Powerco CPP – Portfolio Overview Document

Portfolio Name	Matarangi Zone Substation
Expenditure Class	Capex
Expenditure Category	Growth & Security
As at Date	12 June 2017

Expenditure Forecast[1,2]	Pre CPP	FY19	FY20	FY21	FY22	FY23	Post CPP	CPP Period Total	Project Total
Pre-Internal Cost Capitalisation and Efficiency Adjustments[3] *(2016 Constant NZ$(M))*	$0.0	$0.1	$0.1	$1.3	$3.9	$2.5	$0.0	$7.9	$7.9
Post-Internal Cost Capitalisation and Efficiency Adjustments *(2016 Constant NZ$(M))*	$0.0	$0.1	$0.1	$1.4	$4.0	$2.5	$0.0	$8.2	$8.2

Description

Project need overview	Powerco's Coromandel subtransmission network, specifically around Whitianga (and the surrounding holiday areas), does not meet the desired security of supply standards due to capacity constraints of the existing circuits and the existing 11kV distribution network has limited backfeeding capability.

Proposed solution

Project solution overview	Powerco is proposing to construct a new 66/11kV zone substation at Matarangi near Whitianga, in the Coromandel Planning Area. The substation will be supplied via a ≈12 km overhead line off the existing Whitianga 66kV bus. The new substation is required to cater for the growth in electrical demand that has occurred and is projected to continue at a number of popular holiday destinations to the north of

[1] Forecast expenditure is based on Powerco's financial year (i.e. FY18 is for the period April 2017 through March 2018). Expenditures do not consider general price level changes over time (i.e. are in real or constant terms).
[2] Only includes Growth & Security Expenditure. Some projects discuss and rely on the replacement of assets that are at "end of life". However, the replacement cost for these assets is accounted for in the Replacement Expenditure category.
[3] All other forecast expenditure / cost estimates in this POD are pre-internal cost capitalisation and efficiency adjustments, consistent with this forecast.

	Whitianga (i.e. Whangapoua, Kuaotunu and Opito). The new substation will also significantly improve regional network security and reliability.

Need Identification

Background	Powerco's Coromandel Area encompasses the Coromandel Peninsula[4] and north-eastern section of the Hauraki Plains. The sub-transmission network consists of a 66kV network of mostly overhead lines[5] that supply six zone substations (Kerepehi, Matatoki, Thames, Coromandel, Whitianga and Tairua) (refer to Figure 1 & Figure 3). The sub-transmission network is supplied from the Transpower owned Kopu 110/66kV GXP (located to the south of the Thames township). The area is characterised by rugged, bush-covered terrain, making line access difficult and seasonal weather extremes and cyclones impact heavily on network security. Whitianga and the surrounding localities (the area of focus for this project) are characteristic of resort towns in the Coromandel area, with a seasonal demand peaking in the summer. Also, Whitianga, being the second largest town in the Coromandel area with a population of 3,800[6], has sufficient infrastructure to support an increasing permanent population.
Underlying Drivers and Investment Triggers	The Whitianga Area has a number of constraints that are relevant to the Matarangi project as follows: 1. The coastal townships to the north of Whitianga (including Matarangi and Kuaotunu) are supplied by two 11kV feeders: • **Owera Road Feeder**: a rural overhead line feeder that follows a path north-west from the Whitianga substation to Matarangi, a distance of approximately 15km. The 2015 peak load on this feeder was 3.4MVA. The feeder has a total route length of 58km and a significant portion of the load is at the end of this feeder, it is equipped with two voltage regulators and a pole mounted capacitor bank to provide voltage support. • **Kuaotunu Feeder**: passes through the Whitianga township supplying some urban consumer load before heading north-east to Kuaotunu. The 2015 peak load on the feeder was around 2.3MVA. The feeder has a total route length of 48km and is equipped with 3 voltage regulators to address voltage issues. The loads on the Owera Road and Kuaotunu feeders are projected to continue to increase at estimated 2%pa and 1%pa, respectively. The combined peak load of over 5MVA on the two feeders mean that the backup capabilities of these feeders are limited (during an outage of one of the feeders). 2. Based on the latest demand forecast, Whitianga substation's firm capacity of 15MVA is exceeded as of 2016. The 11kV back-feed from the adjacent 66/11kV substations is very limited meaning that the Whitianga substation does not meet the requirements of Powerco's Security-of-Supply Standard, which recommends that the substation should be afforded a security class of AA. 3. Over the period 2007 through 2014 the Whitianga substation experienced around 3% growth per annum. This growth is generally

