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RCP2 Project Overview Document

Project Name:	**Otahuhu—Wiri Transmission Capacity**
Expenditure Class:	**Base Capex**
Expenditure Category:	**Grid – Enhancement & Development**
As at date:	**June 2014**

Expenditure Forecast *(Real 2012/13 NZ$ (m))*	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	Total
CAPEX	2.5	8.7	6.8			**18.0**

Need Identification

Describe the reason for proposing a project (i.e. **need or trigger**)

The Bombay—Otahuhu circuits are part of the core grid (as defined in the Electricity Industry Participation Code (Code)), refer Figure 1. The Code sets Grid Reliability Standards (GRS) for the core grid, which require that the power system remains in a satisfactory state following a single outage on the core grid (N-1 security standard). A satisfactory state means, amongst other things, that no transmission assets are unacceptably overloaded.

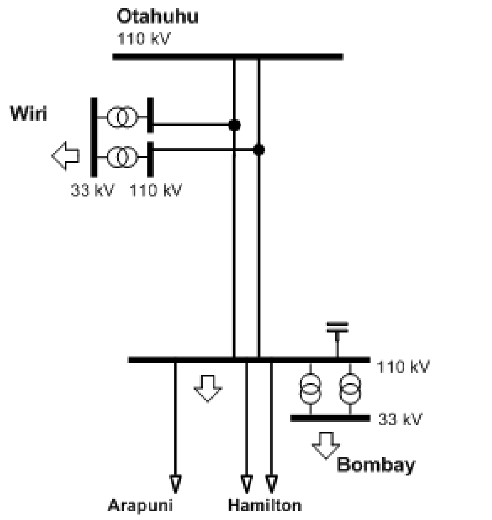

Figure 1 Single line circuit diagram of Bombay-Otahuhu

The Wiri Grid Exit Point (GXP) supplies the Southern Auckland region. The Bombay GXP supplies the Franklin District just south of Auckland including customers around Pukekohe. In our Annual Planning Report (both the 2013 and the more recently published 2014 report) we forecast peak demand growth at both GXPs.

Load growth at both Bombay and Wiri means that, if there are outages on the 110kV Bombay-Otahuhu circuits, we expect circuits between Otahuhu and Wiri to overload at peak demand. We expect peak load growth and generation scenarios to lead to constraints from 2014. If no investment is undertaken, there will be increased market costs and load growth at Wiri and Bombay will need to be restricted to ensure the core grid retains N-1 security

A supporting report, *Options Analysis – Otahuhu-Wiri Transmission Constraint*, provides detail explaining the load forecasts, direction of power flow and generation scenarios and provides constraint charts showing when we expect which circuits or transformers to overload.

Two generation scenarios particularly test the boundaries of transmission flow on the Bombay—Otahuhu circuits.

	• High Auckland generation combined with low Arapuni generation • High Arapuni generation combined with low Auckland generation Given historic power flows, the most likely to of these is the high Auckland/low Arapuni generation scenario.
What is the **timing** of the need and the **confidence level** that issue(s) will eventuate	Based on the 2014 APR forecasts[1] Table 1 shows when, and under which scenario[2], we expect the peak demand growth to cause overloading on circuits. **Circuit (with outage)** / **High Auckland** / **High Arapuni** **OTA-WIR- 1 (or 2) (BOB-OTA-1 (or 2) outage)** / 2014 / 2018 **OTA-WIR-2 (WIR T1 outage)** / 2017 / 2020 **Wiri supply transformer n-1 capacity** / 2019/2020 / 2019/2020 Table 1 Expected overloading dates We are confident that forecast constraints will arise is high for the following reasons: • load forecasts for Bombay are based on the Draft Auckland Unitary Plan which indicates significant increase in the residential and commercial zoning of land in the Pukekohe region; • the low likelihood of new generation in the Auckland and Waikato regions *(See APR 2014, Chapter 5 for the generation assumptions)*; and • actual 2013 dispatch shows that two of the scenarios studied occurred for 51 hours and 21 hours respectively.

Generic assumptions underpinning the need – including any modelling used	We used our power system simulation tool DigSilent to study the power system. The analysis included the following assumptions:
	• the prudent (p90) regional demand forecast; and
	• the following generation dispatch scenarios for generators in the Auckland and Waikato regions:
	  ○ high Auckland generation – Otahuhu B combined Cycle at 370MW, Arapuni at 15MW; and
	  ○ high Arapuni generation – Arapuni at 140 MW, Otahuhu B Combined Cycle at 0MW

[1] The demand forecast used in assessing the Otahuhu—Wiri transmission capacity issue has been updated subsequent to the initial submission of this POD. The more recent forecast has moved the need date by one year.

[2] For detail of the scenarios refer to sections 3.3 to 3.4, *Options Analysis – Otahuhu-Wiri Transmission Constraint.*

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Options analysis

Options

The Code requires us to consider any transmission investment alongside alternatives such as demand management and supply side options. This table provides a list of the options we consider reasonable to resolve the Otahuhu-Wiri transmission capacity problems. We consider these options, and a number of options that we rejected, in the supporting report[3] in line with our Investment Approvals Policy Guidelines.

