboard is equipped with the required quantity and rating of fuses, the LV Distribution Cables are terminated (including neutral conductors), and earth connections are correctly installed for the method of earthing used.
- All HV and LV destination labelling is installed and correct.
- The details of all items of substation equipment are recorded for the Evoenergy Network Asset Register.
- The oil level in the transformer is satisfactory

All high voltage apparatus testing must be in accordance with Evoenergy Document PO07113 “HV Cable and Apparatus Testing.” The earthing system test must be conducted in accordance with Evoenergy Document PO07128 “Distribution Earthing Testing.

2.3 Low Voltage and Earthing Cable Test (Including Service cable)

All low voltage testing must be in accordance with Evoenergy Document PO07249 “Low voltage testing manual”.

2.3.1 Continuity Resistance

The effectiveness of the conductor joints and terminations must be checked using a continuity resistance test using an approved method. For further details, refer to Continuity Testing in Evoenergy Document PO07249 “Low voltage testing manual”.

2.3.2 Loop Impedance

The multiple earthed neutral system (MEN) requires a low impedance neutral to maintain the neutral and earth at the same potential and to ensure adequate fault current flows to operate protective fuses and circuit breakers in the event of a phase to earth fault at an installation. Loop impedances should be kept as low as possible to ensure operation of upstream protective devices. For further details, refer to Neutral Integrity in Evoenergy Document PO07249 “Low voltage testing manual”.

2.3.3 Phasing and Rotation

The phasing of HV and the phasing and rotation of the LV circuits must be checked by carrying out a visual check of the phase colours at each pit/pillar and at the substation low voltage switchboard. The phasing of the service fuses or links at each pit/pillar must be checked against the approved design requirements.

During the energisation process, Evoenergy staff will perform phasing checks across distributor open points at LV Link Pillars. Should circuits fail to phase then energisation of the Project or part thereof will not take place until the cause of the fault is determined and rectified by the appropriate Installation Contractor.

2.3.4 Insulation Resistance

The effectiveness of the circuit insulation must be checked by means of an insulation resistance test using an approved method. Using this method, the test must be carried out on each conductor in turn to the other conductors and earth.

Tests must be carried out from the LV switchboard of the Padmount Substation (with the circuit switch gear in the open position or fuse link removed) or the LV cable termination to overhead lines prior to its connection in accordance with Evoenergy Document PO07249 “Low voltage testing manual”.

2.4 Summary of typical tests required

TYPE OF TEST	APPARATUS
Continuity Resistance	240mm² LV Cables
Phasing & Phase Rotation	All Pits, Pillars and sub LV Boards
Insulation Resistance	LV cables
Insulation Resistance	Transformer HV to LV+E
Insulation Resistance	Transformer LV to HV+E
Insulation Resistance	HV cables + Switchgear to E
HV Withstand	HV Cables and HV Switchgear within 1km of Zone sub
Phasing	HV Switches
Earth Test	Substation LV Earth Substation HV Earth

TABLE 3. TYPICAL TESTS

3. EQUIPMENT LABELLING

Evoenergy requires a uniform labelling identification of substation apparatus, circuits, destination of the HV, LV and service cables. For further details refer to Evoenergy Document PO0735 “Apparatus Terminology & Labelling Standard”.

4. SYSTEM RECORD

Evoenergy maintains a Geographical Information System as a record of asset location and as a source of information for many design and investigative applications and "as-constructed" drawings are used to update this system.

All information on "as-constructed" drawings must be accurate and contain sufficient detail about all underground distribution assets to enable Evoenergy staff to maintain system integrity. Typical information about the assets is given by using appropriate symbols, names, numbers, performance information and physical descriptors (such as dimensions).

To ensure that asset records are maintained in an accurate and up to date manner, details must be kept of the location and type of all Evoenergy assets when they are installed.

To ensure that these records are recorded and displayed in a consistent manner, representation of each asset has been standardised. As well, there is specific information required to ensure that the location of the asset can be determined quickly and accurately for answering enquiries from excavating contractors.

4.1 Substation Records

Every substation installed requires specific information to be recorded. The table below indicates typical data to be recorded for the substation, transformer, and switchgear.

SUBSTATION DATA	TRANSFORMER DATA	HV SWITCHGEAR DATA	LV SWITCHGEAR DATA
Substation no.	Transformer No.	Switchgear no.	Switchgear no.
Suburb	Substation no.	Substation no.	Substation no.
Block and Section	Manufacturer	Make	Make
Street Address	Serial No.	Model	Model
HV Earth value	Tender No.	Type	Type
Date HV earth tested	Tx report no.	Insulation medium	Voltage
LV Earth value	Year of manufacture	Voltage	Year of manufacture
Date LV earth tested	kVA rating	Serial no.	Fuse rating
Location plan of earthing cables	Impedance	Tender No.	
Installation date	No. of taps	Year of manufacture	
Substation Type	% diff. Between taps	Remotely operable	
Function	Volume of oil	Fault Passage Indication	
HV switchgear arrangement	Tx total weight	Fuse rating	
	Installation date		
	No. of phases		
	HV Voltage Selected (eg10450)		
	LV Voltage (nominal)		
	Vector group		

TABLE 4. TYPICAL DATA REQUIRED FOR SUBSTATION RECORDS

4.2 Field recording

The recording of electrical network assets in the field may be based on the PO 060100 “Spatial Data Standards – Electrical Network Assets”. This document is in draft status and outlines the spatial data standards required for submission of spatial data for incorporation in Evoenergy’s geographic information system (GIS). Any concerns on the document must be raised with Geospatial Data Manager.