[4] A rugged, forested, coastal peninsula, with five towns that have a population >1,000. The economy is mostly based on tourism with little heavy industry.
[5] There is a small section of underground 66kV cable between the Kopu GXP and the Thames substation.
[6] Statistics New Zealand, http://www.stats.govt.nz/Census/2013-census, retrieved, 13 August, 2015

	supported by the published census information of the township's population growth. In the future Whitianga is forecast to experience peak demand increasing at 1.7% per annum. 4. At present, a number of the 11kV feeders at the substation have an ICP count well in excess of the maximum for their respective security levels. Whitianga feeders 1 and 5 exceed their maximum number of ICPs for their F3 /F4 security rating. Whitianga feeders 2, 3, 6 and 7 exceed their maximum number of ICPs for their F3 security rating. The rapid growth in Whitianga requires a combination of more feeders and additional zone substation capacity.
Timing of the need	Preparatory work for the new 66/11kV substation is presently underway - Powerco has begun investigating the potential line routes and substation sites[7]. However, discussions with the relevant land owners over which the 66kV line is proposed have yet to begin and consents have yet to be granted by the relevant council. As a result of this, Powerco only expect to begin the project in 2021.

[7] Some geotechnical tests have already been undertaken with the objective of establishing a suitable substation site.

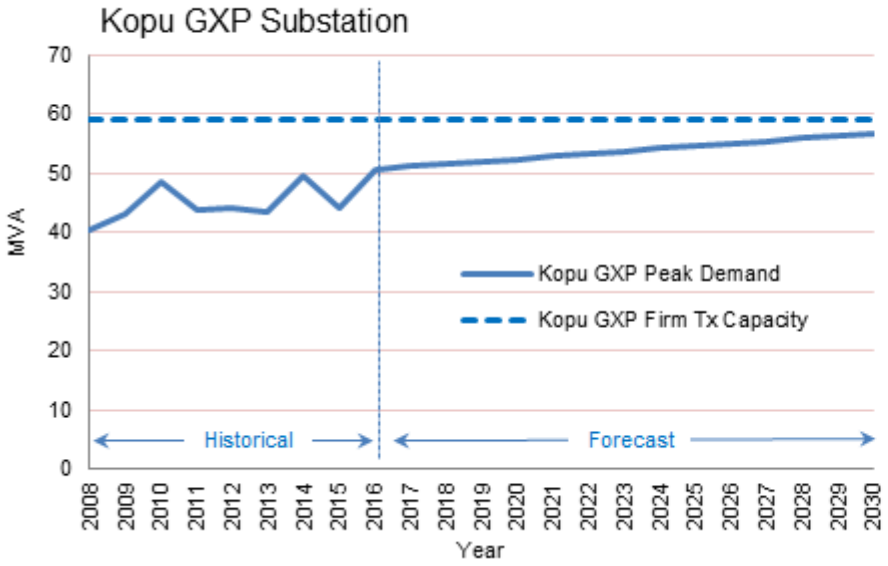
Demand Forecast | Coromandel Area

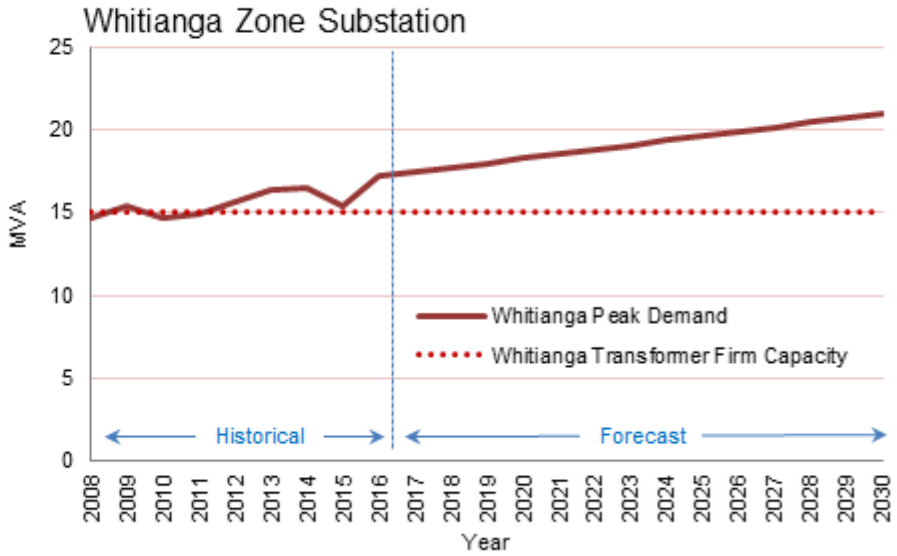
COROMANDEL AREA SUBSTATIONS			FORECAST MAXIMUM DEMAND [MVA]						
SUBSTATION	CLASS CAPACITY	GROWTH	2016	2017	2018	2019	2020	2025	2030
Coromandel	0.0	0.9%	4.7	4.8	4.8	4.8	4.9	5.1	5.3
Kerepehi	0.0	0.7%	10.1	10.2	10.3	10.3	10.4	10.8	11.1
Matatoki	0.0	0.9%	5.6	5.7	5.7	5.8	5.8	6.1	6.3
Tairua	7.5	0.7%	8.6	8.7	8.7	8.8	8.8	9.1	9.4
Thames T1 & T2	0.0	0.3%	13.4	13.5	13.5	13.5	13.6	13.8	13.9
Thames T3	6.9	0.0%	3.4	3.4	3.4	3.4	3.4	3.4	3.4
Whitianga	0.0	1.6%	17.2	17.4	17.7	18.0	18.3	19.6	21.0

COROMANDEL AREA SUBSTATIONS			FORECAST MAXIMUM DEMAND [MVA]						
SUBSTATION	TX CAPACITY	GROWTH	2016	2017	2018	2019	2020	2025	2030
Kopu GXP	60.0	0.9%	50.6	51.1	51.5	52.0	52.4	55.0	56.8

Notes:

1. Class capacity is similar to Firm Capacity in that it represents the capacity that can be delivered following the first outage of any major equipment. Unlike Firm Capacity it considers the long term deliverable capacity after allowing for switching and network reconfiguration (11kV & 33kV) post-fault conditions.
2. All maximum demand values are in MVA.
3. Purple shaded cells indicate that the substation's Class Capacity has been exceeded and network enhancements should be considered.





Options Analysis | Long List of Project Options | High Level Assessment	
