Powerco CPP – Portfolio Overview Document

Portfolio Name	Kopu-Kauaeranga Project
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))*	$2.0	$2.7	$0.3	$0.3	$1.4	$1.1	$1.5	$5.8	$9.4
Post-Internal Cost Capitalisation and Efficiency Adjustments *(2016 Constant NZ$(M))*	$2.1	$3.0	$0.3	$0.3	$1.4	$1.1	$1.5	$6.1	$9.7

Description

Project need overview	Powerco's Coromandel subtransmission network, specifically around Whitianga (and the surrounding holiday areas), has been enhanced over the recent years, however, there remain some sections that still require upgrades as substations in the area do 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 during a contingent event.

Proposed Solution

Project solution overview	Powerco is proposing to install a new ≈8km, 110kV, overhead line that emanates from the Kopu substation and initially follows a north-easterly route across the Warahoe Valley (south & parallel to the Kopu-Hikuai Road, SH25A). The proposed line then transitions north across the Kirikiri Valley, SH25A and finally into the Kauaeranga Valley to terminate on the existing 66kV Kopu-Whitianga overhead 66kV line. The new 110kV capable line would initially operate at 66kV and aligns with Powerco's long term strategy to establish an 110kV circuit between Kopu and Whitianga. The line route has been designated. Options agreements and

[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.

	easement agreements are in place with landowners. One block of land which is subject to Crown/Maori Treaty settlement claim and is expected to take up to five years to resolve. In order to alleviate the thermal capacity issue between Kopu and Kauaeranga in the interim, Powerco proposes to reconductor the 4.4 km Mink-conductored section between Parawai and Kauaeranga together with the thermal upgrade of the existing Kopu to Parawai section to 70°C capability. Doing these projects are necessary to allow deferral of the main Kopu—Kauaeranga line construction for another five years.

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 lines/cables that supplies six zone substations (Kerepehi, Matatoki, Thames, Coromandel, Whitianga and Tairua) (refer to Figure 1 & Figure 3). The sub-transmission network is supplied from the 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 line security. The population is highly seasonal and the demand profile is very peaky. The demand on most zone substations peaks in summer when the temperatures are higher and line sags lower. The largest individual consumers are located in the Thames area; namely A & G Price (≈3.2MW), Thames Toyota (≈0.4MW), Thames Timber (≈1.8MW) and CHH-Kopu (≈1MW).
Underlying Drivers and Investment Triggers	The Coromandel Area has a number of constraints which include the following: 1. The combined 2015 peak demand on the Coromandel, Whitianga & Tairua substations was ≈28.4MVA. During a contingent event on the 66kV line between Kopu and Tairua, sections of the remaining 66kV line between Kopu and Whitianga would be overloaded during peak loading conditions on the Coromandel/Whitianga/Tairua substations. This project focuses on the line section that runs between the Kopu GXP and Kauaeranga (≈5 km of Raccoon conductor between Kopu & Parawai and ≈4.4 km of Mink conductor between Parawai & Kauaeranga). The existing supply network to the three substations does not meet the requirements of Powerco's Security-of-Supply Standard, which recommends a (N-1), no break supply network, security class AAA[5] for the combined load of Coromandel/Whitianga/Tairua. 2. The combined 2015 peak demand on the Coromandel & Whitianga was 20.2MW. During System Normal, the Kopu to Kauaeranga section will overload supplying the two substation loads at peak load. As a result load would need to be shed in order to maintain acceptable 66kV delivery voltages to both zone substations. 3. During 2015 the total load on the Thames substation was ≈15.3MVA. Under normal operating conditions the supply to Thames is via a single 66kV circuit[6]. In the event that there is a fault on the normal Thames supply a second overhead 66kV supply line can be switched in. However, the second circuit is shared with the Coromandel/Whitianga substations and the

[4] The Coromandel Peninsula is a rugged, forested, coastal peninsula, with five towns that have a combined population >15,000. The economy is mostly based on tourism with little heavy industry.
[5] AAA – Supply is uninterrupted in the event of the outage of one major element of the sub-transmission network. Load can be transferred to other substations without interruption by switching on the network if necessary to avoid exceeding ratings (Powerco - Standard 310S001 – Security of Supply Classification – Zone Substations).
[6] A significant section of this circuit is of underground cable construction.

	shared section (≈5 km of Raccoon conductor between Kopu & Parawai) would be overloaded during peak loading conditions. The existing supply network to Thames does not meet the requirements of Powerco's Security-of-Supply Standard, which recommends a (N-1), no break supply network, security class AAA[4] for the Thames substation. Note that the above list is not a complete list of the network constraints within the Coromandel Area and Powerco has additional PoDs/plans/projects to address these other constraints. In particular refer to items 9 & 10 in section titled Reference Documents. In addition the sub-transmission network in the Coromandel Area has a long history of poor performance due to the long overhead lines that traverse across rugged terrain coupled with the meshed configuration that involves a number of 66kV tee connections. The simplification of the existing network is expected to deliver significant benefits to the consumers in the Coromandel Area.
Timing of the need	The constraints identified above presently exist and Powerco has thus already started work on the project. A detailed line design has been undertaken and a line route designated. Easement agreements/options agreements have been negotiated with landowners. However, there is one land parcel which is held up by a Crown/Maori land treaty settlement claim. We estimate that it will take at least five years to finalise. As a result of the delays, Powerco intends to relieve the capacity constraints on the existing Kopu to Kauaeranga line section through a mix of line reconductoring and thermal upgrade works. Timing for the remedial works is in the near-term - FY18 for design with construction to take place in FY19 and FY20. Completion of the remedial works is necessary to defer the main Kopu—Kauaeranga line for another five years.