Along with above document following guidelines can also be followed when recording assets in the field

- Measurements from kerb line and side boundary projections must be used wherever possible

- All measurements must be shown clearly
- All cable sizes and location of joints must be shown
- Measurements required to plot substations, switching stations, submersible service pits, pillars etc. must be shown
- Number and size of conduits must be shown (if conduit extends more than one metre beyond kerb dimension must be shown)
- Location of earth grids and earth electrodes must be shown

It is preferable to dimension from fixed and readily located structures and points. Kerb (back of kerb) lines are the best reference point even though they occasionally change (road widening etc.). Side property boundaries may also be used although front property lines are sometimes difficult to locate exactly. Substations and pits/pillars are also acceptable but are not preferred. Boundary pegs and (to a lesser extent) streetlights can be removed or relocated and are not reliable as a reference point.

Measurements from front property lines, substations and switching stations should be kept to a minimum. Cable types need to be identified on both sides of a cable joint and on the three sides of a T-joint.

DIMENSION	PREFERENCE
Along kerb and/or projection of kerb being measured to projection of kerb of adjoining street	Preferred
Right angle to kerb	Preferred
Along property line and projection of PL	Preferred
Right angle to PL projection of PL	Preferred
Along kerb from projection of PL	Preferred
Along kerb and/or projection of kerb from centre line projection of sub/sws/pit/pillar	Non preferred
Along trench from projection of PL	Non-preferred
Along kerb from projection of peg or along PL from peg	Non-preferred

TABLE 5. FIELD RECORDING PREFERENCES

APPENDIX B – DESIGN OPTIONS

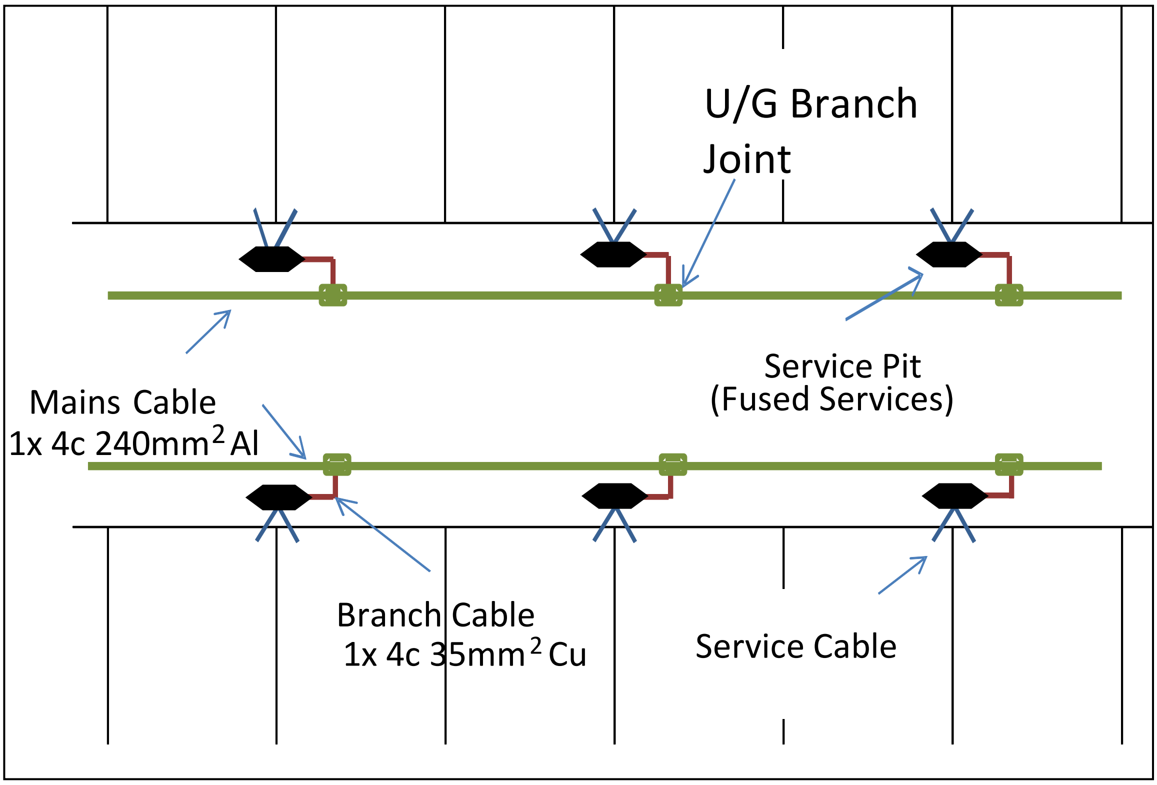
Design option 1, 2 and 3 are for Greenfield development, where the mains cables should be directly buried except where conduit is required, mainly at all road crossings, driveways and near the padmount. Branch cable and Service cable is required to be installed in conduits only. This installation should comply with the shared trench agreement, if used and all the other separation and/or clearance requirements set by Evoenergy.

For medium density housing developments, 240mm² XLPE cable can be designed to run straight from padmount substation to medium density housing block and then be extended to the point of entry box for the block. In this arrangement, all the 240mm² XLPE cables will be fused at LV switchboard of the padmount. Alternatively, medium density housing can be designed using Link pillar, which will give an additional facility of isolation and extension of the LV mains cable for future load.

Design Option 1

In this design option, LV mains cable runs on both sides of the road and an underground pit is connected using a branch joint with 35mm² copper cable as shown in sketch below.

Figure below shows the typical arrangement and layout of LV distribution cables, LV branch cables, Submersible Service Pits and LV Service Cables.