Assessment Process	A wide range of potential options are available for the resolution of electrical network constraints. However, depending on local conditions many of the options may not be suitable. On this basis a two tier Options Analysis is followed. In the first instance all potential options are considered against a set of high level criteria. Those options that are identified as having significant challenges and not favourable are not considered further. A significant issue that Powerco often faces is securing landowner easements and or public support for projects that the local community or landowners are opposed to. For this reason the costs associated with easements/consents are often difficult to estimate and the consenting/land-acquisition stage of a project can take a significant period. Given this fact, Powerco assesses the risk / likelihood of securing development rights for individual projects (within a realistic timeframe) during the high level assessment stage.
Long List of Options	The following table contains a list of the high level project options that are potentially available to resolve the specific network constraints that have been identified within the Whitianga region. Maintaining the status quo by allowing demand to grow and risks to increase is not a viable option. The Whitianga substation firm capacity has already been exceeded and the majority of the 11kV feeders are well over their required ICP counts and therefore security levels. This will mean a considerable reliability cost to Powerco during the study period The non-network options below are not shortlisted due to the following: • Fossil fuelled generation (i.e. diesel generation) is technically viable but not shortlisted due to the cost and environmental/consenting challenges. During network contingencies on the Owera Road or Kuaotunu feeders there would be a shortfall of up to 2MW[8] that would need to be "made up" using stand-by generation. The capital cost of a 2 MW[8] standby diesel generation plant is estimated to range from \$3M to \$4M[9,10]. Additional diesel generators would need to be installed as the demand for electricity increases. • Powerco has not identified any viable renewable generation options that would provide the required security of supply[11]. • Fuel switching and demand side response (DSR) are considered to be deferment strategies. Their viability is not considered to be certain given the growth rates that the Whitianga region has experienced and the fact that the network security levels are already exceeded. The volume of small consumers (and lack of large consumers) further complicates the possibilities associated with fuel switching and DSR. • Powerco currently uses a mains-borne ripple control system to manage significant amounts of hot water cylinder load on its network. During peak loading periods most hot water cylinders are turned off. The demand reduction however is not sufficient to resolve the