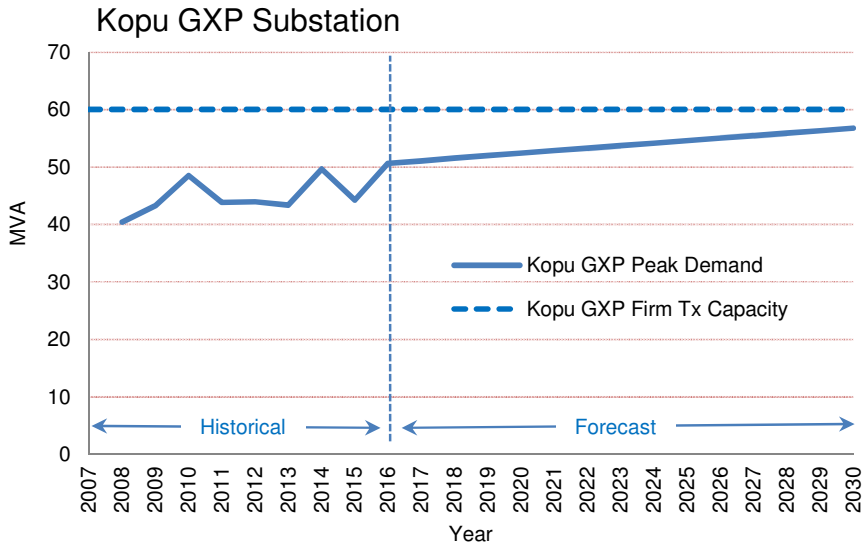
Demand Forecast | Coromandel Area

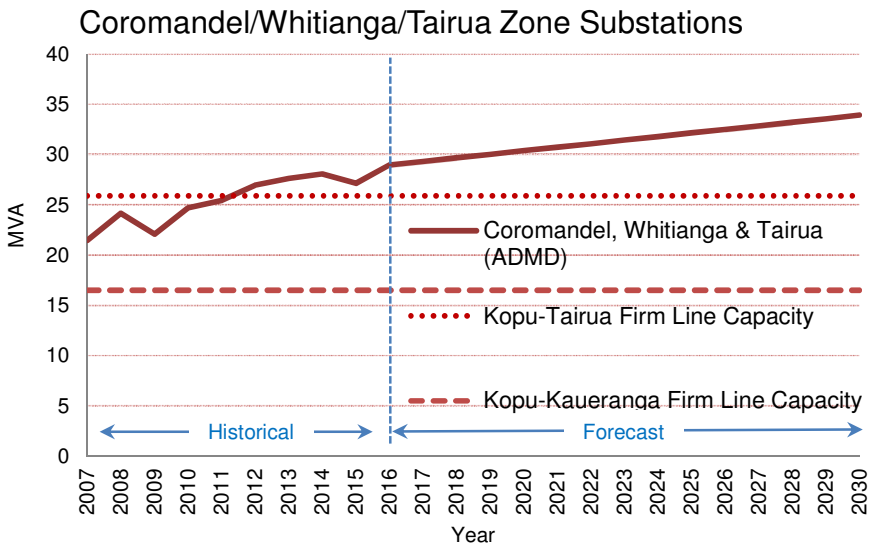
COROMANDEL AREA SUBSTATIONS			FORECAST MAXIMUM DEMAND [MVA]						
SUBSTATION	CLASS CAPACITY	GROWTH	2016	2017	2018	2019	2020	2025	2030
Coromandel	0.0	0.9%	4.7	4.8	4.8	4.8	4.9	5.1	5.3
Kerepehi	0.0	0.7%	10.1	10.2	10.3	10.3	10.4	10.8	11.1
Matatoki	0.0	0.9%	5.6	5.7	5.7	5.8	5.8	6.1	6.3
Tairua	7.5	0.7%	8.6	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

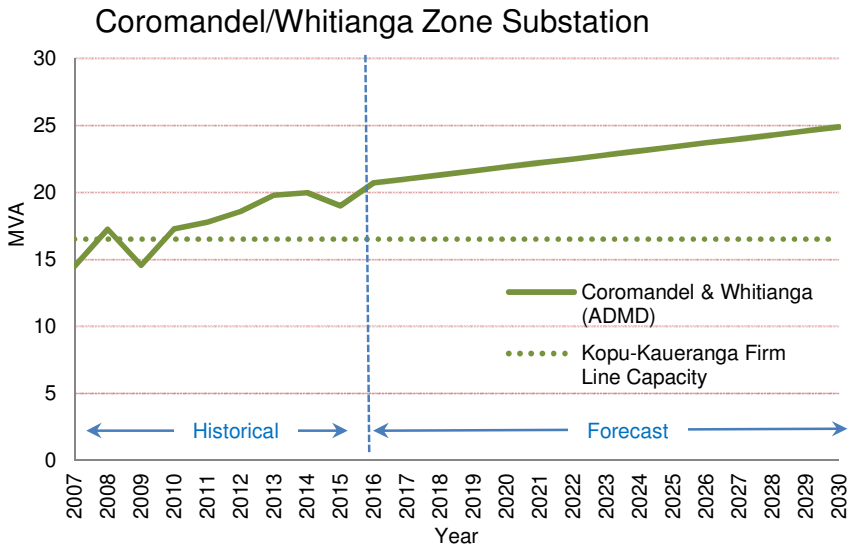
COROMANDEL AREA SUBSTATIONS			FORECAST MAXIMUM DEMAND [MVA]						
SUBSTATION	TX CAPACITY	GROWTH	2016	2017	2018	2019	2020	2025	2030
Kopu GXP	60.0	0.9%	50.6	51.1	51.5	52.0	52.4	54.6	56.8

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.


