CitiPower	ELECTRICITY NETWORKS Network Planning & Development Functional Scope	Powercor Australia

Functional Scope Created	**1/08/2019**	**By**	Chris McCallum		
		Ex:	7690		
Project RO		**Ex:**			
Project Title	Waurn Ponds (**WPD**) ZSS REFCL Installation				
Network No. and F/C					
Last Update	16/01/2020	**By**	C.McCallum	**Version**	1.0
Related Scopes	TQY zone substation				
Project Engineer					
System Planning Engineer	Chris McCallum				
Protection and Control Engineer	Vikram Hadya				
Plant and Stations Engineer					
Asset Strategy Engineer					
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Version	Date	Changes	Responsible Officer
0.1	1/08/2019	Initial Scope	C.McCallum
0.2	02/08/2019	Minor updates	V.Hadya
0.3	08/08/2019	Minor update to Neutral Bus wording and ACR replacements	C.McCallum
0.4	15/11/2019	Minor update to Regulator wording for BARRABOOL RD P89A, updated Distribution Switchgear and HV underground cable.	C.McCallum
1.0	16/01/2020	Finalised scope	C.McCallum

1 Project overview

This project scope covers the migration of the Waurn Ponds zone substation (WPD) system to a resonant earthed network. Migration to a resonant network requires the installation and operation of a ground fault neutraliser (**GFN**). This changes the electrical operating characteristics of a zone substation and its distribution network as follows:

- full voltage displacement occurs on the system for operation of the GFN;
- this significantly stresses equipment on the system and may lead to failure;
- this equipment has been identified and included in this scope for replacement as part of the GFN installation; and
- other limitations will dictate part of the operational protocols that will be developed by Electricity Networks.

The GFN provides potential benefits to single-phase-to-ground faults on the 22kV three phase system. It provides no benefit on the following:

- the 12.7kV Single Wire Return System (**SWER**);
- the 66kV sub-transmission system; and
- the low voltage (**LV**) system.

1.1 Background

To meet the Victorian Government Bushfire Mitigation Regulations performance standards for detection and limiting of arc fault energy on high voltage (**HV**) overhead assets in high bushfire consequence, rapid earth fault current limiters (**REFCLs**) can be used.

A REFCL is a network protection device, normally installed in zone substations that significantly reduce the arc fault energy generated during a phase to ground fault to mitigate against fire ignition.

The Bushfire Mitigation Regulations mandate the following performance criteria (for a phase-to-ground fault on a polyphase electric line with a nominal voltage between 1 kV and 22 kV):

- to reduce the voltage on the faulted conductor in relation to the station earth when measured at the corresponding zone substation for high impedance faults to 250 volts within 2 seconds; and
- to reduce the voltage on the faulted conductor in relation to the station earth when measured at the corresponding zone substation for low impedance faults to:
  - 1900 volts within 85 milliseconds; and
  - 750 volts within 500 milliseconds; and
  - 250 volts within 2 seconds; and
- during diagnostic tests for high impedance faults, to limit:
  - fault current to 0.5 amps or less; and
  - the thermal energy on the electric line to a maximum I^2t value of 0.10;

1.2 Waurn Ponds zone substation

Waurn Ponds 66/22 kV zone substation is a fully switched station consisting of two (2) 25/33 MVA transformers and one (1) 10/13.5 MVA transformers and two (2) capacitor banks, one (1) 1 x 6.0MVar bank and one (1) 4 x 3.0MVar bank. A fully switched zone substation is designed so that in the event of a transformer fault, one transformer will be isolated, and the remaining units will continue to supply the station load. It is located on the urban fringe of Geelong, 9km south-west of the Geelong CBD, on the corner of Hams Rd and Ghazeepore Road and supplies electricity to 35,973 customers in the southern Geelong suburbs of Waurn Ponds, Grovedale, Belmont and Highton, as well as customers in the Surf Coast towns of Torquay, Jan Juc, Anglesea and Lorne. The major customers supplied from WPD zone substation include Deakin University and the Epworth Hospital.

WPD zone substation has electrical connectivity (distribution ties) with the four adjacent zone substations of Colac (CLC), Geelong (GL), Geelong City (GCY) and Geelong East (GLE).

To permit the transfer of loads from adjacent zone substations with the GFN in service the 22kV feeder requirements in section 3 of this scope must also be applied to the portion of the feeders that can be transferred to WPD. GCY014, GL021, GLE012, and GLE013 are the feeders that can be transferred to WPD, as well as sections of CLC014, GCY011, and GL012.

The Switch Zones are as follows:

GCY011 → WPD011 (via GCY014)

Between P130 Roslyn Rd Remote Switch (SW# 26803) and P4 Roslyn Rd Remote Switch (SW# 35267)

GCY014 → WPD011 (or WPD033)

Between P1A Nth Valley Rd Remote Switch (SW# 43504) and GCY014 Feeder CB

GL021 → WPD011

Between P62 Scenic Rd Remote Switch (SW# 13744) and GL021 Feeder CB

GLE012 → WPD012

Between P36A Colac Rd Gas Switch (SW# 42568) and GLE012 Feeder CB

GLE013 → WPD012 (or WPD024)

Between P13 Marshalltown Rd Gas Switch (SW# 23440) and GLE013 Feeder CB

WPD zone substation supplies ten 22kV distribution feeders. These feeders support a mix of urban and rural residential customers, light industry and commercial loads and are a mix of overhead and underground conductors. Due to the sheer size of the WPD distribution network that is impacted by the REFCL system (745.3 km of conductors/cables), including a large amount of underground cable (129.4 km), achieving REFCL compliance requires significant augmentation of the existing zone substation.

The solution with the highest net benefits is to install three (3) GFNs at WPD on the existing three transformers and build a new zone substation at TQY with two (2) GFNs, and all associated distribution line works including nine (9) isolating substations.

Table 1 WPD: existing characteristics (zone substation)

Zone substation	Volume
Feeders	10
Zone substation transformers	3
22kV buses	3
Capacitor banks	2
Station service transformers	2
22kV circuit breakers (switching configuration)	17 (Fully Switched)

Table 2 WPD: existing characteristics (network)

Network	Volume WPD Only	Volume for GL, GCY and GLE Transfers	Volume Totals
Total route length (km)	745.3	120.9	866.2
Underground cable length (km)	129.4	24.5	153.9
Overhead line length (km)	615.9	96.4	712.3
Underground network (%)	17.4%	20.3%	17.8%
Overhead single phase (km)	193.8	6.7	200.5
Estimated network capacitance (A)	494	93	587
Distribution transformers	1,731	364	2,095
HV regulator sites	6	2	8
Fuses	1,850	318	2,168
ACRs	14	8	22
Surge arrestor sites	1,742	452	2,194
HV customers	2 (1 with 2 connections)	1	3

2 ZSS requirements

This functional scope sets out the WPD zone substation requirements, including the following:

- Establish ASC bunds for three (3) REFCLs
- Installation of three (3) Swedish Neutral GFN Arc Suppression Coils (ASC)
- Modification of the 66/22kV transformer earthing arrangement
  - Installation of Transformer Neutral Isolators and Direct Earth Switches
  - Installation of 19kV surge diverters on transformer neutrals
  - Installation of three (3) Neutral Bus Systems
    - Bus CB's
    - NER terminations
    - ASC terminations
    - Neutral VT Installation
- Install ten (10) new post mounted CTs one per HV feeder
- Upgrade station service supply to two (2) new 750kVA kiosk transformers
- Upgrade of the station service supply cabling and installation of new AC distribution board
  - Install current limiting fuses on AC distribution board
- Replace three (3) 22kV Bus VTs (on Bus No.1, Bus No.2 and Bus No.3)
- Replace ALL substation surge arrestors with new 22kV continuous voltage units for resonant network compatibility and 10hr 24kV TOV capability
- Test existing No.1 and No.3 Capacitor Banks. Reconfigure and replace CTs.
- Rearrange the WPD011 and WPD033 feeder exits (feeder rearrangement)
- Replace the existing overhead WPD014 feeder exit with new 240mm^2 3/c 22.a.x.hc.h. underground cable
- Extend station yard and earth grid as required
- Install weather station

Secondary Requirements

Firmware upgrades and new settings for recently installed devices

- Firmware upgrade and new settings for ten (10) feeder protection relays
- Firmware upgrade and new settings for two (2) capacitor bank protection relays
- Firmware upgrade and new settings for four (4) 66kV CB management relays
- Firmware upgrade and new settings for five (5) 22kV CB management relays

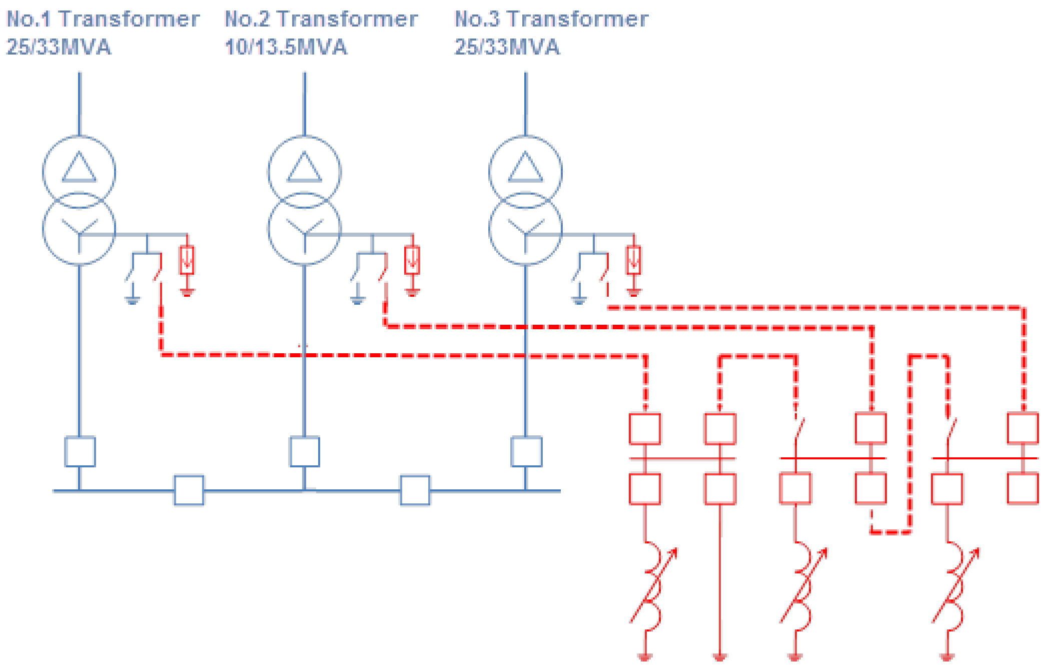
Install the following cubicles

- Install two (2) X Protection ethernet communication cubicles
- Transformer I/O and independent transformer control cubicle
- Install one (1) Neutral Bus Management cubicle
- Install one (1) Earth Fault Management cubicle
- Install three (3) Swedish Neutral GFN cubicles

2.1 Primary plant requirements

The works associated with the installation of the WPD ASC arrangement is summarised in the following single line diagram.