[8] This is the present shortfall and this amount is predicted to increase in the future.
[9] Excludes the ongoing maintenance and operational costs.
[10] Diesel generation plant is estimated to range from \$1,500/kW to \$2,000/kW, depending on whether it is high, medium or low speed plant.
[11] Typical plant might involve wind turbines or photovoltaic arrays. Both of these generators have an intermittent output which cannot be relied upon unless there was significant penetration and diversity.

	major network constraint. • Energy storage solutions could be technically feasible, but are not economically viable at the size required to provide viable back-up for extended periods. For example, an emerging technology that could be employed is storage batteries installed in domestic premises. However, the capital costs associated with 3.6MW[8] of domestic batteries with two hours capacity are estimated to be >$12M[12]. Alternatively, a grid-scale battery solution providing 4MW for two hours would, at current rates, cost >$11M. Many outages could be addressed within two hours and peak demand periods are also usually less than two hours duration. Storage solutions at this size however, would not provide sufficient back-up for extended outages lasting for several hours.. Three network reinforcement options (Numbers 2, 3 and 4) were identified as potential solutions to the network constraints and issues. Option 2 involves the construction of additional 11kV feeders. Options 3 involves the installation of a new 66/11kV substation at Matarangi, and a construction of a 12km long overhead 66kV line linking the new substation with Whitianga substation. Option 4 involves upgrading the existing 11kV distribution network between the Whitianga and the Matarangi areas to 22kV. All three network reinforcements were shortlisted.

[12] The installed costs of domestic battery storage systems are currently around $10k - $12k for a 7kWh unit.

Long List of Options | High Level Assessment

Matarangi Zone Substation		*Long list of projects and high level assessment*	*Assessment Criteria*							
PROJECT FOCUS	**No.**	**PROJECT**	Safety	Fit	Feasible Practical		GEIP	Security	Cost	**Short-list**
Network Reinforcement	1	Do Nothing - Status Quo	✓	✓	✓	✗	✗	✗	✗	✗
	2	Construct 11kV Feeders and Upgrade Transformers	✓	✓	✓	✗	✓	✓	✗	✓
	3	Matarangi Zone Substation - Direct Connection to Whitianga Subs	✓	✓	✓	✓	✓	✓	✓	✓
	4	22kV Proposal	✓	✓	✓	✗	✓	✓	✗	✓
Non-network:	5	Demand Side Response (DSR)	✓	✓	✓	✗	✗	✗	✓	✗
	6	Distributed Generation (DG)	✓	✓	✓	✗	✓	✓	✗	✗

Key:

Safety	Health and Safety: Any significant implications in terms of Safety or Health - new products or compounds or practices, or requires difficult live line access etc.
Fit	Fit for Purpose: Does the option address the need appropriately and does it fit with other developments in the vicinity.
Feasible	Technically Feasible: Consider the complexity, future adaptability, and whether it aligns with company standards, strategies and policies.
Practicality	Practical to Implement: Are there potential environmental or property issues which may be insurmountable. Can it be achieved in the required time frame.
GEIP	Good Electricity Industry Practice (GEIP): Good practice (technically and environmentally) and in terms of AM practice (capacity, age, technological)
Security	Security and Reliability: Does the option provide adequate levels of security and appropriate reliability considering the demand, load type and future growth.
Cost	Some options will intuitively be known to be far more expensive than other options, and this may preclude them.