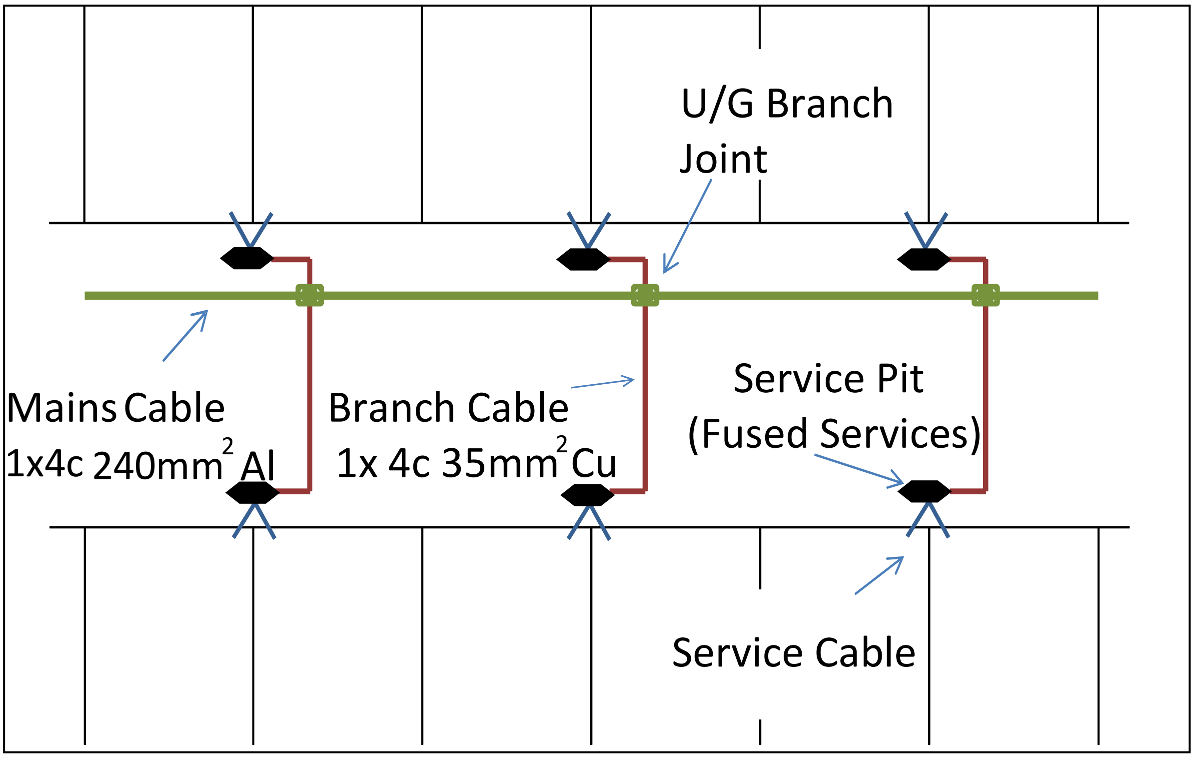


Note: This sketch is indicative only.

Design Option 2

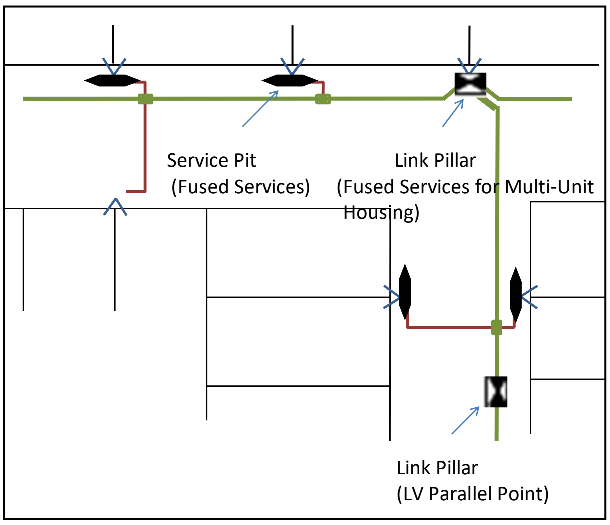
In this design option, LV mains cable runs on one side of the road and an underground pit is connected using a branch joint with 35mm² copper cable as shown in sketch below.

Figure Below shows the typical arrangement and layout of LV Distribution Cables, LV Branch Cables, Submersible Service Pits and LV Service Cables.



Note: This sketch is indicative only.

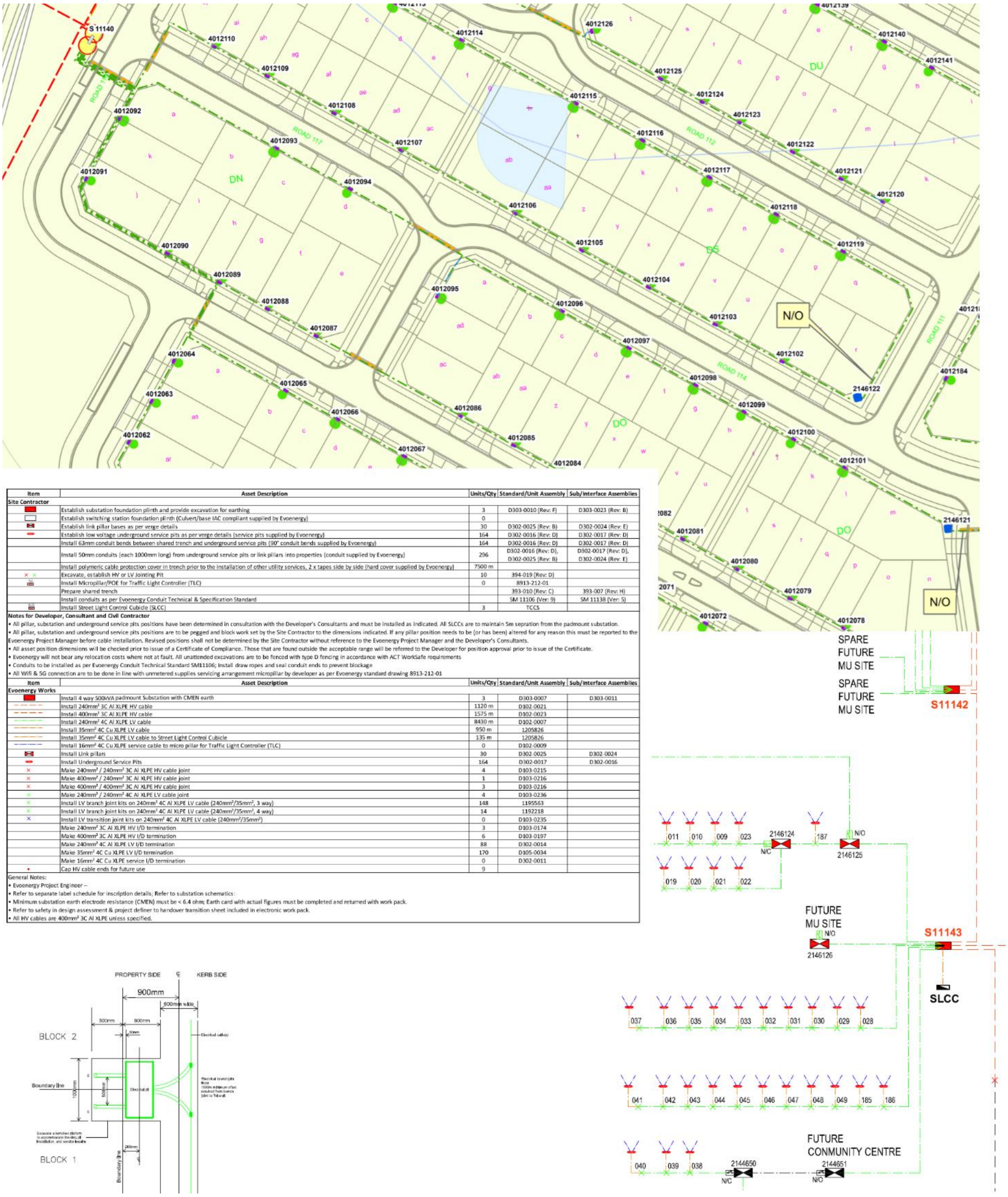
Below figure shows the typical arrangement and layout of LV Distribution Cables, LV Branch Cables, Submersible Service Pits and Link Pillars.