Kopu GXP Substation
MVA
Year
Kopu GXP Peak Demand
Kopu GXP Firm Tx Capacity
Historical
Forecast


Coromandel/Whitianga/Tairua Zone Substations
MVA
Year
Coromandel, Whitianga & Tairua (ADMD)
Kopu-Tairua Firm Line Capacity
Kopu-Kaueranga Firm Line Capacity
Historical
Forecast


Coromandel/Whitianga Zone Substation
MVA
Year
Coromandel & Whitianga (ADMD)
Kopu-Kaueranga Firm Line Capacity
Historical
Forecast

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 can have fatal flaws. 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 the reality of trying to secure 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 as in this case with the Treaty settlement claim, which impacts on project delivery. 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 Coromandel Area. The four non-network options (Nos. 2, 3, 4 & 5) are not shortlisted on the following basis: • Fossil fuelled generation (i.e. diesel generation) is technically viable but not shortlisted due to the cost and environmental/consenting challenges. Under network contingencies there would be shortfall of ≈10MW[7] that would need to be "made up" using stand-by generation. The capital cost of a 10MW[7] standby diesel generation plant is estimated to range from $15M to $20M[8,9]. • Powerco has not identified any viable renewable generation options that would provide the required security of supply[10]. • 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 Coromandel Area has experienced and the fact that the network security levels are already well 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. • 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 10MW[9] of domestic batteries with two hours capacity are estimated to be >$29M[11].

[7] This is the present shortfall and this amount is predicted to increase in the future.
[8] Excludes the ongoing maintenance and operational costs.
[9] 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.
[10] Typical plant might involve wind turbines or photovoltaic arrays. Both of these generators have an intermittent output which cannot be relied upon unless there issignificant penetration and diversity.
[11] The installed costs of domestic battery storage systems are currently around $10k - $12k for a 7kWh unit.

	Alternatively, a grid-scale battery solution providing 9MW for two hours would, at current rates, cost >$25M. Many outages would be addressed within two hours and peak demand periods are rarely sustained for several hours. However, storage solutions at this size would not provide sufficient back-up for extended outages. Three network reinforcement options were shortlisted (Nos. 6, 7 & 8) as they address the relevant network constraints that have been identified. All the short listed options will increase the line capacity from Kopu GXP to Kaimarama (via Kauaeranga) but are reliant on the resolution of the existing 66kV network constraint at Kaimarama. The options for resolving "the Kaimarama constraint" and the preferred options are discussed in "*PoD-G14 Kaimarama-Whitianga Sub-transmission Enhancement*". Another related network constraint is that associated with the overloading of the Kopu-Tairua line (that is discussed in the section titled "Needs Identification"). The options for resolving this constraint are discussed in "*PoD-G6 Kopu-Tairua Sub-transmission Enhancement*").

Long List of Options | High Level Assessment

Kopu-Kauaeranga 66kV Line Project		*Long list of projects and high level assessment*	*Assessment Criteria*						
PROJECT FOCUS	**No.**	**PROJECT**	Safety	Fit	Feasible Practical	GEIP	Security	Cost	**Short-list**
Do Nothing	1	Allow the electrical demand & risk of consumer non-supply to inc	✓	✗	✗	✗	✗	✓	✗
Non-network	2	Distributed Generation (DG) including peak lopping generation	✓	✗	✓	✓	✓	✗	✗
	3	Fuel switching to reduce electrical demand	✓	✓	✗	✗	✓	✗	✗
	4	Demand Side Response (DSR)	✓	✓	✗	✗	✓	✗	✗
	5	Energy storage	✓	✓	✓	✓	✗	✗	✗
Network Reinforcement	6	New line from Kopu to Kauaeranga	✓	✓	✓	✓	✓	✓	✓
	7	Thermal upgrade Kopu-Kauaeranga	✓	✓	✓	✓	✓	✓	✓
	8	Reconductor Kopu-Kauaeranga	✓	✓	✓	✓	✓	✓	✓