Options Analysis | Short List of Options

Option	Capital Cost[13]	Description
Option 2 ***(Upgrade the Whitianga substation and install additional 2x11kV feeders)***	$9.2M	This option involves the following network enhancements: • The upgrade of the existing 2 x 66/11kV transformers at the Whitianga substation to 2 x 16/24MVA. • The construction of 2 x 11kV feeders running north-east of the Whitianga substation to increase network security, improve network reliability and cope with increasing load in the Matarangi and Kuaotunu areas. The 11kV feeders will consist of the following sections: approximately 8.3km of overhead line section from Whitianga substation to the Matarangi turn off; a further 10km of overhead line from Simpsons Beach to Black Jack Road turn off; underground cable extension of approximately 2.2km from Whitianga-3 feeder to Wharekaho beach; and a further 6km cable from the Whitianga substation to Harbour Lights Terrace.
Option 3 ***(Matarangi Substation – Single Line Direct Connection to Whitianga Substation)***	$7.9M	This option involves a new 66/11kV substation at Matarangi as illustrated in Figure 2 and Figure 4 and includes the following components: • The consenting and construction of a new single bank, 7.5MVA 66/11kV substation. The land for this substation would need to be purchased, consented and designated. • The above mentioned substation would have 4 x 11kV feeder breakers that would connect/integrate into the existing 11kV network via underground 11kV cables that are installed from the new substation to terminate on the relevant overhead 11kV lines. Additional 11kV switchgear (ABS) would need to be installed to isolate the existing 11kV lines. • The construction of a new 12 km, single circuit, 66kV sub-transmission line diversion from the new substation to Whitianga substation. The consents, easements and compensation for the 12km line route would need to be negotiated.
Option 4 ***(Upgrade existing 11kV distribution network to 22kV)***	$12.6M	This option involves upgrading the existing 11kV distribution network between the Whitianga and Matarangi areas. It will involve a number of changes to the existing network as 22kV is not currently in operation in this area. These will include but not limited to, substation equipment, protection, signalling, communications upgrade. A new transformer will be required at Whitianga substation, and replacement distribution transformers will be required on the network affected by the 22kV upgrade. All of the existing 11kV cabling will need to be replaced with 22kV cables. With the level of upgrade required, appropriate consents and easements will need to be acquired and negotiated for this project negotiated.

[13] The total capital cost of each project. The costs do not consider the time value of money and do not include the economic value of other factors (i.e. network losses and consumer outage costs).

Option Analysis | Advantages vs Disadvantages

The following sections summarise the advantages/disadvantages associated with the short listed options. The intention being to also capture project risks and inter-dependencies.

Option	Advantages	Disadvantages
Option 2 ***(Upgrade the Whitianga substation and install additional 2x11kV feeders)***	• Moderate improvement in network reliability. • Ability to stage the project (if economic) by initially installing only one 11kV feeder with the second 11kV feeder being installed as demand increases.	• Steadily increasing reliance on the Whitianga substation. • 11kV feeders have to traverse over sections of private land which will present easement/consenting risks. • Doesn't resolve the issue of large loads supplied over long distances at 11kV.
Option 3 ***(Matarangi Substation – Single Line Direct Connection to Whitianga Substation)***	• Increased diversity of sub-transmission supply due to the existence of an extra 66/11kV substation supplying the Whitianga area. • Significant reduction in 11kV feeder lengths which improves network reliability/redundancy. • Reduces 11kV line/cable losses.	• Land/easement/consenting risks associated with installing a 12km, 66kV line across private land. The costs to secure the right to install the substation and line are thus somewhat uncertain.
Option 4 ***(Upgrade existing 11kV distribution network to 22kV)***	• Increases the capacity of the two feeders.	• Similar land/easement/consenting risks to Options 2 and 3. • Significant replacement and/or upgrades of existing equipment including zone substation and distribution transformers. • Introducing a new distribution voltage will require extra equipment needed to be procured for Powerco's spares inventory. • Does not improve network reliability as feeder lengths are kept the same.