Note: This sketch is indicative only.

Design Option 3

Below figure shows the typical issued for construction design for Greenfield development including the single line diagram showing the spare circuits for future and normally open and closed links; scope of work detailing all types of work (cabling, jointing, padmount installation, civil works for contractor etc.); verge details (if not as per the shared trench.

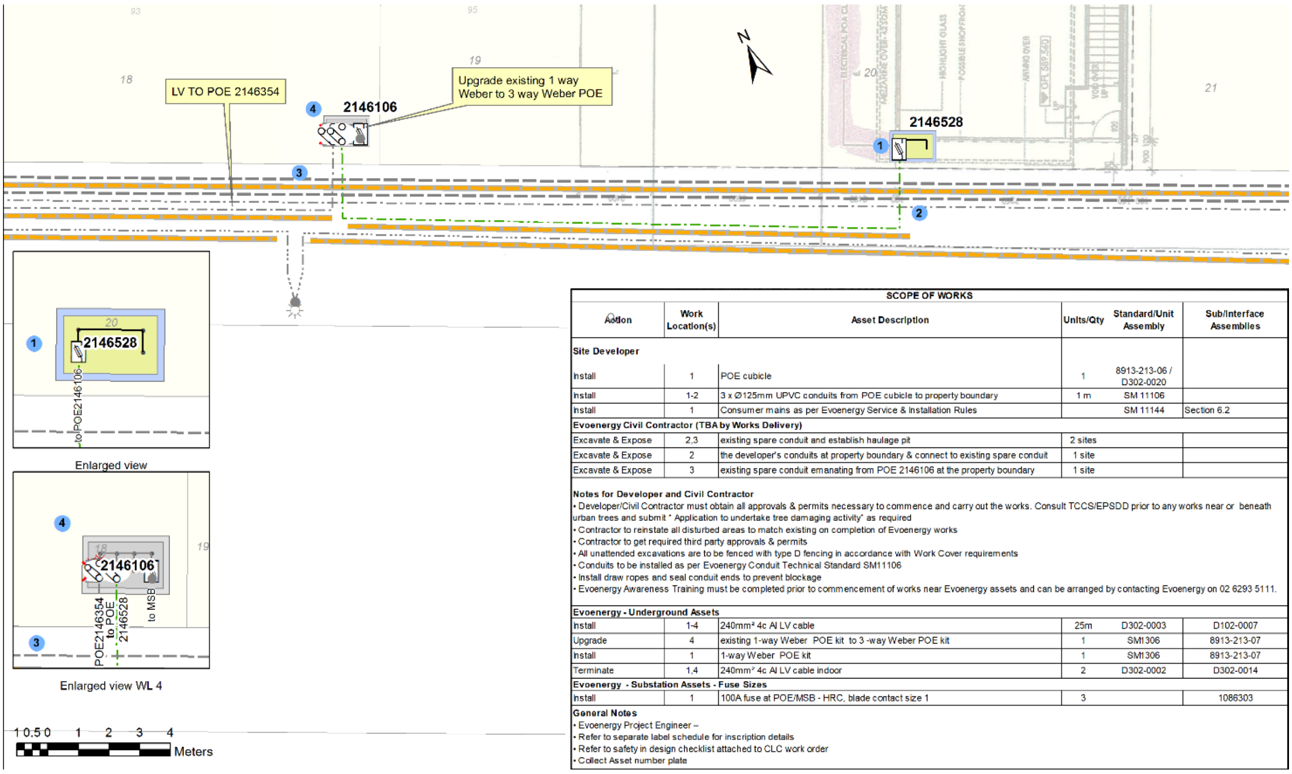


Item	Asset Description	Units/Qty	Standard/Unit Assembly	Sub/Interface Assemblies
Site Contractor				
	Establish substation foundation plinth and provide excavation for earthing	3	D303-0010 (Rev: F)	D303-0023 (Rev: B)
	Establish switching station foundation plinth (Culvert/base IAC compliant supplied by Evoenergy)	0		
	Establish link pillar bases as per verge details	30	D302-0025 (Rev: B)	D302-0024 (Rev: E)
	Establish low voltage underground service pits as per verge details (service pits supplied by Evoenergy)	164	D302-0016 (Rev: D)	D302-0017 (Rev: D)
	Install 63mm conduit bends between shared trench and underground service pits (90° conduit bends supplied by Evoenergy)	164	D302-0016 (Rev: D)	D302-0017 (Rev: D)
	Install 50mm conduits (each 1000mm long) from underground service pits or link pillars into properties (conduit supplied by Evoenergy)	296	D302-0016 (Rev: D), D302-0025 (Rev: B)	D302-0017 (Rev: D), D302-0024 (Rev: E)
	Install polymeric cable protection cover in trench prior to the installation of other utility services, 2 x tapes side by side (hard cover supplied by Evoenergy)	7500 m		
	Excavate, establish HV or LV Jointing Pit	10	394-019 (Rev: D)	
	Install Micropillar/POE for Traffic Light Controller (TLC)	0	8913-212-01	
	Prepare shared trench		393-010 (Rev: C)	393-007 (Rev: H)
	Install conduits as per Evoenergy Conduit Technical & Specification Standard		SM 11106 (Ver: 9)	SM 11138 (Ver: 5)
	Install Street Light Control Cubicle (SLCC)	3	TCCS	
Notes for Developer, Consultant and Civil Contractor • All pillar, substation and underground service pits positions have been determined in consultation with the Developer's Consultants and must be installed as indicated. All SLCCs are to maintain 5m sepration from the padmount substation. • All pillar, substation and underground service pits positions are to be pegged and block work set by the Site Contractor to the dimensions indicated. If any pillar position needs to be (or has been) altered for any reason this must be reported to the Evoenergy Project Manager before cable installation. Revised positions shall not be determined by the Site Contractor without reference to the Evoenergy Project Manager and the Developer's Consultants. • All asset position dimensions will be checked prior to issue of a Certificate of Compliance. Those that are found outside the acceptable range will be referred to the Developer for position approval