Options Analysis | Short List of Options		
Option	**Capital Cost[12]**	**Description**
Option 6: ***New Line From Kopu to Kauaeranga***	$9.4M	The following enhancements are proposed (refer to Figure 2 and Figure 4): • A new ≈8km, 110kV-capable overhead line from the Kopu substation to join up with the existing Kopu—Coroglen 66kV line. The line would traverse across rugged terrain, in a north-north-easterly direction, to join the existing 66kV in the upper Kauaeranga Valley. The new line will significantly increase the network capacity into Kaimarama and ultimately deliver additional security of supply to Whitianga/Coromandel/Tairua. Building the line is delayed due to easement issues surrounding Crown/Maori Treaty settlement claims. Estimated earliest start for line construction is FY2022 with completion in FY2024. • A new 66kV line circuit breaker bay at Kopu GXP. This would be installed by Transpower. • A ≈200m section of 66kV underground cable adjacent the Kopu substation. This cable would run from the new 66kV circuit breaker bay to an underground-overhead termination structure close into the Kopu GXP. • A manual air break switch near Kauaeranga in order to isolate the Parawai- Kauaeranga section of the existing 66kV line. • Land easement and consent for 66kV operation, initially. Approximately 8.5km. • Due to delays with securing easement for the 110 kV line route, the existing Mink-section between Parawai and Kauaeranga will be reconductored and the existing Raccoon-section between Kopu GXP and Parawai will be thermally upgraded to 70C capability. In the short term as easements have yet to be finalised for the 110 kV line route, the reconductoring of Parawai—Kauaeranga and thermal upgrade of Kopu—Parawai will temporarily relieve the thermal constraint of the existing sections until the new 110 kV-capable line is completed. Once the new line is completed, it would be operated at 66 kV until load growth necessitates the conversion of the Kopu-Whitianga line to 110 kV operation, which is expected in the long term ≈2035. The installation of the new 110 kV-capable line would remove the existing 66kV tee at Parawai and deliver a security of supply class of AAA[5] to the Thames substation. With this option, it resolves the overloading constraint on the Kopu-Whitianga 66kV line that occurs during network contingencies and which is discussed in the section titled “Need Identification”.
Option 7: ***Thermal upgrade of Kopu-Kauaeranga***	$9.0M	This option involves thermally upgrading the existing Kopu-Kauaeranga section of 66kV line to have a maximum conductor operating temperature of 70°C[13]. The upgrade of the line is expected to require landowner negotiations to secure a line easement due to the fact that taller poles or intermediary poles are expected to be required to manage safety clearances. The upgraded Mink and Raccoon conductor line would have a summer rating of 26MVA, which would be overloaded by ≈28%[14] during an

[12] 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).

[13] The existing line is designed with a maximum conductor operating temperature of 50°C.

		outage of the Kopu-Tairua circuit. The shortfall of ≈5MW (in 2015) would need to be "made up" using, for example, diesel generation. This option would not address the overloading constraint on the Kopu-Whitianga 66kV line that occurs during network contingencies, which is discussed in the section titled "Need Identification". It would not deliver a security of supply of AAA[5] to (i) the Thames substation and (ii) the combined Coromandel/Whitianga/Tairua substation load. Eventually as load grows, the same section would overload again in System Normal, making a more robust solution favourable in the long term.
Option 8: ***Reconductor Kopu-Kauaeranga***	$8.3M	This option proposes the following enhancements: • Replacing the existing Kopu-Kauaeranga section of Mink/Raccoon conductor line with a high capacity conductor (i.e. Neon AAAC built with a maximum operating temperature of 70°C) and insulating the line to operate at 110kV. The upgrade would require the replacement of a significant number of the existing line support structures and as a result an easement would need to be negotiated with the landowners along the route. • Replacing the existing manual 66kV air break switches on the Thames circuits and the intertie line/cable between Thames South and Parawai with automated switches in order to deliver Thames a security of supply class of AA+[15] security at best. AAA is not achievable through this approach. Operational changeover between supply circuits would be done on a break-before-make basis, similar to today, for restoration of supply to Thames from KPU1092. This option would address the thermal overloading constraint on the Kopu-Kauaerange 66kV section in the medium to long term. However it would not deliver a security of supply of AAA[5] to (i) the Thames substation and (ii) the combined Coromandel/Whitianga/Tairua substation load.

[14] When supplying the combined 2014 peak electrical demand on the Coromandel, Whitianga & Tairua substations.
[15] AA+ Supply may be lost in the event of the outage of one major element of the sub-transmission network. Supply is restored automatically within 15 seconds by automatic switching at sub-transmission or distribution level (Powerco - Standard 310S001 – Security of Supply Classification – Zone Substations).

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 6: ***New Kopu-Kauaeranga Line***	• Significantly increases post contingency transfer capacity to Coromandel, Whitianga and Tairua. • Delivers a class AAA[5] security of supply to both the Thames load and the Coromandel/Whitianga/Tairua load. • Removes the 66kV tee at Parawai and simplifies the network protection systems. This will increase network reliability. • The line route has been designated. Options agreements/easements in place with the relevant landowners except for Crown block of land which is subject to Treaty settlement claims. • Reduces electrical losses.	• The proposed route crosses land that is subject to a land settlement claim, which presents risk of project delays. This delay necessities the build of interim line upgrade projects thereby pushing up the cost of this option. • Requires Transpower to install an additional 66kV circuit breaker bay at the Kopu substation.
Option 7: ***Thermal upgrade of Kopu-Kauaeranga***	• Relies on the existing line routes (i.e. no additional lines to be built).	• The Coromandel, Whitianga & Tairua substations will need to be operated for a period on one 66kV circuit whilst the line upgraded. • Does not deliver the Thames load and the Coromandel/Whitianga/Tairua load a class AAA[5] security. • The landowners along the existing route would need to agree to the upgrade and easements/access would need to be secured. • The existing complex protection system would remain. • Relies on diesel generation to relieve overloading on the Kopu-Kauaeranga section of the 66kV line. • Does not facilitate the future upgrade of the Kopu-Whitianga line to 110kV. • Additional voltage support (capacitor banks) would need to be installed at Whitianga and Tairua to address voltage constraints.
Option 8: ***Reconductor Kopu-Kauaeranga***	• Relies on the existing line routes (i.e. no additional lines to be built). • Reduces electrical losses.	• The Coromandel, Whitianga & Tairua substations will need to be operated for a significant period on one 66kV circuit whilst the line is re-conductored. • Does not deliver the Thames load and the Coromandel/Whitianga/Tairua load a class AAA[5] security. • The landowners along the existing route would need to agree to the

		upgrade and easements/access would need to be secured. • The existing complicated protection system would remain.
Shared Features	• Utilise known technology and proven designs.	• All options rely on "*PoD-G14 Kaimarama-Whitianga Sub-transmission Enhancement*" proceeding to realise full benefits. • The delivery of class AAA[5] security to the Coromandel/Whitianga/ Tairua load is reliant on "*PoD-G6 Kopu-Tairua Sub-transmission Enhancement*" proceeding.