Figure 3 WPD Proposed Neutral Diagram



2.1.1 Arc suppression coil

Install three (3) x Swedish Neutral – Ground Fault Neutraliser's Arc Suppression Coil (ASC) components. The arc suppression coil is a paper wound copper coil wrapped around a solid iron core and immersed in oil. This arc suppression coil is of fixed reluctance but contains an array of capacitors in parallel that are switch as part of the tuning process of the coil. The coil also features an LV winding for coupling of these capacitors and the Residual Current Compensator.

Primary neutral and earth connections are via elbows.

As oil filled device, it shall be installed in a bunded area in accordance with current standards.

The GFN ASC's are to be installed in a yet to be determined location of the yard (see proposed arrangement in Section 4 of the Appendix, subject to a design review);

- install Ground Fault Neutraliser comprising of three (3) x 17-200A ASC and residual current compensation modules with maximum available tuning steps onto the provided pad mount within a newly established bunded area;
- the footing of the ASC shall reside on the installed 150mm steel beams fixed to the concrete pad; and
- install cable connections to and from the Neutral System.

2.1.2 GFN inverter room

Install one (1) GFN inverter hut in the WPD zone substation yard (see proposed arrangement in Section 4 of the Appendix, subject to design review).

2.1.3 Zone substation surge arrestors

In a non-effectively earthed system, the voltage displacement caused under earth fault conditions results in the healthy phases experiences full line-to-line voltage on a line-to-ground basis. Surge arrestors used in Powercor substations do not have the Temporary Overvoltage Capability required for these conditions.
To accommodate transition to a resonant network:

- Replace all sub-standard zone substation surge arresters with a station class (class 2) 22kV continuous voltage arrestor (ABB MWK22 or equivalent)

2.1.4 Zone substation capacitor banks

The existing No.1 and No.3 capacitor banks are connected in grounded star with CTs which require replacement. To make these existing capacitor banks meet resonant network requirements:

- The neutral star-point earth shall be removed from the No. 1 and No.3 22kV Capacitor Banks
    - Neutral (star-point) structure must provide sufficient insulation to allow for continuous neutral displacement (12.7kV + 10%) under system earth fault conditions
    - The primary designer shall review the existing design to ensure the neutral point is fit for continuous operation at 13.97kV
    - The star point shall be reconfigured as a floating neutral, and the neutral structure re-designed if necessary
- Replace CTs on capacitor bank with new REFCL compliant CTs.

2.1.5 Neutral system arrangement

- Three (3) new kiosk type ground mounted modules as per ZD081
    - One (1) module is to be Type A comprising of four (4) circuit breakers
    - One (1) module is to be Type B1 comprising of three (3) circuit breakers and one (1) switch
    - One (1) module is to be Type B2 comprising of two (2) circuit breakers and one (1) switch
- Transformer neutral connection assets
    - HV neutral cable
    - Neutral bus connection isolator
- System earth connection

The Neutral Bus system facilitates simple use of the different earthing methodologies and permits isolation of the transformer neutral in case of access or internal fault.

- The Neutral Bus system and all connection assets shall be continuously rated to 13.97kV
- The Type A neutral bus module has CTs on two (2) of the CBs. Connection to one (1) transformer neutral and to the Type B1 neutral bus module is to be via a CB with CT at the neutral bus module end.
- The Type B1 neutral bus module has CTs on two (2) of the CBs. Connection to one (1) transformer neutral and to the Type B2 neutral bus module is to be via a CB with CT at the neutral bus module end.
- The Type B2 neutral bus module has a CT on one (1) of the CBs. Connection to one (1) transformer neutral and to the Type B1 neutral bus module is to be via a CB with CT to one (1) transformer neutral end.

Neutral Bus

The connection to the neutral bus module shall be via elbow connections. Four (4) elbows are required per module for; Type A neutral bus:

- Transformer neutral connection (1 x transformers)
- ASC connection
- Solid ground connection
- Neutral bus tie connection

Type B1 neutral bus:

- Transformer neutral connection (2 x transformers)

- ASC connection
- Neutral bus tie connection

Type B2 neutral bus:

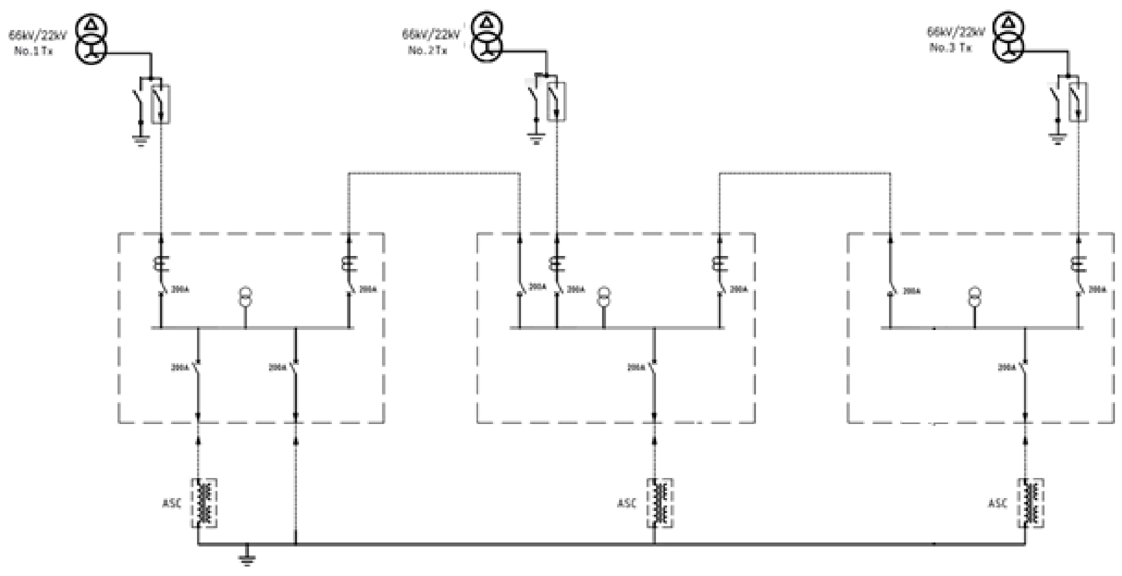
- Transformer neutral connection (1 x transformers)
- ASC connection
- Neutral bus tie connection
- Spare connection

Neutral Voltage Transformer

A neutral VT shall be included in each of the Neutral Bus modules, connected directly to the bus as shown in ZD081.

- 22000 √3 / 110 √3
- Class 0.5M1P
- Output: 15VA
- Frequency: 50 Hz
- Voltage Factor: 1.9 for eight (8) hours
- Dielectric Insulation Level: 24/50/150kV
- Australian Standard: AS 60044.2.

Figure 4 Proposed WPD neutral system single line diagram



2.1.6 Transformer Earthing and Ground Bypass Isolators

The three (3) 66/22kV transformers in service at WPD are delta/star connected with the neutral of the star windings directly earthed.

The neutral earthing arrangement for each transformer shall be modified to permit connection to the Neutral Bus system. For each transformer neutral connection point;

- Insulate the neutral conductor and install independent Neutral Bus/Direct Ground isolators
  - This is required so that if the neutral bus is to be taken out of service the transformer neutrals can be earthed by closing these ground by-pass isolators.
- Install single phase HV cable and cable terminations between the new Transformer Neutral Bus Isolators and the relevant Neutral Bus CB via elbow connections on the Neutral Bus RMU

2.1.7 Neutral surge diverter

Install a Station Class (Class 2) 19kV surge diverter between the transformer neutral bus and the substation earth grid, as close to the transformer neutrals as possible (ABB MWK19 or equivalent).

2.1.8 22kV Bus VT

Replace the existing No.1, No.2 and No.3 22kV bus VTs with the following specification:

- Frequency: 50Hz
- Ratio: 22,000/110/110V
- Connection: Star/Star/Star
- Vector Group: YNyn0yn0
- Neutral for HV and 2 LV Windings: Solidly Earthed
- Output: 100VA Per Phase Per Secondary Winding
- Accuracy: Class 0.5M1P per secondary winding at the specified voltage factor
- Voltage Factor: 1.9 for 8 Hours
- Category B

2.1.9 Station Service Transformer

Retire the existing 100kVA 22kV Station Service Transformers from the No.1 and No.3 22kV buses.

- Install two (2) new 750kVA 22kV Station Service Kiosk Transformers
  - The general arrangement drawing in Section 4 of the Appendix shows the suggested location for these kiosks.
  - Connect the new station service transformers to the No.1 and No.3 22kV buses, protected by HV fuses on the bus.

2.1.10 Adjacent non-REFCL ZSS 22kV feeder transfers

To identify where surge arrestors need to be replaced and how much of the network needs to be surveyed to hardened and balanced the network so that non-REFCL network can be transferred onto a REFCL network.

The following switching zone which is the transfers from non-REFCL subs that need to be considered

- GCY011→ WPD011 (via GCY014)
  - CLOSE P130 Roslyn Rd Remote Switch (SW# 26803)
  - OPEN P4 Roslyn Rd Remote Switch (SW# 35267)

- GCY014 → WPD011 (or WPD033)
  - CLOSE P1A Nth Valley Rd Remote Switch (SW# 43504)
  - OPEN GCY014 Feeder CB

- GL021 → WPD011
  - CLOSE P62 Scenic Rd Remote Switch (SW# 13744)
  - OPEN GL021 Feeder CB

- GLE012 → WPD012
  - CLOSE P36A Colac Rd Gas Switch (SW# 42568)
  - OPEN GLE012 Feeder CB

- GLE013 → WPD012 (or WPD024)

- CLOSE P13 Marshalltown Rd Gas Switch (SW# 23440)
- OPEN GLE013 Feeder CB

2.1.11 22kV Insulators

Replace all existing under rated pin insulators with 24kV rated station post insulators

2.1.12 GFN Sensitivity

The existing WPD 22kV Network consists of an estimated 616km of overhead line and 129km of underground cable. This leads to a network charging current of approximately 437 amps, by 2026 this figure is forecast to be 770 amps.