prior to issue of the Certificate. • Evoenergy will not bear any relocation costs where not at fault. All unattended excavations are to be fenced with type D fencing in accordance with ACT WorkSafe requirements • Conduits to be installed as per Evoenergy Conduit Technical Standard SM11106; Install draw ropes and seal conduit ends to prevent blockage • All Wifi & 5G connection are to be done in line with unmetered supplies servicing arrangement micropillar by developer as per Evoenergy standard drawing 8913-212-01				
Item	**Asset Description**	**Units/Qty**	**Standard/Unit Assembly**	**Sub/Interface Assemblies**
Evoenergy Works				
	Install 4 way 500kVA padmount Substation with CMEN earth	3	D303-0007	D303-0011
	Install 240mm² 3C Al XLPE HV cable	1120 m	D102-0021	
	Install 400mm² 3C Al XLPE HV cable	1575 m	D102-0023	
	Install 240mm² 4C Al XLPE LV cable	8430 m	D102-0007	
	Install 35mm² 4C Cu XLPE LV cable	950 m	1205826	
	Install 35mm² 4C Cu XLPE LV cable to Street Light Control Cubicle	135 m	1205826	
	Install 16mm² 4C Cu XLPE service cable to micro pillar for Traffic Light Controller (TLC)	0	D102-0009	
	Install Link pillars	30	D302-0025	D302-0024
	Install Underground Service Pits	164	D302-0017	D302-0016
	Make 240mm² / 240mm² 3C Al XLPE HV cable joint	4	D103-0215	
	Make 400mm² / 240mm² 3C Al XLPE HV cable joint	1	D103-0216	
	Make 400mm² / 400mm² 3C Al XLPE HV cable joint	3	D103-0216	
	Make 240mm² / 240mm² 4C Al XLPE LV cable joint	4	D103-0236	
	Install LV branch joint kits on 240mm² 4C Al XLPE LV cable (240mm²/35mm², 3 way)	148	1195563	
	Install LV branch joint kits on 240mm² 4C Al XLPE LV cable (240mm²/35mm², 4 way)	14	1192218	
	Install LV transition joint kits on 240mm² 4C Al XLPE LV cable (240mm²/35mm²)	0	D103-0235	
	Make 240mm² 3C Al XLPE HV I/D termination	3	D103-0174	
	Make 400mm² 3C Al XLPE HV I/D termination	6	D103-0197	
	Make 240mm² 4C Al XLPE LV I/D termination	88	D302-0014	
	Make 35mm² 4C Cu XLPE LV I/D termination	170	D105-0034	
	Make 16mm² 4C Cu XLPE service I/D termination	0	D302-0011	
•	Cap HV cable ends for future use	9		
General Notes: • Evoenergy Project Engineer – • Refer to separate label schedule for inscription details; Refer to substation schematics: • Minimum substation earth electrode resistance (CMEN) must be < 6.4 ohm; Earth card with actual figures must be completed and returned with work pack. • Refer to safety in design assessment & project definer to handover transition sheet included in electronic work pack. • All HV cables are 400mm² 3C Al XLPE unless specified.				

Note: This sketch is indicative only.

Design Option 4

Below figure shows the typical issued for construction design for supply to commercial development in Brownfield development including the single line diagram of PoEs with labels; scope of work detailing all types of work (cabling, jointing, PoE, Fuses, civil works for contractor etc.)