Recommendation	
Preferred Option	**Option 6 :** New Kopu-Kauaeranga Line
Reasons for choosing Option	Despite being the most expensive, Option 6 delivers the highest net benefit and has the following additional features that deliver significant benefit (in comparison to Options 7 & 8): • It delivers the Thames substation a security of supply class of AAA[5] • It will ultimately deliver a security of supply class of AAA[5] to the Coromandel/Whitianga/Tairua substations (this is dependent on PoD-G6 & PoD-G14 proceeding to realise full benefits). • It separates out the sub-transmission supply to Thames from the supply to Coromandel/Whitianga/Tairua. This will simplify the existing protection systems and improve the overall network reliability. • During construction of the project, consumers in the Coromandel Area would not be exposed to a higher risk of non-supply.

Option 6| Detailed Costs[16]

Item	Description	Actual Cost	Projected Cost
A	Property & Consent Costs		
A.1	Easements and consenting (future)	-	$917,260
B	Investigation and Reporting Costs		
B.1	Consultants/Investigations/Lawyers	$1,554,188	-
C	Substation Costs		
C.1	None (Transpower will provide new 66kV line bay)	-	-
D	Interim Solution (Reconductor Mink & Thermally Upgrade Raccoon)		
D.1	Reconductor Mink section	-	$2,200,000
D.2	Thermally Upgrade Raccoon section	-	$380,000
E	Line and Cable Costs		
E.1	66kV Underground Cable and UG to OH Transition Structure	-	$259,000
E.2	110kV Line construction cost	-	$3,777,774
E.3	Detailed Overhead Line Design (completed)	$292,477	-

E	Committed/Historical Costs (A+B+C+D)	$1,846,665	
F	Future Projected Costs (A+B+C+D)		$7,534,034
G	Anticipated Final Cost (E+F)		**$9,380,699**

[16] Excludes Powerco's internal/overhead costs, i.e. internal cost capitalisation and IDC.

Option 6 | Implementation Plan				
Project or Action	**Start Year[1]**	**End Year[1]**	**NZ $'000 [1]**	**Details / Comments**
Project costs to date	-	FY14	$1,847	Costs that have already occurred.
Future land/easements/compensation/legal	FY18	FY21	$917	Costs associated with easements, compensation, designations etc. to secure the line corridor.
Interim deferment solution - Reconductor Mink Section Parawai - Kauaeranga	FY18	FY19	$2,200	Costs associated with interim solution of reconductoring the mink section of the existing Kopu-Kauaeranga line
Interim deferment solution - Thermal Upgrade section Kopu GXP - Parawai	FY19	FY19	$380	Costs associated with interim solution of thermally upgrading the racoon section of the existing Kopu-Kauaeranga line
66kV Underground Cable	FY22	FY22	$259	Costs associated with ≈100m section of 66kV underground cable to terminate on the 66kV switchyard. Costs include the costs of an overhead to underground transition structure.
110kV Overhead Line	FY22	FY24	$3,778	Costs associated with the construction of ≈8km of single circuit, neon conductor, 110kV overhead line.
Total Project Costs ➔	**FY14**	**FY24**	**$9,381**	Includes Only Growth & Security Expenditure.

Supporting Documents	
Planning documents ***Standards | Policies*** ***Reviews and Consultant reports*** ***Concept Designs | Estimates***	1. Kopu-Kauaeranga sub-transmission enhancement Options Analysis report. 2. Kopu-Kauaeranga 110kV Transmission Line – Detailed Design, May 2014. 3. Powerco's Demand Forecast 2016. 4. Powerco's 2016 Asset Management Plan (AMP). 5. Powerco's Area Plans Summary, 2017 6. "*310S001 Security-of-Supply Classifications – Zone Substations*", Powerco Standard. 7. "*393S041 Zone Substation Transformer Ratings*", Powerco Standard. 8. "*393S035 Electrical Network Conductor Rating Standard*", Powerco Standard. 9. PoD-G14 Kaimarama-Whitianga Sub-transmission Enhancement. 10. PoD-G6 Kopu-Tairua Sub-transmission Upgrade.

Notes/Assumptions	
Generic assumptions in relation to Options Costs	• Costs are expressed in 2016 (real) dollars. • The costs quoted are to construct the network • 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.
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. Their costs have then been refined by further investigations. • Property and consenting costs are usually a high risk area involving considerable uncertainty. Treaty settlement claims have an effect on introducing unpredictable delays to the project.