Preferred Option	
Preferred Option	**Option 3- Matarangi Substation – Single Line Direct Connection to Whitianga Substation**
Reasons for choosing Option	Option 3 is preferred for the following reasons: • As feeder lengths are shortened, the network reliability improvements would be significant with the result that consumers are subjected to significantly less outages. • The chosen option will cater for demand growth past the 20 year study period. With the significant reduction in the length of the long 11kV feeders that supply consumers to the north of Whitianga, a corresponding reduction in electrical losses & voltage constraints would be realised. • It provides the greatest net benefit. • It delivers zone substation diversity to the region.

Option 3| Detailed Costs[14]

Item	Description	Actual Cost	Projected Cost
A	Property & Consent Costs		
A.1	Resource consents	-	$10,000
A.2	Building consent fees	-	$10,000
A.3	Matarangi Substation designation	-	$100,000
B	Line Easement		
B.1	Whitianga - Matarangi 66kV Line Easement Cost**	-	$2,400,000
C	Substation Costs		
C.1	Matarangi substation design and construction	-	$2,346,960
C.2	Whitianga substation design and construction	-	$404,510
D	Line and Cable Costs		
D.1	Whitianga - Matarangi 66kV Line	-	$2,358,120
D.2	Matarangi Cable Works	-	$124,000
D.3	Whitianga Cable Works	-	$149,508

E	Committed/Historical Costs (A+B+C+D)	$0	
F	Future Projected Costs (A+B+C+D)		$7,903,098
G	Anticipated Final Cost (E+F)		**$7,903,098**

[14] Excludes Powerco's internal/overhead costs.
** Easement cost estimates based on unit rates.

Option 3 | Implementation Plan Project or Action	Start Year[1]	End Year[1]	NZ $'000[1]	Details / Comments
Line route investigations and establishment	FY19	FY22	$120	Investigative work to establish a credible route, including preliminary line designs, route surveys, land owner discussions and property advice.
Future substation land-purchase/consents	FY19	FY22	$300	The designation and purchase of a suitable substation site.
Future line land/easements/ compensation/consents	FY19	FY22	$2,400	The easements, compensation and designations etc. in order to secure a line route.
Matarangi and Whitianga Substation Design and Construction	FY22	FY23	$2,451	The design, procurement, construction and project management associated with a 66/11kV substation. Including costs to integrate the substation into the existing 11kV network.
Whitianga - Matarangi 66kV Line	FY22	FY23	$2,632	The construction of a new 12 km, single circuit, 66kV sub-transmission line diversion from the new Matarangi substation to Whitianga substation
Total Project Costs ➔	**FY19**	**FY23**	**$7,903**	Includes Only Growth & Security Expenditure.

Supporting Documents and Models	
Planning documents ***Standards | Policies*** ***Reviews and Consultant reports*** ***Concept Designs | Estimates***	1. Matarangi Substation Project Options Analysis_Final. 2. Matarangi Substation Project Economic Evaluation 3. Matarangi- CCE, Jacobs,VH00012-RPT-EEE-021, dated August 2015. 4. Matarangi Project Costs 27-10-2016 5. Powerco's 2016 Asset Management Plan (AMP). 6. Powerco Network Development Plan 2017. 7. Transpower's Annual Planning Report 2016. 8. "*310S001 Security-of-Supply Classifications – Zone Substations*", Powerco Standard. 9. "*393S041 Zone Substation Transformer Ratings*", Powerco Standard. 10. "*393S035 Electrical Network Conductor Rating Standard*", Powerco Standard.

Notes/Assumptions	
Generic Assumptions in relation to Options Costs	• Costs are expressed in 2016 (real) dollars. • The capital costs fall within the Growth and Security expenditure categories only. • The capital costs only include Powerco's capital expenditure (not Transpower or other parties). • The costs include all costs associated with the proposed projects (or alternate options) regardless of whether those costs fall within the CPP period or not, although they do not include any sunk costs (committed already). • Reliability costs are the NPV of the Value of Loss Load calculation for each option
Specific Assumptions in Relation to Options Costs	• Cost estimation for the options has initially been achieved via a desktop study using Powerco's standard building block unit costs. They costs have then been refined by further investigations. • Property and consenting costs are usually a high risk area involving considerable uncertainty. Proposed underground cable is installed where possible in road reserve.