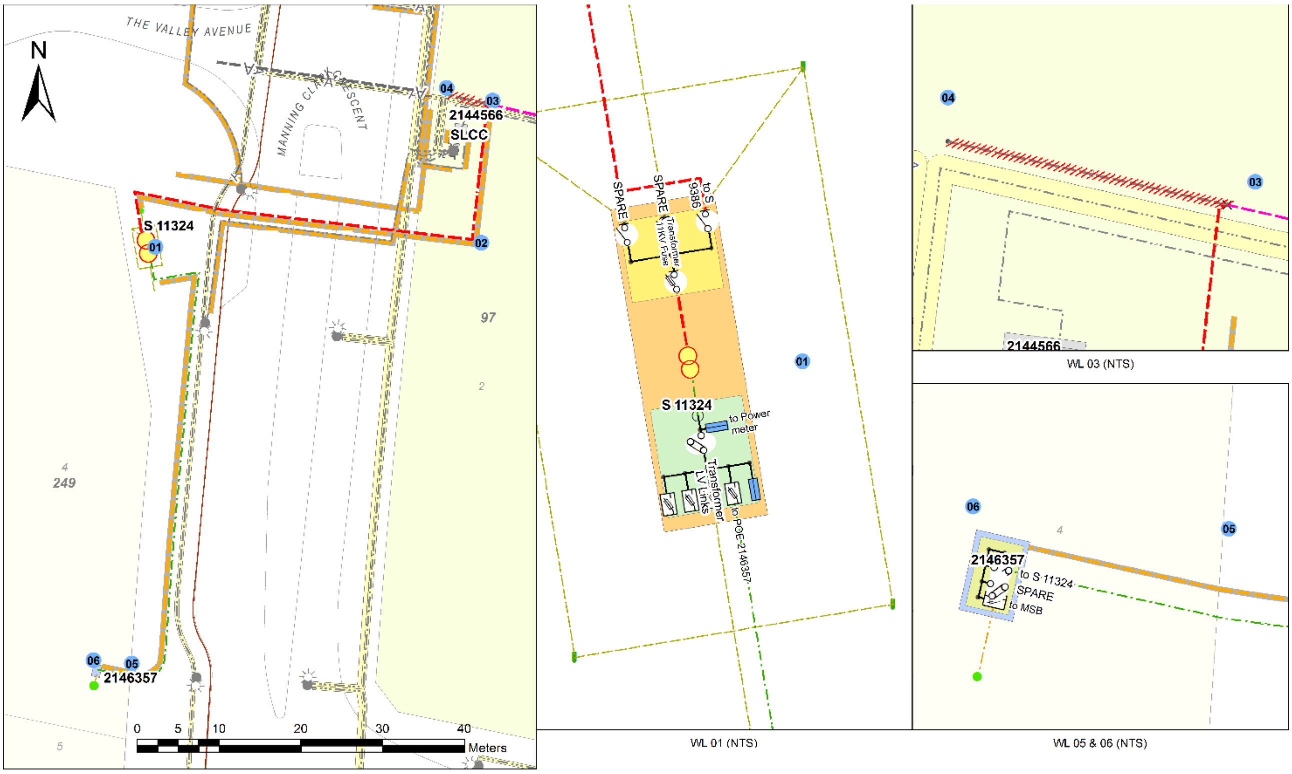


SCOPE OF WORKS					
Action	Work Location(s)	Asset Description	Units/Qty	Standard/Unit Assembly	Sub/Interface Assemblies
Site Developer					
Install	1	POE cubicle	1	8913-213-06 / D302-0020	
Install	1-2	3 x Ø125mm UPVC conduits from POE cubicle to property boundary	1 m	SM 11106	
Install	1	Consumer mains as per Evoenergy Service & Installation Rules		SM 11144	Section 6.2
Evoenergy Civil Contractor (TBA by Works Delivery)					
Excavate & Expose	2,3	existing spare conduit and establish haulage pit	2 sites		
Excavate & Expose	2	the developer's conduits at property boundary & connect to existing spare conduit	1 site		
Excavate & Expose	3	existing spare conduit emanating from POE 2146106 at the property boundary	1 site		
Notes for Developer and Civil Contractor • Developer/Civil Contractor must obtain all approvals & permits necessary to commence and carry out the works. Consult TCCS/EPSDD prior to any works near or beneath urban trees and submit " Application to undertake tree damaging activity" as required • Contractor to reinstate all disturbed areas to match existing on completion of Evoenergy works • Contractor to get required third party approvals & permits • All unattended excavations are to be fenced with type D fencing in accordance with Work Cover requirements • Conduits to be installed as per Evoenergy Conduit Technical Standard SM11106 • Install draw ropes and seal conduit ends to prevent blockage • Evoenergy Awareness Training must be completed prior to commencement of works near Evoenergy assets and can be arranged by contacting Evoenergy on 02 6293 5111.					
Evoenergy - Underground Assets					
Install	1-4	240mm² 4c Al LV cable	25m	D302-0003	D102-0007
Upgrade	4	existing 1-way Weber POE kit to 3 -way Weber POE kit	1	SM1306	8913-213-07
Install	1	1-way Weber POE kit	1	SM1306	8913-213-07
Terminate	1,4	240mm² 4c Al LV cable indoor	2	D302-0002	D302-0014
Evoenergy - Substation Assets - Fuse Sizes					
Install	1	100A fuse at POE/MSB - HRC, blade contact size 1	3		1086303
General Notes • Evoenergy Project Engineer – • Refer to separate label schedule for inscription details • Refer to safety in design checklist attached to CLC work order • Collect Asset number plate					

Note: This sketch is indicative only.

Design Option 5

Below figure shows the typical issued for construction design for supply to multiunit site using the padmount substation in Brownfield development including the earthing details; scope of work detailing all types of work (cabling, jointing, PoE, Fuses, civil works for contractor etc.).