To meet the sensitivity requirements of the GFN, it is recommended that the network be limited to less than 93 amps. This is a result of a sensitivity analysis surrounding a number of unknown parameters in the WPD network. In order to achieve this, the 22kV network must be rearranged, to cater for the ability to 'split' the buses, HV isolating substations need to be installed (see 3.11 HV isolation substations) and a new zone substation at Torquay (TQY) is to be built.

The following requirements are necessary to split the WPD 22kV buses:

2.1.13 22kV Works

In order to arrange the substation in such a way that when the 22kV bus is split, the capacitive charging current is balanced across the 3 REFCLs, the following works are required.

<u>22 kV Feeder rearrangement</u>

To balance the network charging current among the 3 split buses the following feeders need to be rearranged at the feeder exit

- WPD011 with WPD033
- WPD033 with WPD011

Notes:

- All WPD feeder names in this scope are referencing existing feeder names.

<u>WPD014 feeder exit</u>

Due to space restrictions within the WPD zone substation, it is proposed to underground the WPD014 feeder exit to provide space for the ASCs and neutral bus systems.

From the WPD014 feeder exit to pole 9 WPD to Anglesea Rd (LIS 28102) replace the existing 6/.186, 7/.062 ACSR overhead conductor with new 240mm2 3/c 22.a.x.hc.h. underground cable – approx. 520m.

2.1.14 22kV Bus Nomenclature

Any large scale changes to the 22kV yard require that consideration is given to the naming of plant in the substation from an operational perspective. This is critical from a healthy and safety perspective as well as from an operational

Nameplates in the 22kV Yard must be reviewed and any that do not conform with the new naming of primary plant must be replaced.

- Review nameplates of all 22kV Circuit Breakers, Buses, Isolators, Disconnect Switches, Earth Points and Cables.

All Primary and Secondary drawings must be reviewed and any that do not conform with the new naming of primary plant must be updated.

- Review all drawings with references to 22kV Circuit Breakers, Buses, Isolators, Disconnect Switches, Earth Points and Cables.

Particular attention shall be given to the naming of primary plant items in the operational systems to ensure that any naming changes in the field are updated in the operational software such that switching instructions are correct when printed. This requires coordination between the field works, the SCADA group and network operations.

2.1.15 22kV Feeder CT's

The existing feeder CT specifications are outlined below.

Table 3 Feeder CT Info

Feeder	CT Spec	Required Action
WPD011	10P100 600-300-100/5	Not suitable for sensitivity requirements, require new CT installation.
WPD012	0.2PL100 1600-900-600/5	Not suitable for sensitivity requirements, require new CT installation.
WPD013	0.2PL100 1600-900-600/5	Not suitable for sensitivity requirements, require new CT installation.
WPD014	10P100 600-300-100/5	Not suitable for sensitivity requirements, require new CT installation.
WPD021	10P100 600-300-100/5	Not suitable for sensitivity requirements, require new CT installation.
WPD022	10P100 600-300-100/5	Not suitable for sensitivity requirements, require new CT installation.
WPD024	10P100 600-300-100/5	Not suitable for sensitivity requirements, require new CT installation.
WPD031	2.5P150 600/5	Not suitable for sensitivity requirements, require new CT installation.
WPD032	0.2PL100 1600-900-600/5	Not suitable for sensitivity requirements, require new CT installation.
WPD033	10P100 600-300-100/5	Not suitable for sensitivity requirements, require new CT installation.

The 22kV feeder CTs require testing to determine their suitability for REFCL fault detection and feeder balancing. A process is currently underway to determine the performance of different CTs across the Powercor network to further guide REFCL scoping requirements. Horizon breakers have been identified to have appropriate accuracy, but still require testing.

The performance requirements do not align to any conventional standard and must be confirmed through a particular set of tests.

At WPD, all ten (10) 22kV feeder CTs require the installation of post mounted CTs 600-300/5A 40-20VA class 0.1.

2.1.16 Earth Grid Resistance

Experience from our REFCL Trial substations has shown that the earth grid impedance in multiple REFCL substations negatively impacts on the ability to achieve 25.4 kΩ fault detection. In our desired range of network size an earth grid impedance of 0.45 Ω will result in a neutral voltage developed in the unfaulted bus up to 1.5kV which is greater than the fault detection threshold for required capacity.

At WPD zone substation, the following works are required to reduce the earth grid impedance as low as possible.

- Site survey, earth grid and soil resistivity testing
- Detailed analysis and modelling of earth grid and soil conditions
- Design of earth grid modification works
- Additional earth stakes and earth grid installation

2.1.17 Other considerations

Other considerations required are:

- Replacement of 66/22kV transformers if they fail tests
- Lighting study/review
- Replacement of neutral structures if there any clearance or quality issues
- Asbestos and contaminated soil
- Restumping of control room
- Earth grid extension
- Testing of underground exits on WPD012, WPD013, WPD032 (check if required due to construction timing as this cable is planned to be retired as part of the TQY zone substation scope). If they fail, replace with new 300mm2 cu cable.
- Vegetation removal

2.2 Civil works requirement

For Neutral System

- Install concrete foundation pad for neutral system module
- Install neutral cable conduit, control cable conduit and provision for solid earth grid connections
- Install neutral cable conduits from transformers to neutral system module
- Install conduits to ASC and solid earth grid connection
- Install conduits for secondary circuits

For ASC

- Install neutral cable conduit, control cable conduits and solid earth grid connections
- Pour concrete foundation
- Install steel beam, 150mm high at a width designed to accommodate the placement of the GFN Arc Suppression coil
- Install bunding to EPA requirements

For Station Service Supplies

- Install concrete foundation for new station service transformers
- Review station service transformer foundations and enclosure for upgrade to 750kVA. Note the existing station services is 100kVA

For new 22kV No.1, No.2 and No.3 Bus VTs

- Install concrete footings for new structures
- Install control cable conduits for both 22kV VT

2.3 Secondary works

The following outlines the Protection and Control requirements.

All secondary drawings shall be in the wiring schematic format consistent with the existing suite of drawings for the station.

2.3.1 Station RTU Cubicle

Install:

- One (1) SEL-3505-4 RTACs for RTU & High Voltage Customer NVD comms
- One (1) Tekron GPS Clock
- Station I/O Controllers (SEL-2440) for HW connections to non-DNP devices

Design Notes:

- RTAC to be used for establishing DNP session to 22kV relays
- RTAC NVD to be used for new neutral displacement blocking scheme for 22kV connected generators

2.3.2 Transformer Control Cubicle

Retire:

- Existing SCD-5200 RTU based transformer parallel control scheme

Install:

- Install three (3) SEL-2440 relays to digitise transformer I/O
- Install one (1) SEL-451 relay to implement independent transformer control

Design Notes:

- Configure transformer control relay to digitally summate feeder loads and perform line drop compensation calculations as well as utilise bus tie and transformer CB status' to perform independent voltage control.

2.3.3 SubLAN X & Y Protection A Loop Cubicle

Install:

- Standard 23" protection cubicle
- Two (2) RST-2228 Ethernet Switches for
  - X RST-2228-21 SubLAN
  - X RST-2228-22 SubLAN

Design Notes:

- Y Protection Ethernet switches are not required at this stage however the design should cater for future installation

2.3.4 SubLAN X & Y Protection B Loop Cubicle

Install:

- Standard 23" protection cubicle
- Two (2) RST-2228 Ethernet Switches for
  - X RST-2228-41 SubLAN
  - X RST-2228-42 SubLAN

Design Notes:

- Y Protection Ethernet switches are not required at this stage however the design should cater for future installation

2.3.5 REFCL Cubicle 1

Install:

- Standard Swedish Neutral GFN cubicle with associated devices for GFN control

Design Notes:

- The design party to advise of the preferred cubicle construction type to advise procurement of the GFN requirements

2.3.6 REFCL Cubicle 2

Install:

- Standard Swedish Neutral GFN cubicle with associated devices for GFN control

Design Notes:

The design party to advise of the preferred cubicle construction type to advise procurement of the GFN requirements

2.3.7 REFCL Cubicle 3

Install:

- Standard Swedish Neutral GFN cubicle with associated devices for GFN control

Design Notes:

The design party to advise of the preferred cubicle construction type to advise procurement of the GFN requirements

2.3.8 Station Earth Fault Management Cubicle

Install:

- Standard 23" protection cubicle
- One (1) SEL-451 relay for Station Earth Fault Management (SEFM)
- One (1) SEL-451 relay for Station Earth Fault Management (SEFM) Extension for 3rd GFN
- Two (2) Elspec Digital Fault Recorders

2.3.9 Neutral Bus Management Cubicle

Install:

- Standard 23" protection cubicle
- One (1) GE-F35 relay for Neutral Bus Management & X MEF
- One (1) GE-C60 relay for Neutral Bus Management Extension

2.3.10 66kV X CB Management Cubicles

66kV CB 'A', 'B', 'G' and 'H' CB management relays (SEL-351S) are adequate and do not require replacement. These relays require a firmware and setting configuration upgrade.

Upgrade:

- Four (4) SEL-351S X CB Management and X CB Fail relays for
  - 66kV CB A
  - 66kV CB B
  - 66kV CB G
  - 66kV CB H

Design Notes:

- These are to be configured for tripping from the REFCL for in-station faults.

2.3.11 22kV X CB Management Cubicles

22kV CB '1-2 Bus Tie', '2-3 Bus Tie', No 1, No2 and No3 Trans 22kV CB management relays (SEL-351S) are adequate and do not require replacement. These relays require a firmware and setting configuration upgrade.

Upgrade:

- Three (3) SEL-351S X CB Management and X CB Fail relays for
  - No1 Trans 22kV CB
  - No2 Trans 22kV CB
  - No3 Trans 22kV CB
  - 1-2 22kV BT CB
  - 2-3 22kV BT CB

Design Notes:

- These are to be configured for tripping from the REFCL for in-station faults.

2.3.12 Feeder Protection Cubicles

The existing feeder protection relays (SEL-351S) are adequate for REFCL works. These relays will require firmware upgrades and new relay configurations. Feeder protection settings are to be reviewed.

Upgrade:

- Ten (10) SEL-351S relays for:
  - WPD011 Feeder protection
  - WPD012 Feeder protection
  - WPD013 Feeder protection
  - WPD014 Feeder protection
  - WPD021 Feeder protection
  - WPD022 Feeder protection
  - WPD024 Feeder protection
  - WPD031 Feeder protection
  - WPD032 Feeder protection
  - WPD033 Feeder protection

Design Notes:

- Neutral CT ratio to be considered in relay setting
  - In addition rating of CTs and settings must consider handover between sensitive earth fault protection and inverse time earth fault protection

2.3.13 PQM & VAR Control Cubicle

Install:

- Standard 23" protection cubicle
- Three (3) ION-9000 relay for:
  - No1 Bus Summation PQM
  - No2 Bus Summation PQM
  - No3 Bus Summation PQM
- One (1) SEL-2411 relay for:
  - No1 Cap Bank step switch management
- One (1) SEL-451 relay for:
  - Split Bus VAR Control

2.3.14 Capacitor Bank Protection Cubicle

The existing two (2) capacitor bank protection relays (SEL-351S) are adequate for REFCL works. This relay will require firmware upgrades and new relay configurations. Protection settings are to be reviewed.