Figure 1: Existing Kopu GXP Sub-transmission Network: Geographic Diagram

Figure 2: Option 3: New Matarangi Substation: Geographic Diagram

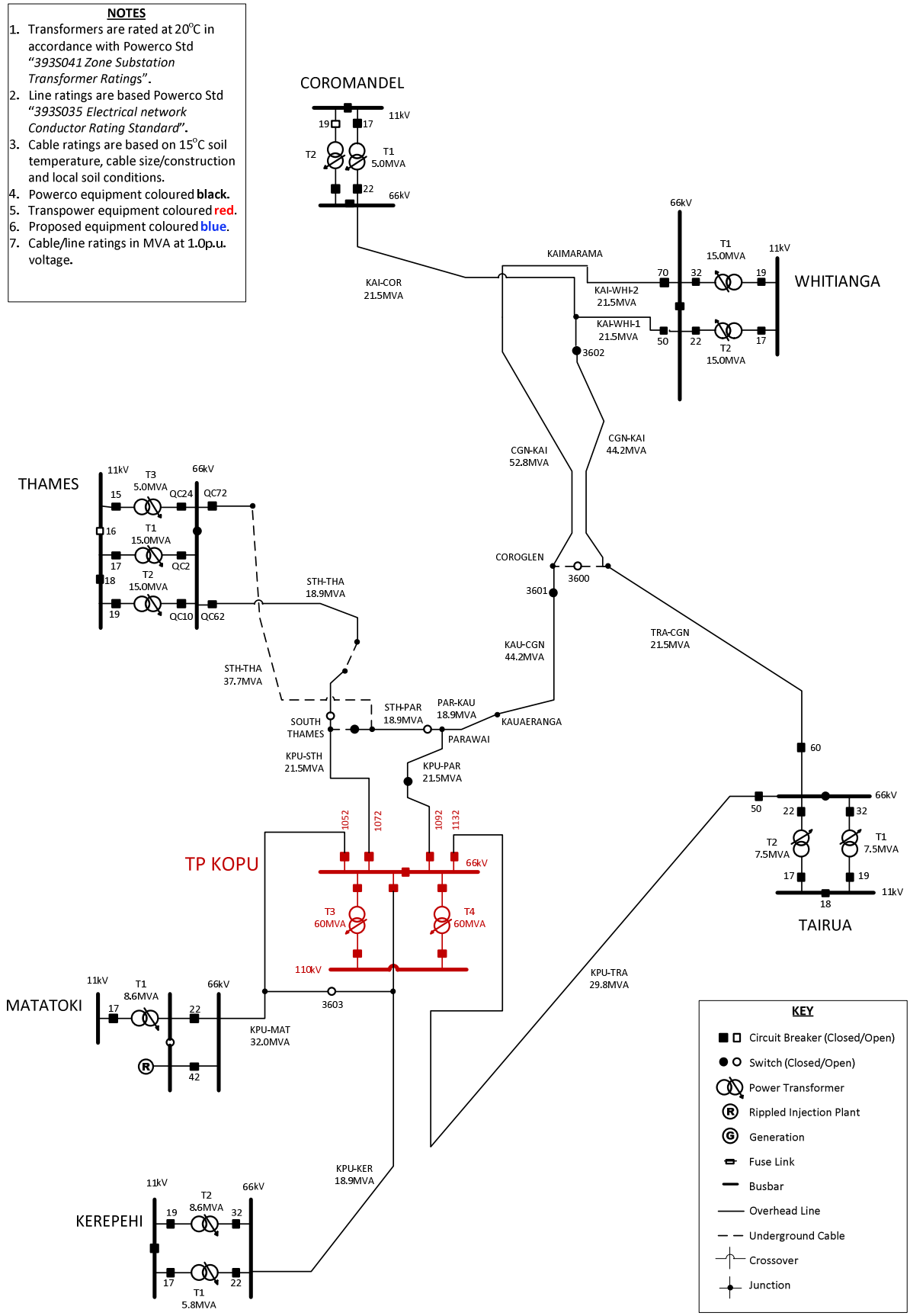