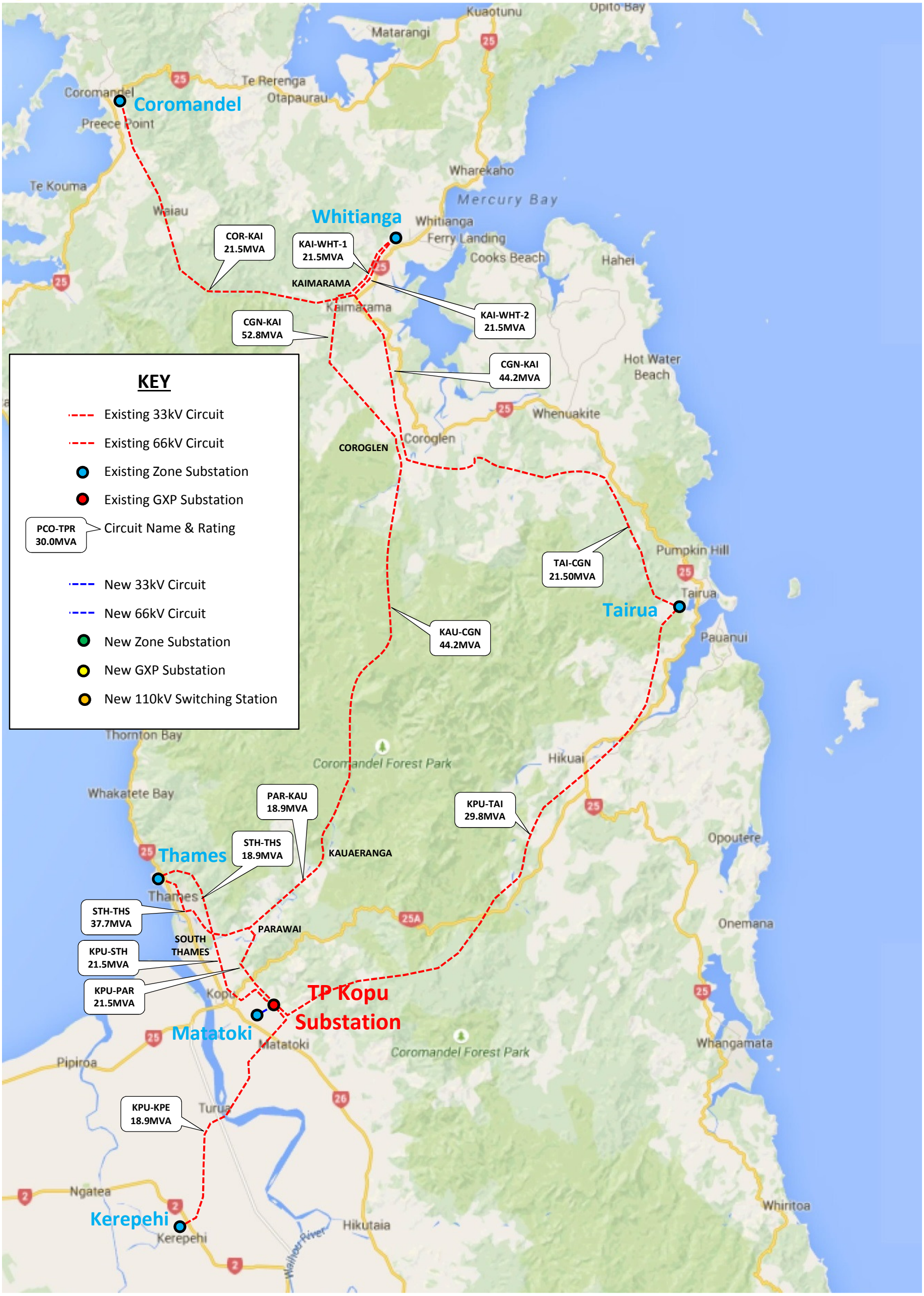


Figure 1: Existing Kopu GXP Sub-transmission Network: Geographic Diagram

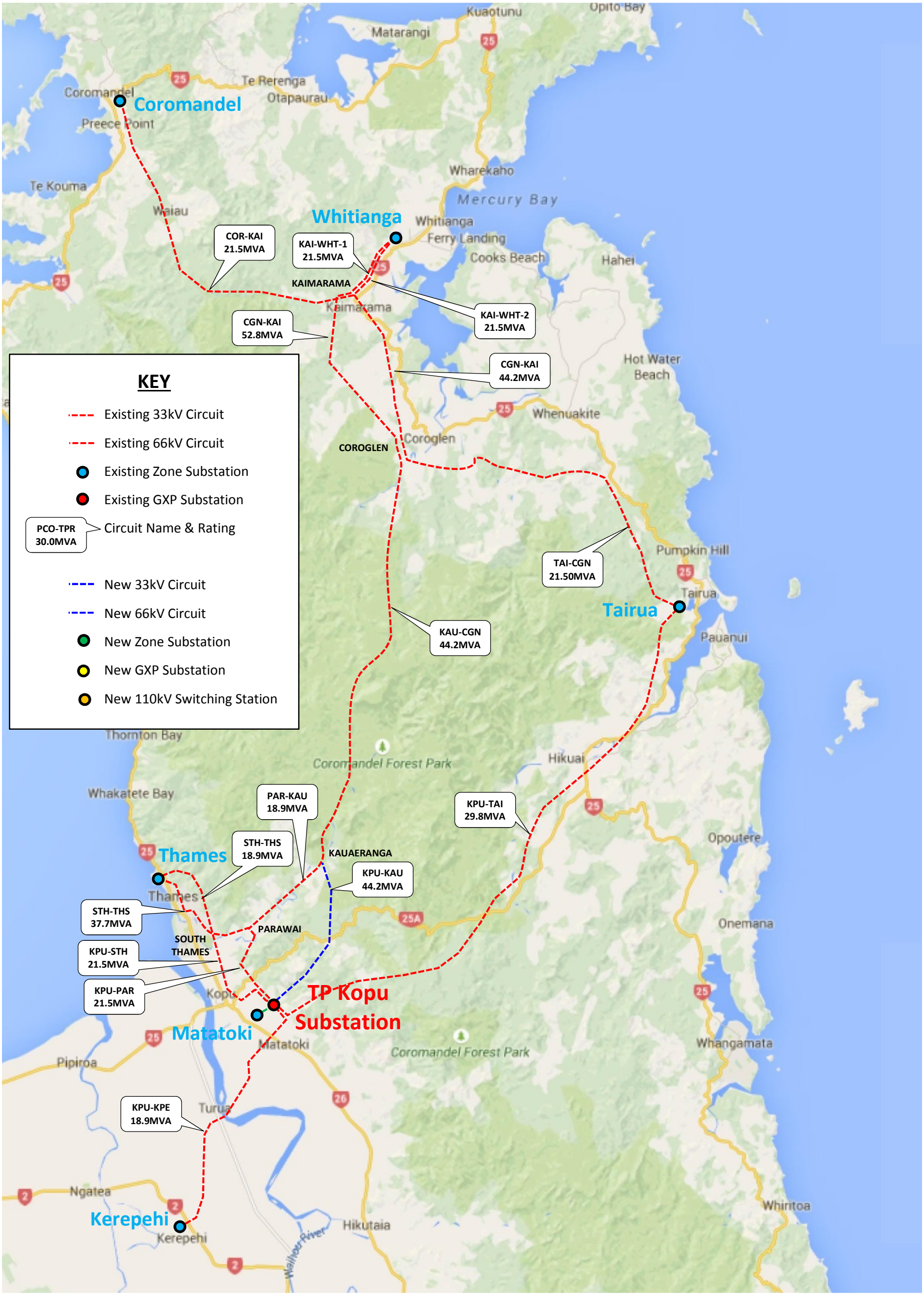


Figure 2: Option 6 New Kopu-Kauaeranga Line: Geographic Diagram

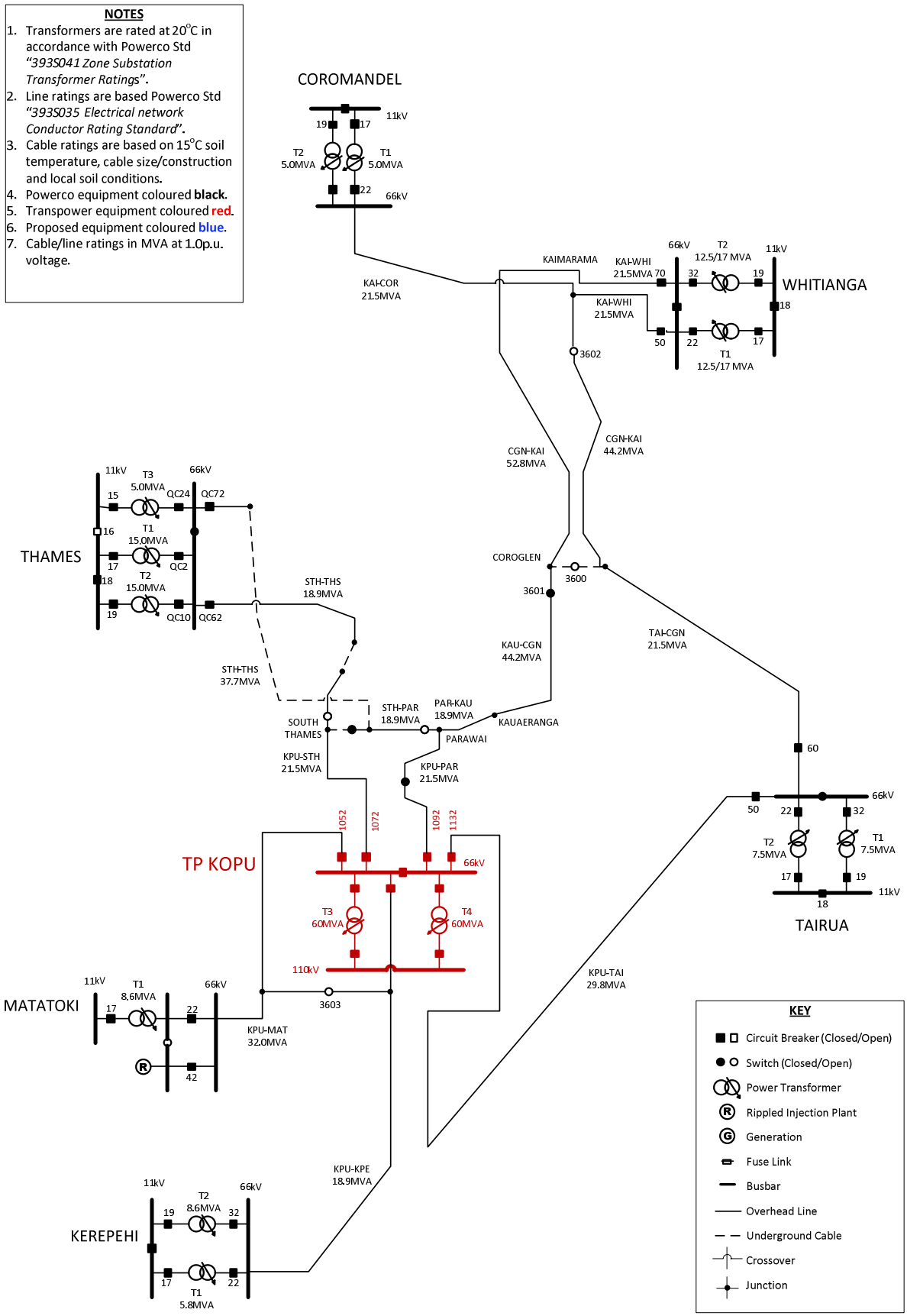


Figure 3: Existing Kopu GXP Sub-transmission Network: One-Line Diagram