Upgrade:

- Two (2) SEL-351S relays for:
  - No1 Capacitor bank protection
  - No3 Capacitor bank protection

Design Notes:

- Neutral CT ratio to be considered in relay setting

2.3.15 IEC61850 Configuration

- IEC61850 Design Integration Spreadsheet
  - Prepare new IEC-61850 design integration spreadsheet
  - Add and configure all new relays performing functions through IEC-61850
  - Map and re-configure signals to new and existing relays as per relevant Scheme Documents
- IEC61850 Architect & GE UR Setup
  - Configure CID files for all new relays performing functions through IEC-61850 as per Design Integration Spreadsheet
  - Prepare station 'SCD' file as per Design Integration Spreadsheet
- IEC61850 Scheme document drawings
  - Produce scheme document drawings to match configured Design Integration Spreadsheet

2.3.16 GPS Clock

- Establish time synchronisation to new relays

2.3.17 SCADA works

- Update Single Line Diagram to accommodate new SLD
- Update Alarm Pages to include new relays and retire old relays
- New configurations required for SEL RTACs

2.3.18 Fibre Optic works

- Establish new Fibre connections to new control room, inverter hut
- X & Y Fibre paths are to be diverse

2.3.19 DC Distribution

- Review station DC supplies for new loading requirements

2.3.20 AC Station service supplies

- Install AC distribution as per current standard

2.3.21 Building access control system

- Install building access control system and intrusion detection as per current standard

2.3.22 Fire System & Indication

- Install fire system as per current standard

2.3.23 AC Charger & DC System

- Load calculation for DC System to be attached in RESIS

2.3.24 Fibre Patch Panel

- Install X fibre patch panel/wall box
- Y fibre patch box to be installed at rear of any Y protection cubicle
- Fibre paths are to be diverse and Multimode OM3 (Aqua) fibre to be utilised

2.3.25 Operator Desk

- N/A

2.3.26 Station HMI works

- Create SLD and control pages
- Create IEC61850 status pages

2.3.27 Weather Station

A weather station is to be installed in order to provide monitoring of temperature, solar radiation, wind speed and humidity in the area. This provides an indication of REFCL sensitivity as it will fluctuate as the network damping (resistive leakage to earth) will vary with weather conditions. Care is to be taken when earthing the weather station to ensure there is no risk of damage to the control room from lightning strikes.

2.3.28 Building and Property Considerations

Yard Lighting

Switch yard lighting shall be reviewed to ensure adequate coverage of the ASC, Neutral System.

Fire Suppression

The ASC winding is immersed in oil. A review of its design and the amount of contained oil is required to determine if any fire suppression assets are required.

3 22 kV distribution feeder requirements

3.1 Surge diverters and insulation limitations

The operating principle of the GFN uses a tuned reactance to choke fault current in the event of a single-phase-to-ground fault. As a result, displacement of the line-to-ground voltage occurs in the healthy phases. Whilst line-to-line voltages remain at 22kV, the line-to-ground voltage rises to 22kV, phase-to-ground, on the two healthy phase's subsequently stressing substation and distribution equipment. In the case of surge diverters, this displacement cannot be tolerated and as such the diverters require replacement.

To accommodate the GFN installation, replace approximately 4,214 surge diverters across the 22kV three phase and single phase system. This is made up of 998 three phase sites and 611 single phase sites.

This covers all feeders ex WPD ZSS as well as surge arrestors on the GCY011, GCY014, GL021, GLE012 and GLE013 transfers.

The replacement diverters should be of 22kV continuous rating with a 10 hour 24kV TOV rating such as the ABB POLIM D 22kV arresters.

CitiPower and Powercor previous standard surge diverters were the ABB MWK 20 and POLIM D 20 arresters.

These, and all previous types except Bowthorpe ‘Type A’ arresters do not meet the overvoltage requirement needed for use with a GFN and therefore the higher rated arresters are required.

These surge diverters will be a new standard, applicable to distribution systems with a GFN installed.

3.2 Distribution transformers

Operation of the GFN displaces the neutral voltage of the entire 22kV system from the bus to the outer extremities of the feeders. This is different from an NER arrangement, when displacement is at its highest for a fault on the 22kV bus, and decreases for faults occurring down the feeders.

During GFN commissioning, voltage offset testing will simulate the voltage displacement that will occur for a single-phase-to-ground fault (22kV phase-to-ground).

1. Some distribution transformers may not be in a condition to withstand the overvoltage and will subsequently fail during the voltage offset testing
2. Some distribution transformers may fail following repeated subjection to sustained over-voltages caused post commissioning due to normal operation of the GFN

At this time, experience from network resilience (voltage stress) testing does not support a proactive replacement of any distribution transformers.

3.3 Line regulators

Single phase open-delta-connected Cooper regulators displace the system neutral voltage by regulating line-line voltages on two phases as opposed to three.

Closed-delta independent regulator control schemes tap each regulator independently, a similar displacement to the neutral voltage occurs, as per the open-delta mode.

All regulator works shall be compliant with current CitiPower and Powercor standards for 22kV regulators.

The WPD distribution network contains six (6) 22kV regulating systems with two (2) on the GCY011, GCY014, GL021, GLE012, GLE013 transfer feeders:

Table 4 WPD regulating systems

Feeder	Name	Manufacturer	Phasing	Scope of works
WPD011	BARRABOOL RD P89A REG	Cooper – 1 x 50A pole mounted	RW	No action required due to the regulator being on a single phase line.
WPD014	LORNE LINE P421A P421B REG1	Cooper - 3 x 200A ground mounted	RWB	Nil
WPD014	HENDY MAIN RD P5 REG	Cooper - 1 x 50A pole mounted	BR	Can be retired once the TQY zone substation is built
WPD014	COALMINE ROAD P7 REG	Wilsons - 1 x 10MVA ground mounted	RWB	Nil
WPD021	CAMP RD P216 REG	Cooper - 3 x 200A ground mounted	RWB	Require new CL7 control box only to tap all phases together.
WPD021	JAN JUC P4 REG	Cooper - 2 x 200A pole mounted	RWB	Can be retired once the TQY zone substation is built

Table 5 GCY011, GCY014, GL021, GLE012, GLE013 regulating systems

Feeder	Name	Manufacturer	Phasing	Scope of works
GLE013	CONNEWARRE REG P183A	Cooper - 3 x 300A ground mounted	RWB	Require new CL7 control box only to tap all phases together.
GLE013	BLACKROCK P8 REG	Cooper - 3 x 200A ground mounted	RWB	Require new CL7 control box only to tap all phases together.

3.4 Admittance balancing

The ground fault neutraliser uses a tuned inductance (Petersen Coil / Arc Suppression Coil) matched to the capacitance of the distribution system. The 3 phase 22kV distribution system ex WPD zone substations contains approximately 616 km of overhead conductor length (excluding SWER). Of this 616 km, 194 km (32%) is single phase. With the GCY011, GCY014, GL021, GLE012, and GLE013 transfers, the numbers are 712 km of overhead conductor length (excluding SWER) and of this 712 km, 200 km (28%) is single phase. Whilst planning philosophies have always attempted to balance the single phase system, inevitably this is difficult to achieve. In order to balance the capacitance of the three phase system such that the ASC can be correctly tuned, balancing substations will be placed at nodes on the system that utilise low voltage capacitors to inject the missing capacitance onto the system.

Note: Balance does not refer to the balancing of load. System balance is required from a capacitance-to-ground perspective and affected by route length and single phase connected distribution equipment. However, load balance is still important from a power quality perspective.

A reconciliation (survey) of all 22kV overhead and underground lines routes shall be conducted to assess the scope of the network balancing requirements.

The following steps shall be outworked prior to GFN installation;

1. Consolidate all “Single Phase” and “unknown” conductor into the “BR”, “RW” or “WB” categories
   (i) validate “Single Phase” and “unknown” conductor where required

(ii) spot check the validity of current phasing information

2. Consolidate all single phase transformers on the 22kV system and assign to one of the "BR", "RW" or "WB" categories
3. Ascertain the construction types for all sections
   (i) Indicate whether LV subsidiary exists
4. Consolidate all "1 Phase" and "unknown phase" 22kV cable and assign phase information
5. If single phase circuits are used underground, ascertain the design principles behind the single phase underground sections
   (i) Conductor type, two or three core?
   (ii) Treatment of the unused core (earthed or phase bonded)—if bonded, to what phase?

The course balance shall look at sections of the system in 'switchable blocks' and for any re-phasing and finite admittance balancing opportunities in order to balance out the single phase route lengths and large single phase spurs where the capacitance is fairly easy to approximate.

A tuneable balancing approach shall then look at the system again in switchable blocks for the application of 3-phase admittance balancing substations.

The use of 3-phase admittance balancing substations will provide accurate capacitive balancing in each section. Admittance balancing substations shall be placed at the following locations to enable switching of balanced blocks of the system. The blended approach to admittance balancing is designed to cater for the historical use of single phase spur lines, single phase cable and the variability in capacitive balancing. The number of re-phasing sites, single phase balancing units and 3 phase balancing units are also informed by experience from tranche one and two scoping, and scaled to the relative network parameter of this substation.

Table 6 Balancing requirements summary

Balancing concept	Number of sites	Volume for GL, GCY and GLE Transfers
Re-phasing Sites	53	16
Single Phase Balancing Units	19	5
3 Phase Balancing Units	56	14
RC Gas Switches	28	4

3.5 Automatic Circuit Reclosers (ACRs) and remotely controlled gas switches

Each RVE or VWVE ACR on the WPD network should be replaced with the current standard Schneider N27 ACR which has inbuilt voltage measurement.

Each ACR or remote controlled gas switch requires a modern control box which has required programmable functions and up to date firmware. ACR and gas switch control box replacements are required (for CAPM5 or GCR300 control boxes) in order to:

- automatically detect REFCL operation and prevent incorrect operations de-energising customers;
- provide advanced fault locating algorithms capable of detecting REFCL fault confirmation tests; and
- continue to operate in the traditional manner automatically when REFCL is not in operation.

SWER transformer supplies for ACRs have been proven to fail.

Replace all ACRs SWER supply transformers.