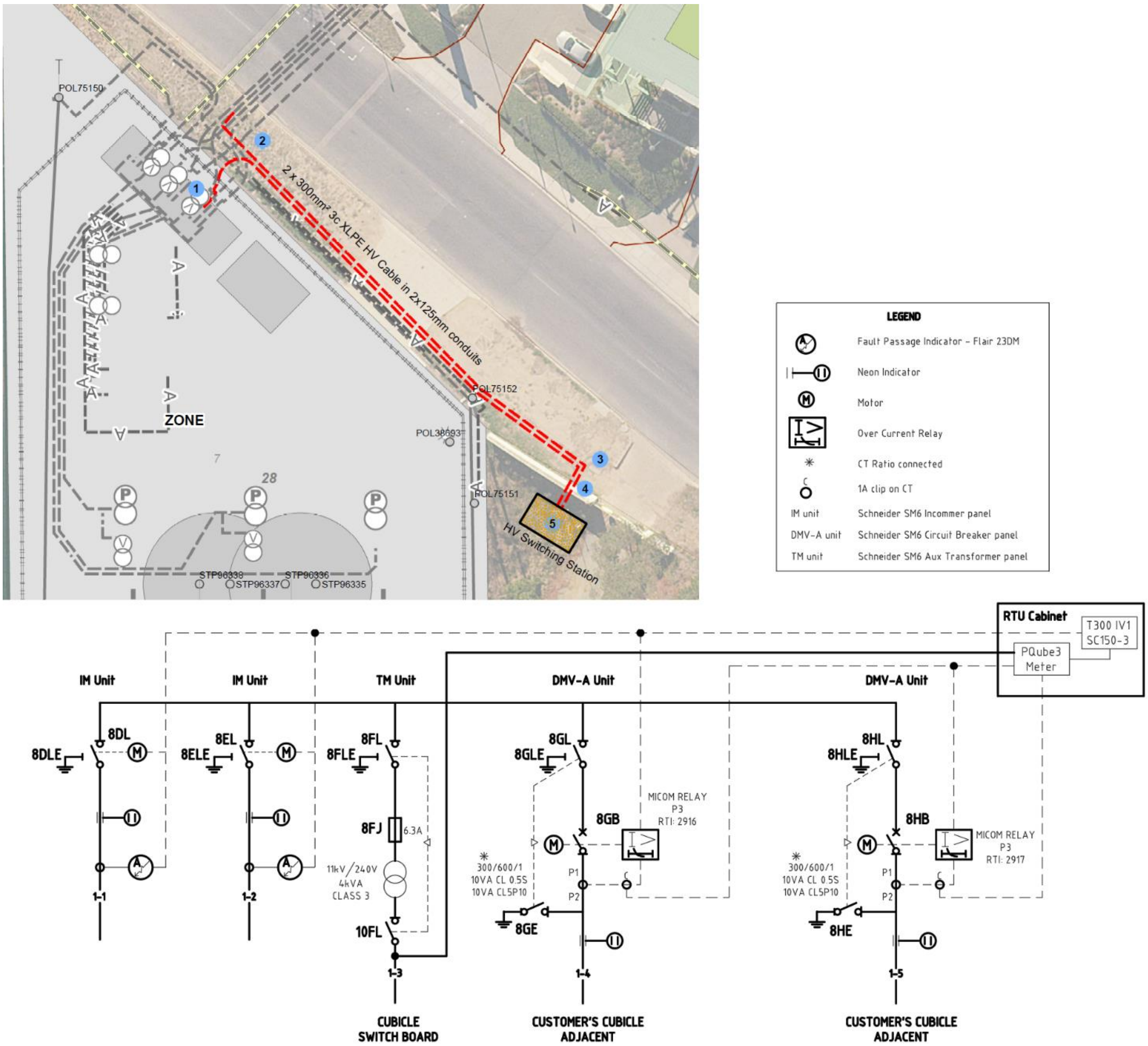


Location	Action	Work Location(s)	Asset Description	Units/Qty	Standard/Unit Assembly	Sub/Interface Assemblies
Site Developer						
B4 S249 Gungahlin; Manning Clark Cr	Install	06	POE cubicle along with conduit bends (3x125mm UPVC)	1	SM1306	
B4 S249 Gungahlin; Manning Clark Cr	Install	06 - 05	3 x Ø125mm UPVC conduits from POE to property boundary	5 m	SM11106	
B4 S249 Gungahlin; Manning Clark Cr	Arrange		Provide unhindered access in the verge (Manning Clark Cr side)	As Req'd		
B4 S249 Gungahlin; Manning Clark Cr	Arrange		Provide surveyed pegs for the block boundary	1		
Evoenergy Civil Contractor (TBA by Works Delivery)						
B4 S249 Gungahlin; Manning Clark Cr	Install	01	New Universal Plinth (as per the DA drawings)	1	D303-0023	
B4 S249 Gungahlin; Manning Clark Cr	Excavate	01	Around the plinth for earth grading ring	1		
B4 S249 Gungahlin; Manning Clark Cr	Install	01 - 02 - 03	2 x Ø125mm UPVC conduits from Sub plinth to Joint pit (Note: Underbore through the road and excavation for the rest of route)	65m	SM11106	
B4 S249 Gungahlin; Manning Clark Cr	Establish	03	HV cable jointing pit (3m x 5m)	1	394-019	
B4 S249 Gungahlin; Manning Clark Cr	Install	01 - 05	2 x Ø125mm UPVC conduits from Sub plinth to Joint pit (Note: Through excavation)	55m	SM11106	
B4 S249 Gungahlin; Manning Clark Cr	Connect	05	2 x Ø125mm UPVC conduit with developer supplied conduit at property boundary	1		
Notes for Developer and Civil Contractor **• All excavations near live cables are to be completed by Evoenergy accredited contractor and must be Evoenergy inducted and completed Evoenergy Network Awareness Training.** **This can be arranged by contacting Evoenergy on 02 6293 5111.** • Developer/Civil Contractor must obtain all approvals & permits necessary to commence and carry out the works. Consult TCCCS/ACTPLA prior to any works near or beneath urban trees and submit " Application to undertake tree damaging activity" as required; • Developer/Civil Contractor to reinstate all disturbed areas to match existing on completion of Evoenergy works • Developer/Civil Contractor to get required third party approvals & permits (eg Road ACT for road opening permit & TCCS for minipillar footing) • All unattended excavations are to be fenced with type D fencing in accordance with ACT WorkSafe requirements • Conduits to be installed as per Evoenergy Conduit Technical Standard SM11106; Install draw ropes and seal conduit ends to prevent blockage						
Evoenergy - Underground Assets						
B4 S249 Gungahlin; Manning Clark Cr	Install	01	500kVA 4 way Padmount Substation 11324 with Separate Earthing	1	D303-0007	D101-0022; D303-0009
B4 S249 Gungahlin; Manning Clark Cr	Install	01 - 02 - 03	240mm² 3c Al HV cable	75m	D102-0021	
B4 S249 Gungahlin; Manning Clark Cr	Test	03	Existing 240mm² 3c Al HV cable (VLF & Megger)	1		
B4 S249 Gungahlin; Manning Clark Cr	Cut & re-route	03	240mm² 3c Al HV cable to joint pit	1		
B4 S249 Gungahlin; Manning Clark Cr	Make cable joint	03	240mm² 3c Al HV STJ	1	D103-0215	
B4 S249 Gungahlin; Manning Clark Cr	Terminate	01	240mm² 3c Al HV I/D	1	D103-0174	
B4 S249 Gungahlin; Manning Clark Cr	Install	06	630A 3 way Weber POE kit	1		1151964
B4 S249 Gungahlin; Manning Clark Cr	Install	01 - 05 - 06	240mm² 4c Al LV cable	75m	D102-0007	
B4 S249 Gungahlin; Manning Clark Cr	Terminate	01 , 06	240mm² 4c Al LV I/D; 315A fuse	2	D302-0014	1086455
B4 S249 Gungahlin; Manning Clark Cr	Terminate	01	Consumer mains cables into POE 2146357	1		
General Notes: • Evoenergy Project Engineer – • Refer to separate label schedule for inscription details; Refer to substation schematics; • Minimum substation earth electrode connected resistance (Sep) must be < 14 ohm; Earth card with actual figures must be completed and returned with work pack. Refer to earth card ID 411517 • Refer to safety in design assessment & project definer to handover transition sheet included in electronic work pack						