NOTES

1. Transformers are rated at 20°C in accordance with Powerco Std *"3935041 Zone Substation Transformer Ratings"*.
2. Line ratings are based Powerco Std *"3935035 Electrical network Conductor Rating Standard"*.
3. Cable ratings are based on 15°C soil temperature, cable size/construction and local soil conditions.
4. Powerco equipment coloured **black**.
5. Transpower equipment coloured **red**.
6. Proposed equipment coloured **blue**.
7. Cable/line ratings in MVA at 1.0p.u. voltage.

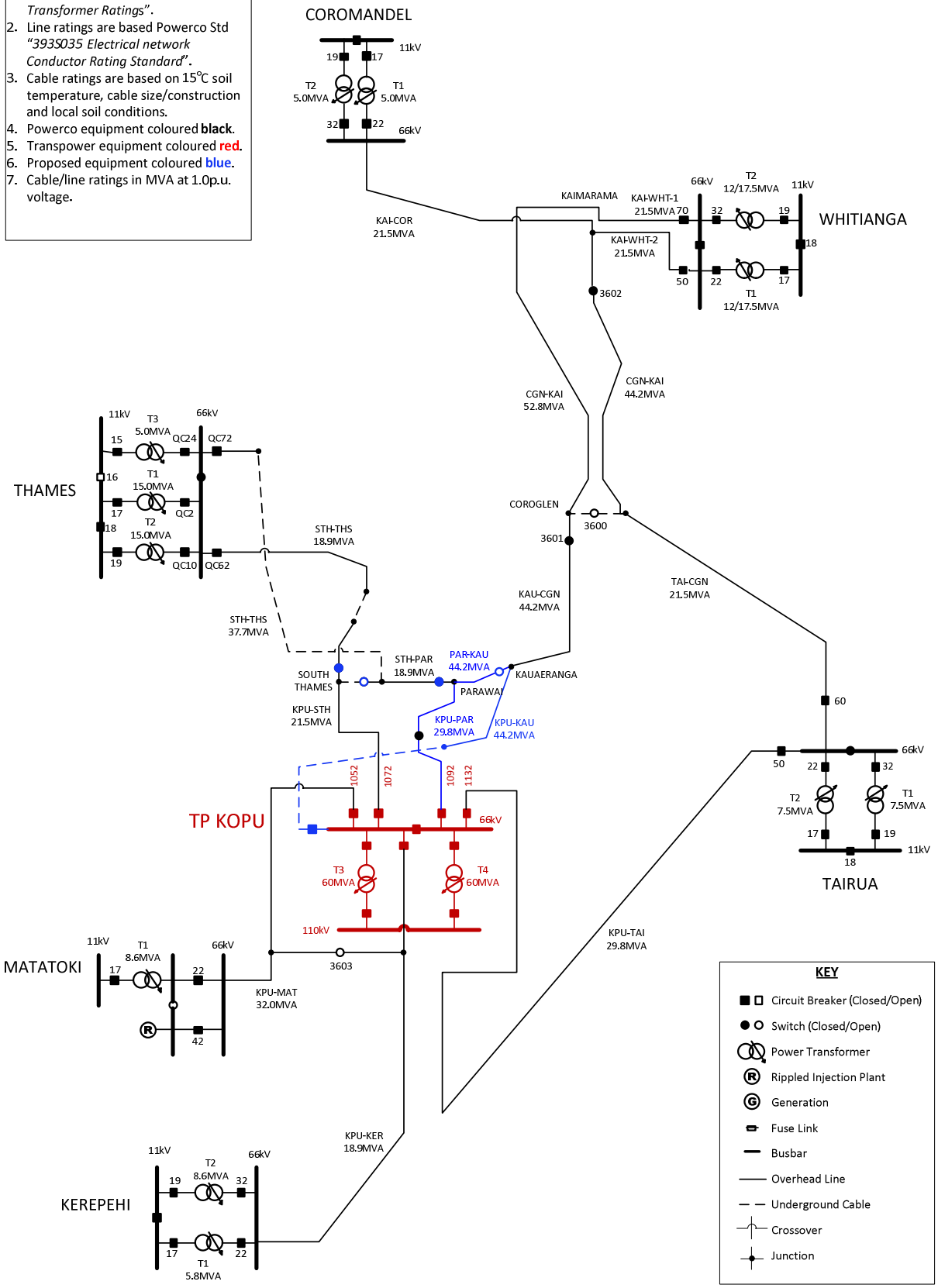


Figure 4: Option 6: New Kopu-Kauaeranga Line

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