Table 7 ACR replacements

Feeder	Name	Operating voltage	Phase code	Control Box Model	ACR model
WPD011	MERRAWARP RD P2 ACR	22kV	RWB	CAPM5	N24
WPD011	BARRABOOL RD P65 ACR	22kV	RWB	ADVC2	unknown
WPD011	MARCUS-MT PLEASANT P3 ACR	22kV	RWB	ADVC	N24
WPD012	TORQUAY-PIONEER P118 ACR	22kV	RWB	ADVC	N24
WPD012	PIONEER RD P2 ACR	22kV	RWB	ADVC3	N24
WPD014	LORNE LINE P342 ACR	22kV	RWB	ADVC3	N24
WPD014	HENDY MAIN-BRUSHFIELD P1 ACR	22kV	RWB	ADVC3	N24
WPD014	ANGLESEA P265 ACR	22kV	RWB	ADVC2	rve
WPD021	BELL BRAE P142 ACR	22kV	RWB	ADVC2	rve
WPD022	FISCHER-FOAM P38 ACR	22kV	RWB	ADVC	N27
WPD022	TORQUAY RD P269 ACR	22kV	RWB	ADVC	N24
WPD024	HORSESHOE BEND RD P38 ACR	22kV	RWB	ADVC	N24
WPD031	COOLABAH-DRIVE P3 ACR	22kV	RWB	ADVC3	N24
GCY014	LATROBE-FYANS P70 ACR	22kV	RWB	ADVC	N24
GCY014	LATROBE-MARSHALL P65 ACR	22kV	RWB	ADVC	N24
GCY014	ROSLYN-ROBERTS P1 ACR	22kV	RWB	ADVC	N24
GL021	SHANNON AVE P54 ACR	22kV	RWB	ADVC2	N24
GLE012	NAGLE-HIGH P19 ACR	22kV	RWB	ADVC	N24
GLE012	FRYERS RD P1A ACR	22kV	RWB	ADVC	N24
GLE013	BLUESTONE SCHOOL RD P196 ACR	22kV	RWB	ADVC	N24

Feeder	Name	Operating voltage	Phase code	Control Box Model	ACR model
GLE013	GOLF LINKS-NOBLE P31 ACR	22kV	RWB	ADVC	N24
GLE013	FLINDERS PDE P101 ACR	22kV	RWB	ADVC	N24

Table 8 Sectionaliser/Remote Controlled Gas Switch replacements

Feeder	Name	Operating voltage	Phase code	Control Box Model	AS/Remote SW model
WPD011	SCENIC RD 62	22kV	RWB	GCR300	EGS
WPD011	NTH VALLEY RD P1A	22kV	RWB	ADVC2	EGS
WPD011	BARRABOOL RD P2A	22kV	RWB	ADVC2	RL27
WPD012	HAMS-ANGLESEA SW CAB	22kV	RWB	Talus 200	unknown
WPD012	HAMS-ANGLESEA SW CAB	22kV	RWB	Talus 200	unknown
WPD012	HAMS-ANGLESEA SW CAB	22kV	RWB	Talus 200	unknown
WPD012	HAMS-ANGLESEA SW CAB	22kV	RWB	Talus 200	unknown
WPD014	ANGLESEA RD SP109A	22kV	RWB	ADVC2	RL27
WPD014	WRAY W CAMP AS	22kV	RWB	ADVC2	RL27
WPD014	COALMINE RD 8	22kV	RWB	ADVC2	RL27
WPD014	LORNE LINE 364	22kV	RWB	ADVC2	RL27
WPD014	HARVEY P64	22kV	RWB	ADVC2	RL27
WPD021	GREAT OCEAN E ANGLESEA	22kV	RWB	ADVC2	RL27
WPD021	PARKER P46	22kV	RWB	ADVC2	EGS
WPD021	ANGLESEA RD SP110	22kV	RWB	ADVC2	RL27
WPD021	CAMP P217 AS	22kV	RWB	ADVC2	RL27
WPD022	FISCHER ST P17 AS	22kV	RWB	ADVC2	RL27
WPD024	HORSESHOE BEND-STRETTON SW CAB	22kV	RWB	Talus 200	unknown

Feeder	Name	Operating voltage	Phase code	Control Box Model	AS/Remote SW model
WPD024	HORSESHOE BEND-STRETTON SW CAB	22kV	RWB	Talus 200	unknown
WPD024	HORSESHOE BEND-STRETTON SW CAB	22kV	RWB	Talus 200	unknown
WPD024	HORSESHOE BEND-STRETTON SW CAB	22kV	RWB	Talus 200	unknown
WPD024	CONNEWARRE LINE P179	22kV	RWB	ADVC2	unknown
WPD024	CHARLEMONT RD P64	22kV	RWB	ADVC2	RL27
WPD032	OCEAN RD SPUR 25	22kV	RWB	ADVC2	RL27
WPD032	GROSSMANS RD SPUR 42	22kV	RWB	ADVC2	RL27
WPD032	TORQUAY RD 289	22kV	RWB	ADVC2	RL27
WPD032	DARIAN-SURFCOAST SW CAB	22kV	RWB	Talus 200	unknown
WPD032	DARIAN-SURFCOAST SW CAB	22kV	RWB	Talus 200	unknown
WPD032	DARIAN-SURFCOAST SW CAB	22kV	RWB	Talus 200	unknown
WPD032	DARIAN-SURFCOAST SW CAB	22kV	RWB	Talus 200	unknown
WPD032	OCEAN RD SPUR P46	22kV	RWB	ADVC2	RL27
WPD032	BRISTOL RD P1	22kV	RWB	ADVC2	RL27
GCY011	ROSLYN RD P4	22kV	RWB	CAPM3	unknown
GCY014	ROSLYN RD 130	22kV	RWB	CAPM3	EGS
GCY014	LATROBE TCE P57	22kV	RWB	ADVC2	RL27
GL021	NOBLE ST P17 AS	22kV	RWB	ADVC2	RL27
GLE012	SPRING ST 68	22kV	RWB	ADVC2	RL27
GLE013	BARWON HEADS RD 274	22kV	RWB	ADVC2	unknown

Table 9 ACR and control box requirements summary

Units	Number of sites
ACR replacements	2
Control box replacements	4

3.6 Fuse savers

HV Fuses pose a difficulty in operating a network with a REFCL. Maintaining capacitive balance is critical in the network, and scenarios that result in 1 or 2 out of 3 fuses blowing in a 3 phase section, such as phase-phase faults can result in large capacitive imbalances. These imbalances can result in loss of REFCL sensitivity, REFCL maloperations resulting in widespread outages or REFCL backup schemes operating to remove the REFCL from service.

Fuse Savers are to be installed as a 3 phase ganged unit such that when any individual phase operates for a fault, all 3 phases open in unison de-energising a balanced section of the network regardless of the fault type.

Fuse Savers are required to operate for any fused section with a downstream network capacitive charging current of 540 mA or greater.

In some locations where the network fault levels are high, Fuse Savers cannot be used as they do not have the appropriate fault breaking capacity. In these situations, an ACR is required to clear faults as a three phase device else the feeder will be tripped on days of high sensitivity.

Table 10 Fuse saver requirements

Units	Number of sites	Volume for GL, GCY and GLE Transfers
Fuse savers	49	9

3.7 HV underground cable

Experience from REFCL testing has shown that HV underground cable can fail due to a number of flaws. Manufacturing techniques in the past have relied on steam curing of XLPE cables which can in the presence of higher voltages, result in extensive water treeing and subsequent failure. Additionally, joints and other terminations produce higher stress and can be a point of failure. The following lengths of cable are required to be replaced.

Table 11 HV underground cable requirements

Location	Length (m)
Cable failure length	9,631

3.8 Distribution switchgear

Overhead distribution switchgear has been shown to be largely resilient to the phase to earth over-voltages experienced in a resonant network. There is no planned replacement of these assets.

Based on our tranche one experience, we will replace 100% of the ABB and F&G switchgear as well as 6 per cent of all other distribution switchgear.

At WPD there are twenty five (25) RMU replacements estimated.

Table 12 Switchgear replacements

Unit	Volume
Distribution switchgear	25

3.9 HV isolation substations

The isolating substation will isolate a section of network so that it does not contribute charging current to what is seen by the GFN units at WPD. It is proposed to install nine (9) 6 MVA HV isolating substations which is estimated to reduce the charging current by up to 198 amps presently and up to 339 amps by 2026. The locations proposed are growth areas on WPD and all isolated areas are proposed to have two HV isolation substations to enable transfers. Three of the nine isolating substations will be located in the area of the current WPD supply area that will be transferred to the new Torquay zone substation. To meet the requirements of the bushfire mitigation program on which the REFCL solution is founded, all sections of network downstream of an isolating substation will be underground.

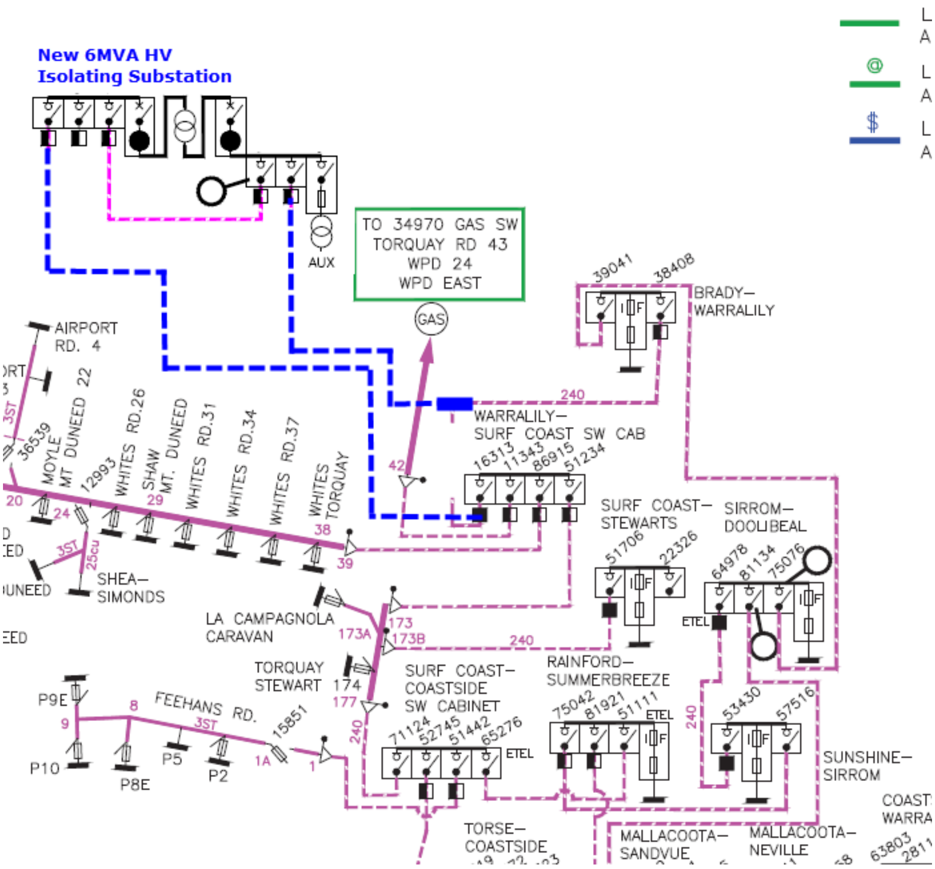
Note that these substations require ESV exemptions.