Note: This sketch is indicative only.

Design Option 6

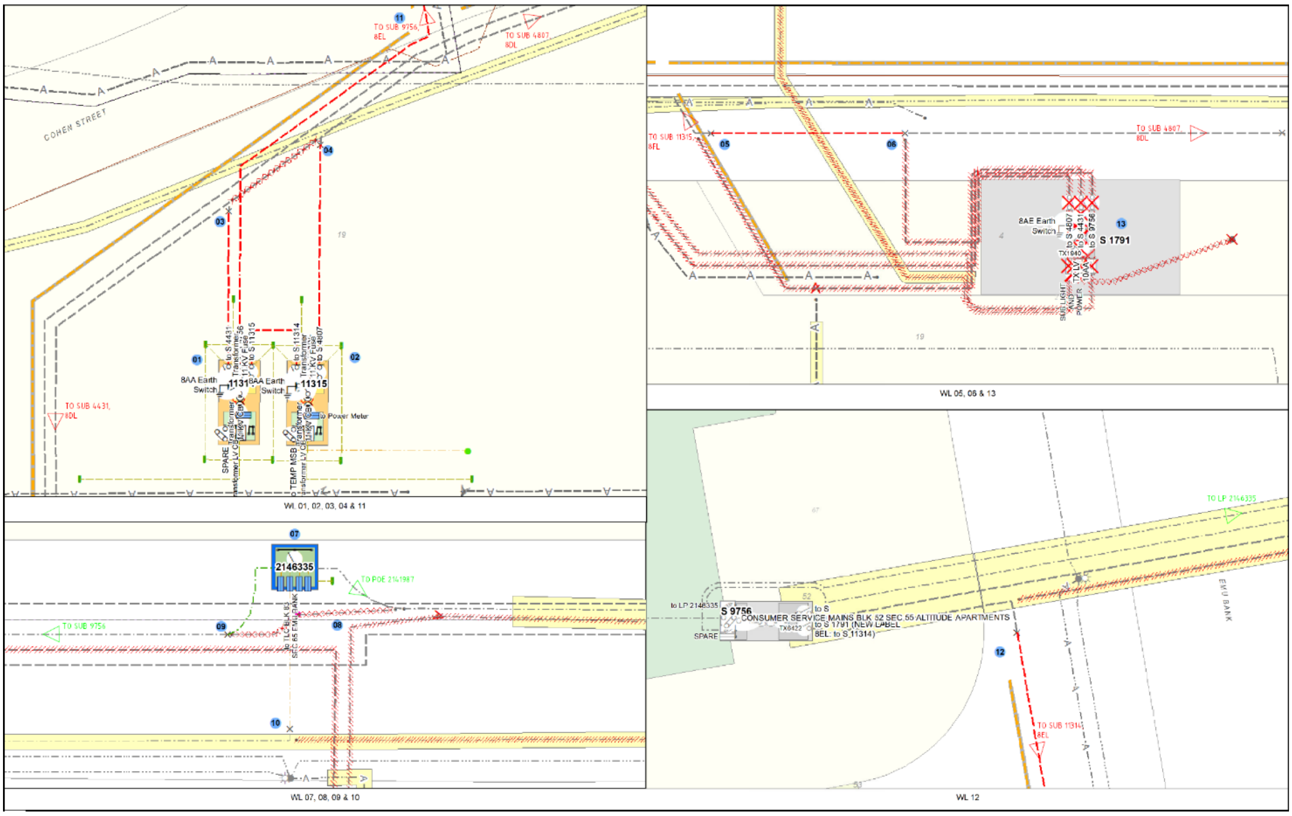
Below figure shows the non-typical design for HV supply to industrial site using the switching substation in Brownfield development from zone substation. This arrangement is required to be approved through network alteration proposal process.



Note: This sketch is indicative only.

Design Option 7

Below figure shows the typical design for LV supply through twin padmounts arrangement with non-typical CMEN earthing. The design also includes the decommissioning of Chamber substation along with circuit destinations.



Note: This sketch is indicative only.