Figure 3 Existing Kopu GXP Sub-transmission Network: Single-Line Diagram

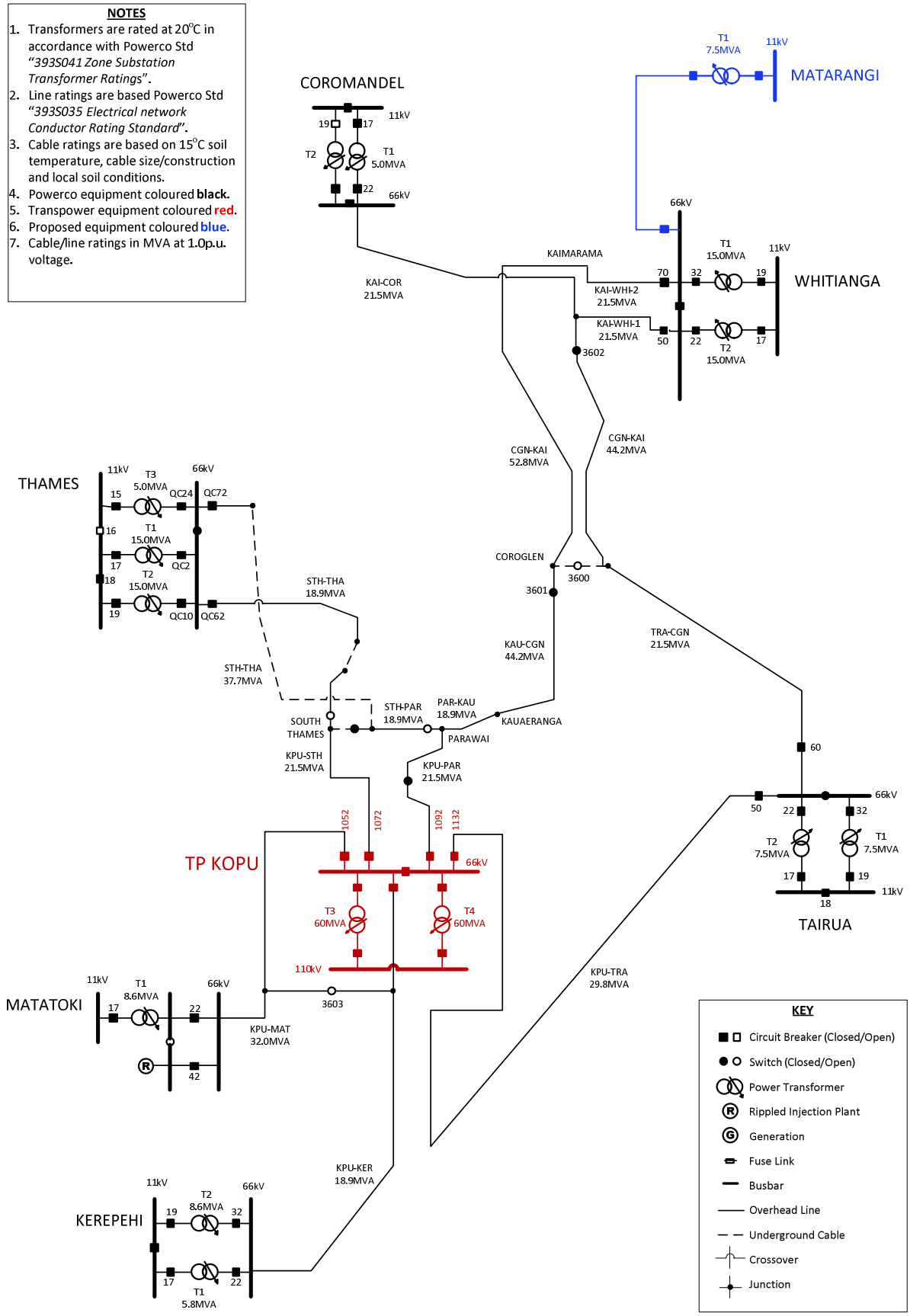


Figure 4 Option 3: New Matarangi Substation: Single-Line Diagram