See Section 5 of the Appendix for a map of the proposed HV isolating substation locations.

The following nine (9) 6 MVA isolating substations are required to tie into these points at WPD (these are proposed locations, see the Network Solutions group for an update of the tie in points closer to construction):

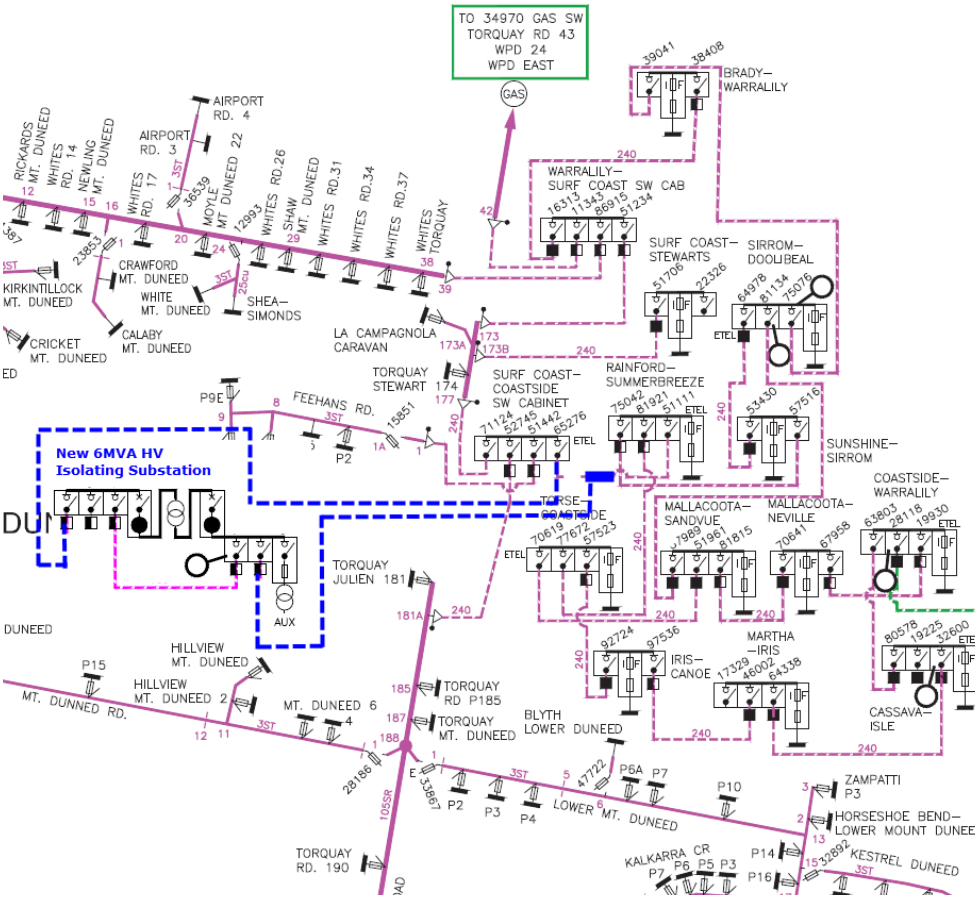
- WPD022 – tie in between SW# 16313 of the Warralily – Surf Coast Switch Cabinet (not upstream as the WPD022 backbone is to be maintained for switchability) and SW# 38408 of the Brady – Warralily double switch kiosk substation – 240mm^2 3/c 22.a.x.hc.h. underground cable to be used (600m estimated).

Figure 5 Proposed WPD MT DUNEED Operations Diagram



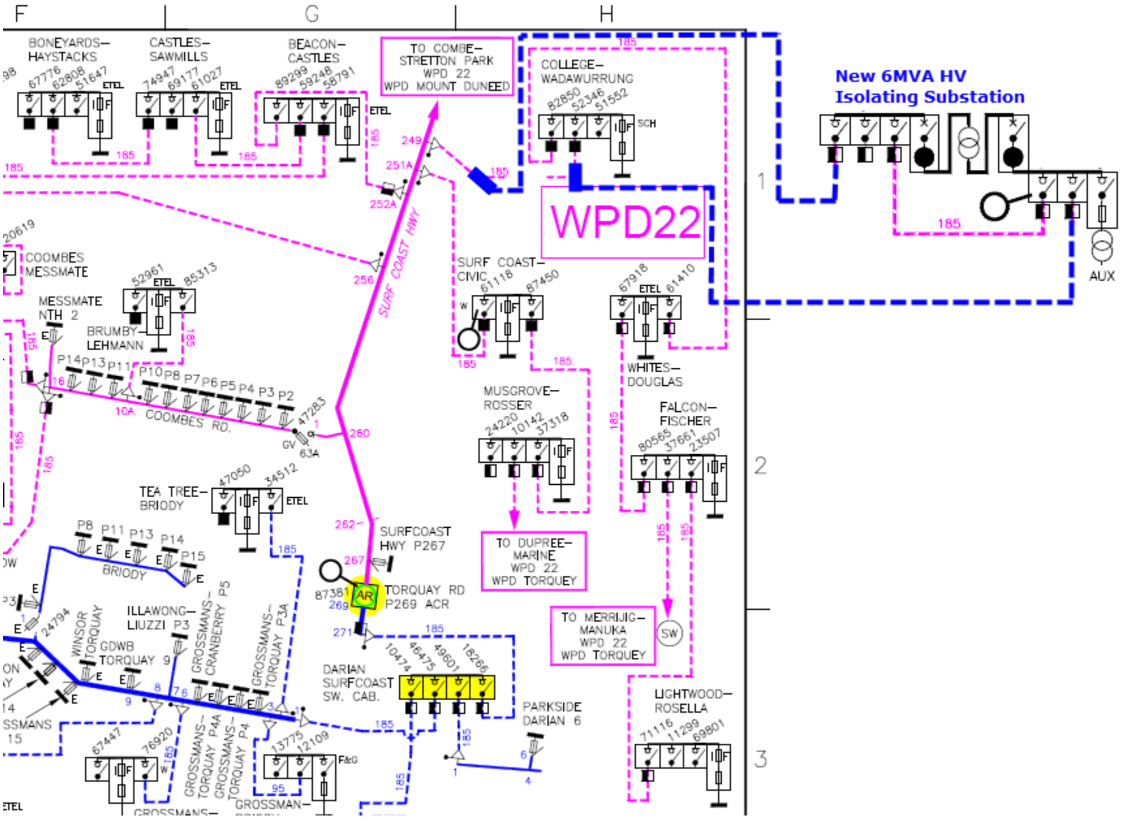
- WPD022 – tie in between SW# 65276 of Surf Coast – Coastside Switch Cabinet (not upstream as the WPD022 backbone is to be maintained for switchability) and SW# 51111 of the Rainford – Summerbreeze triple switch kiosk substation – 240mm^2 3/c 22.a.x.hc.h. underground cable to be used (350m estimated).

Figure 6 Proposed WPD MT DUNEED Operations Diagram



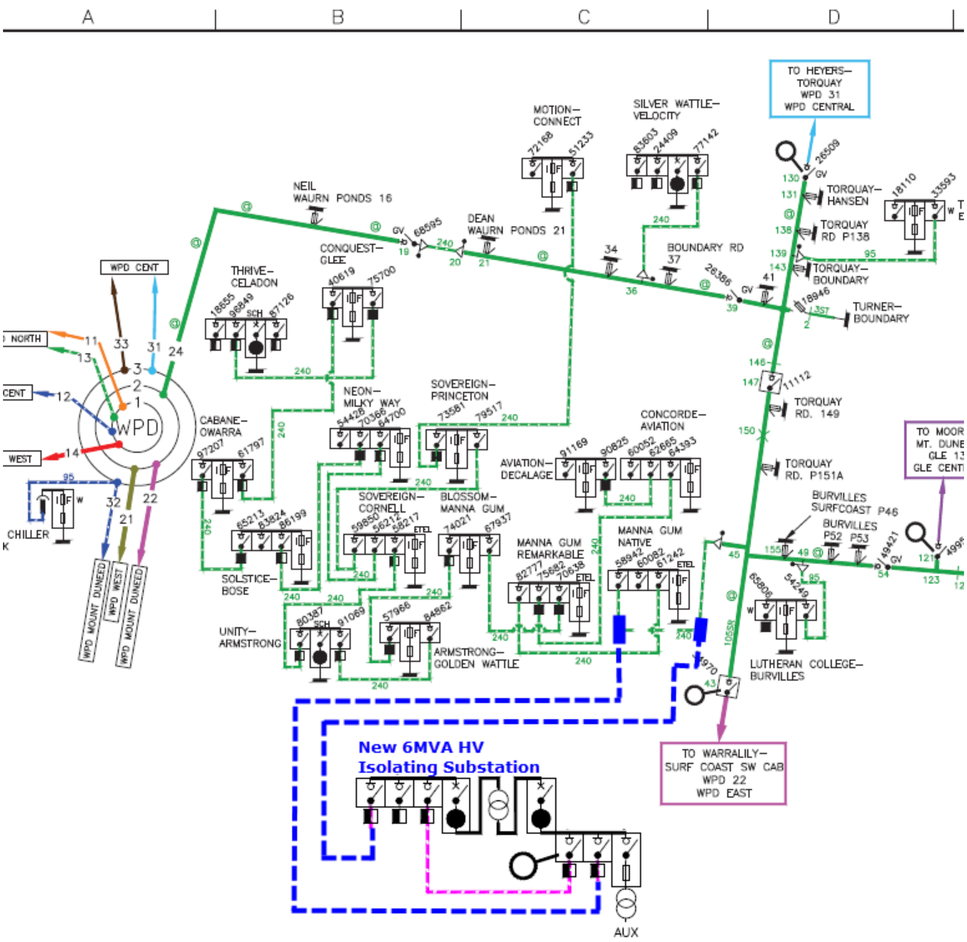
- WPD022 – tie in between the cable head on pole 249 Torquay Road (LIS 35209) and SW# 52346 of College – Wadawurrung triple switch kiosk substation – 185mm[2] 3/c 22.a.x.hc.h. underground cable to be used (50m estimated).

Figure 7 Proposed WPD JAN JUC Operations Diagram



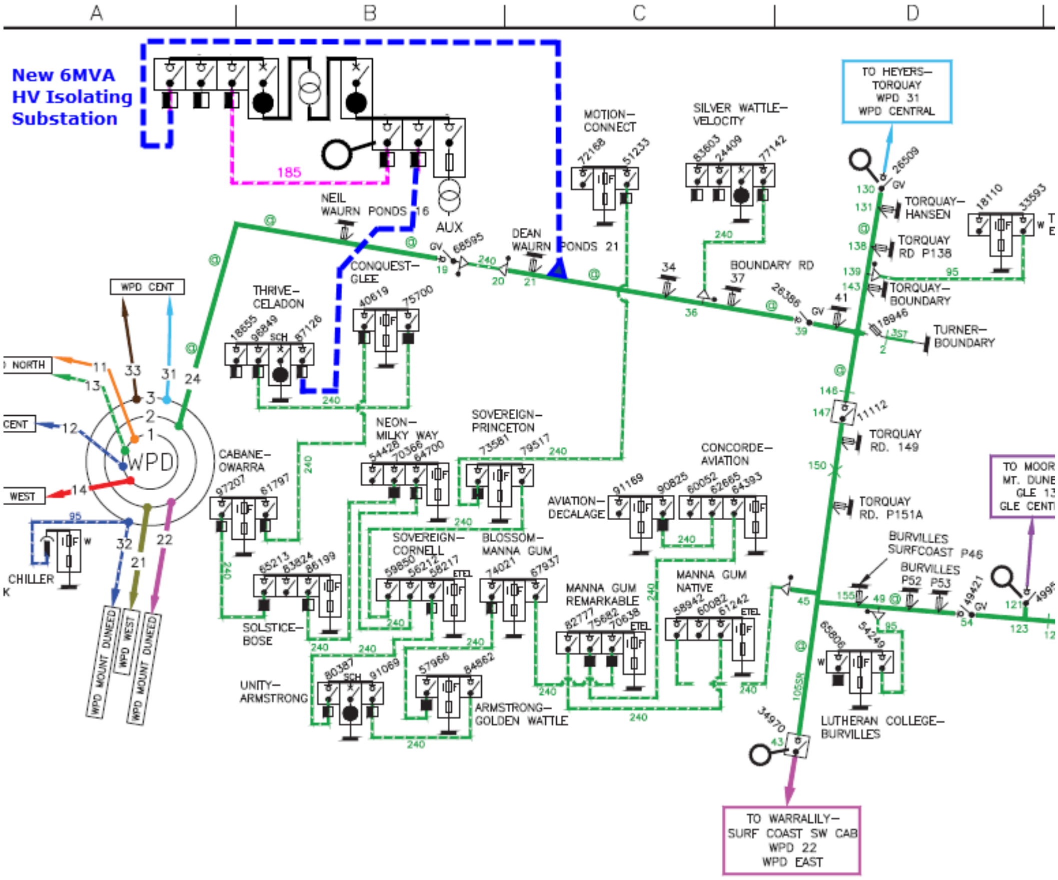
- WPD024 – tie in between the cable head on pole 155 Torquay Road (LIS 750148) and SW# 58942 of Manna Gum – Native triple switch kiosk substation – 240mm² 3/c 22.a.x.h.c.h. underground cable to be used (50m estimated).

Figure 8 Proposed WPD EAST Operations Diagram



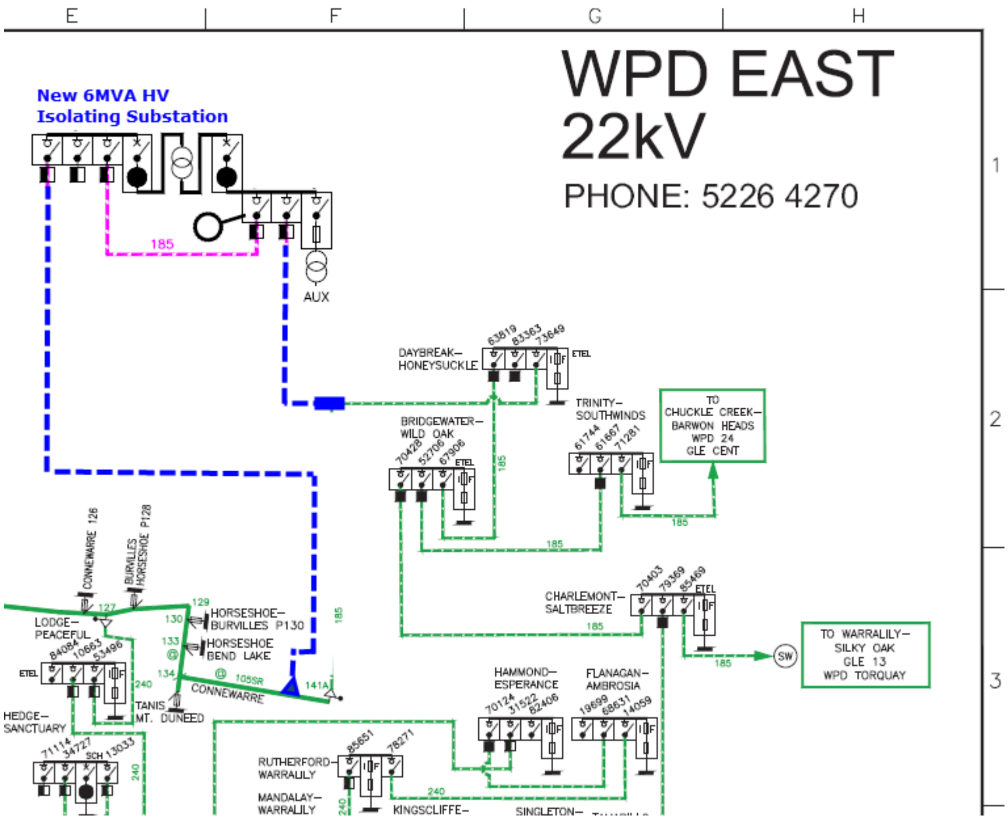
- WPD024 – tie in between a new cable head on Boundary Road and a spare switch (SW# 18655 or SW# 87126) of the Thrive – Celadon triple switch kiosk substation – 240mm² 3/c 22.a.x.hc.h. underground cable to be used (800m estimated).

Figure 9 Proposed WPD EAST Operations Diagram



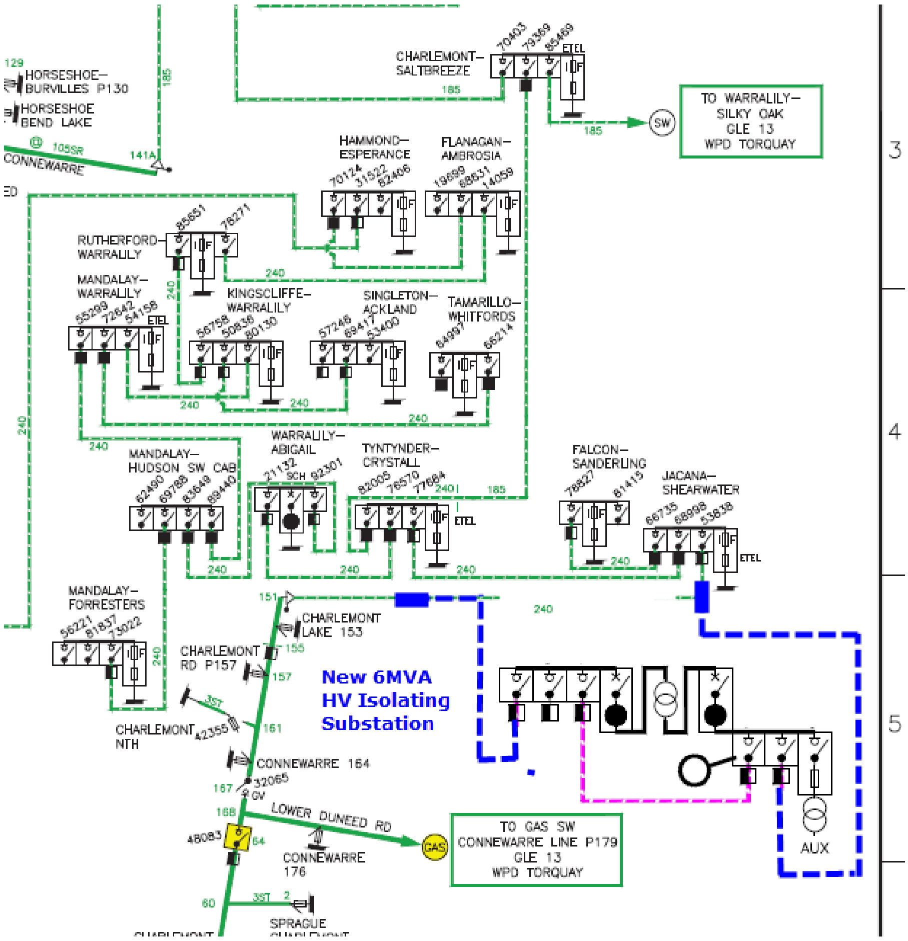
- WPD024 – tie in between a new cable head in Paddock Road (previously Lake Rd) and the 185mm^2 3/c 22.a.x.hc.h. underground cable to SW# 73649 of Daybreak – Honeysuckle triple switch kiosk substation – 185mm^2 3/c 22.a.x.hc.h. underground cable to be used (600m estimated).

Figure 10 Proposed WPD EAST Operations Diagram



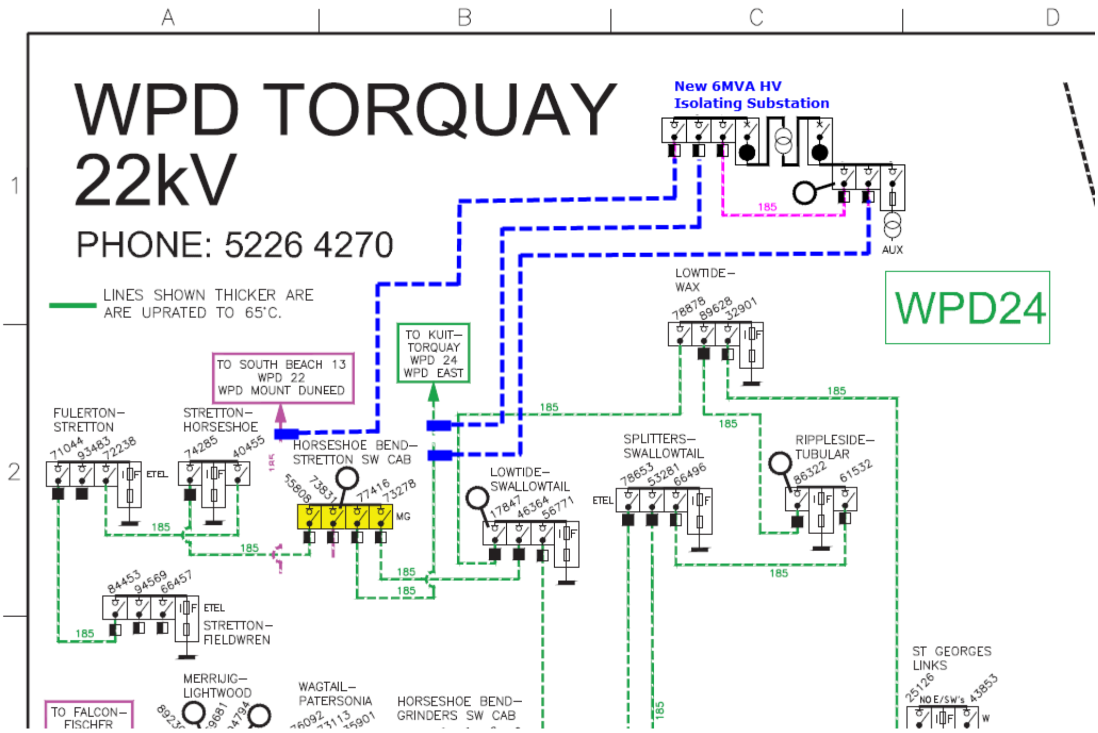
- WPD024 – tie in between the cable head on pole 151 Connewarre Line (LIS 827681) and SW# 53838 of Jacana – Shearwater triple switch kiosk substation (underground cable to be downstream of isolating transformer, this isolating transformer is to be an open point once the TQY zone substation is built, the isolating transformer to be bypassed until the feeders are rearranged as part of the TQY zone substation project) – 240mm^2 3/c 22.a.x.hc.h. underground cable to be used (1,300m estimated but this is based on the current network configuration, it is expected that the required metres will be reduced as new kiosks are installed to the south as the URD estates continue to develop between now and the construction period).

Figure 11 Proposed WPD EAST Operations Diagram



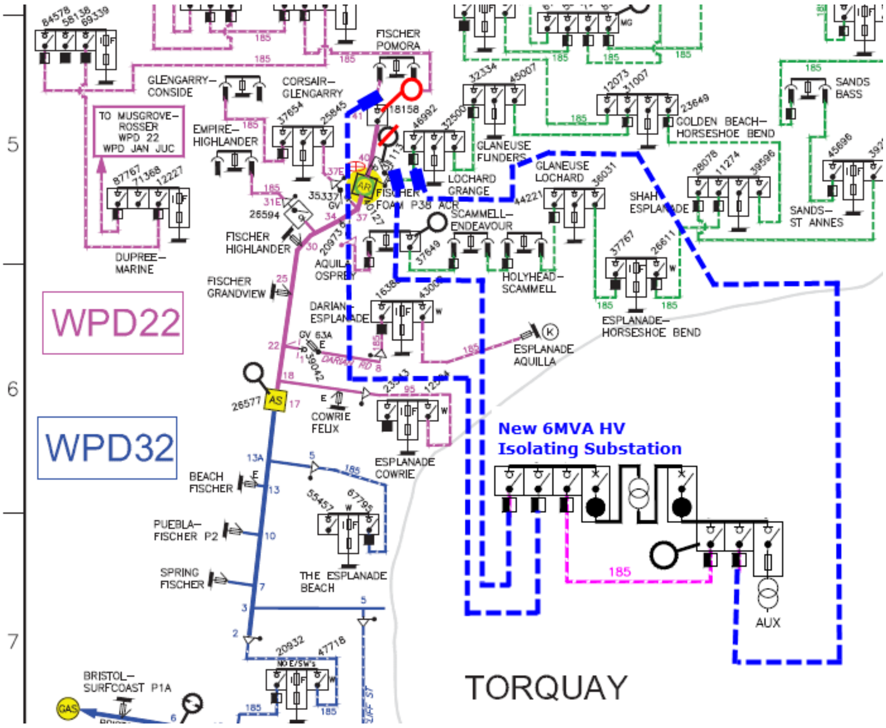
- WPD024 – tie in between the cable head on pole 41 Horseshoe Golden Beach spur (LIS 852654) and SW# 77416 of the Horseshoe Bend - Stretton switch cabinet. Also divert the cable or run a new cable from the cable head on pole 15 South Beach Road spur to the spare switch on the upstream side of the isolating substation. If new cable is used retire the 185mm^2 3/c 22.a.x.hc.h. underground cable between pole 15 South Beach Road and SW# 73831 of the Horseshoe Bend - Stretton switch cabinet, otherwise retire the unused section of cable to the Horseshoe Bend - Stretton switch cabinet – 185mm^2 3/c 22.a.x.hc.h. underground cable to be used (300m estimated).

Figure 12 Proposed WPD TORQUAY Operations Diagram



- WPD024 – tie in between the cable head on pole 40 Fischer Street (LIS 33967) and SW# 46992 of the Lochard Grange double switch kiosk substation. Cut the cable between the cable head on pole 41 Fischer Street (LIS 933267) and the Fischer Pomora loop through kiosk substation, and extend to the spare switch on the upstream side of the isolating substation – 185mm^2 3/c 22.a.x.hc.h. underground cable to be used (200m estimated). Note that land is scarce in this area and a residential block may need to be purchased for the isolating transformer site, presently Nearmaps/Google Street View show vacant blocks in Lochard Drive and Fischer Street.

Figure 13 Proposed WPD TORQUAY Operations Diagram



Note that some isolating substations need distribution transfers to occur to ensure the downstream sections of network still have adequate protection. Some of the HV isolating substations are to be bypassed until the TQY zone substation scope has been built, these requirements and distribution transfers will be provided by the Network Solutions group during the construction phase.

3.10 HV customer isolation substations

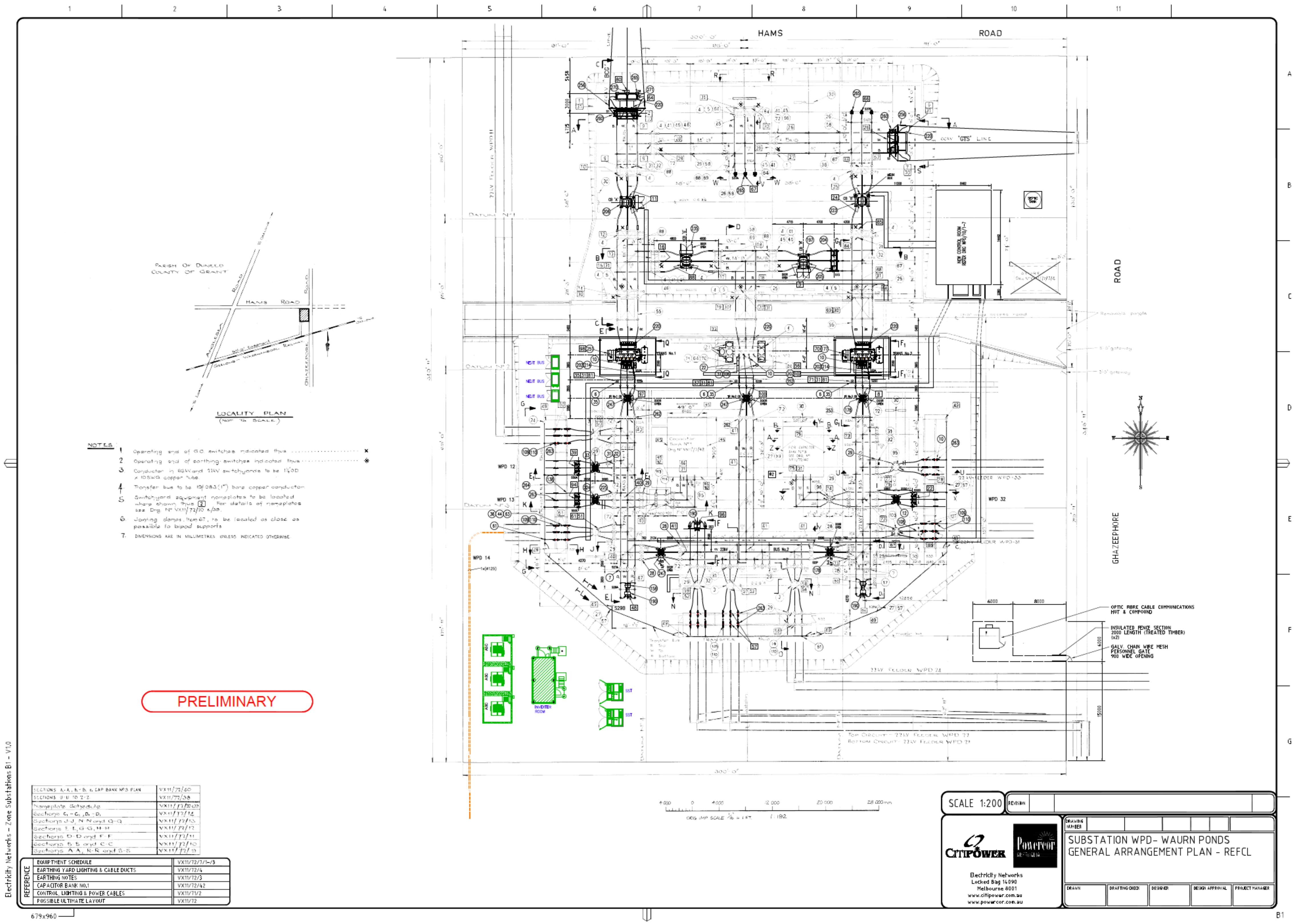
The Electricity Distribution Code stipulates that at the point of connection to a customer on the 22kV network, the phase to earth voltage variations in the distribution code (section 4.2.2) no longer applies during a REFCL condition.

For HV customers, this means that they need to ensure that their network can tolerate these conditions. Given this, all HV customers will now have an ACR installed at their supply point.

Install three (3) new ACRs for the following HV customers:

- WPD013 – Satyam Deakin
- WPD033 – Deakin University
- GLE013 – Barwon Water Treatment Plant

4 Appendix: Proposed Site General Arrangement



5 Appendix: Proposed HV Isolating Substation Locations