Option type	Option	Considered further?
Demand-side	Contracted demand response, e.g. pre-contingency load management. Vector shifting load to maintain the load within the n-1 capacity of the interconnection assets.	**Short term option only**
Transmission	Special Protection Scheme (SPS) to reconfigure grid post contingency. This option includes bussing the Arapuni-Bombay circuit at Hamilton. The special protection scheme removes the post contingency overloading and can be used in the short to medium term to enable deferral of capex. Bussing the Arapuni—Bombay circuit at Hamilton increases the longevity of the solution.	**Short term option only**
	110 kV cable - Install a new 110 kV cable between Otahuhu and Wiri and connect directly to a new 110/33 kV 120 MVA supply transformer at Wiri	**yes**
	33 kV cable – Install a new 33 kV cable between Otahuhu and Wiri and connect directly to a new 110/33 kV 120 MVA supply transformer at Wiri	**yes**
	110 kV reconductoring - Reconductor the 110 kV Otahuhu-Wiri circuits to simplex sulphur 75C	**yes**
	Bombay 220/110 kV interconnection - Install one 220/110 kV 150 MVA transformer at Bombay with a tee connection onto one of the Huntly–Otahuhu circuits	**yes**
	New GXP to offload Wiri – Construct a new GXP to take load off Wiri	**yes**
	New GXP to offload Bombay – Construct a new GXP to take load off Bombay	**yes**
	Circuit bonding – Bond the circuits between Bombay - Wiri and Otahuhu - Wiri	**yes**
	Split the 110 kV system – Dismantle either Bombay-Wiri or Otahuhu-Wiri circuit sections or Bombay-Hamilton circuits to split the 110 kV	**yes**

[3] Section 4, *Options Analysis – Otahuhu-Wiri Transmission Constraint.*

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Short list options	
Contracted demand-side response and an SPS provide short-term solutions to defer transmission investment. Development plans to meet the required Otahuhu-Wiri transmission capacity until 2029 are summarised below. The development plans are described in more detail in the supporting report[4]. A new supply transformer at Wiri, or for some options upgrading the supply transformer, is included in the development plans to understand the overall best network solution. The costs of the transformer investment would be part of a customer investment contract rather than base capex.	
Contracted demand response (DR)	Pre-event demand response remains open as an option depending on the cost and viability and the potential loss benefits foregone should a transmission investment be delayed. This will be discovered through a thorough investigation of the deferral options. Section 4 of *Options Analysis – Otahuhu-Wiri Transmission Constraint* provides further consideration of demand-side response.
Special protection scheme(SPS)	Investment that enables temporary post event reconfiguration of the grid to maintain supply. This option may be used to defer the need for investment to relieve the Otahuhu-Wiri transmission constraint. The SPS removes the post contingency overloading and can be used in the short to medium term to enable deferral of capex. Bussing the Arapuni—Bombay circuit at Hamilton increases the longevity of this solution. The SPS is included in each of the transmission development plans.

[4] Section 5, *Options Analysis – Otahuhu-Wiri Transmission Constraint*

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Transmission development plans						
Development plan	**2014**	**2019**	**2021**	**2026**	**2028**	**2034**
1: Otahuhu-Wiri 110 kV cable	SPS or DR	110 kV cable from Otahuhu to Wiri Additional 110/33 kV supply transformer at Wiri	Replacement of Wiri T1 (supply transformer) based on asset health indicators		110 kV bus at Wiri	220/110 kV interconnection at Bombay
2: 33 kV cable	SPS or DR	33 kV cable from Otahuhu to Wiri Additional 110/33 kV supply transformer at Wiri	Replacement of Wiri T1 (supply transformer) based on asset health indicators		110 kV bus at Wiri	220/110 kV interconnection at Bombay
3: 110 kV reconductoring	SPS or DR	Reconductor Otahuhu-Wiri Upgrade the Wiri 110/33 kV supply transformers Upgrade the conductor capacity from Wiri transformers to Wiri Tee connection				
4a: Bombay 220 / 110 kV interconnection	SPS or DR	220/110 kV interconnection at Bombay Upgrade the Wiri 110/33 kV supply transformers Upgrade the conductor capacity from Wiri transformers to Wiri Tee connection				
4b: Bombay 220 / 110 kV interconnection	220/110 kV interconnection at Bombay	Upgrade the Wiri 110/33 kV supply transformers Upgrade the conductor capacity from Wiri transformers to Wiri Tee connection				

5: New GXP to offload Wiri	SPS or DR	New GXP at Wiri	Replacement of Wiri T1 (supply transformer) based on asset health indicators	220/110 kV interconnection at Bombay		
6: New GXP to offload Bombay	SPS or DR	New GXP at Bombay Upgrade the Wiri 110/33 kV supply transformers Upgrade conductor capacity from Wiri transformers to Wiri Tee connection 220/110 kV interconnection at Bombay	Replacement of Wiri T1 (supply transformer) based on asset health indicators			
7: Circuit bonding	SPS or DR	Bond Otahuhu-Wiri and Bombay-Wiri Upgrade the Wiri 110/33 kV supply transformers 220/110 kV interconnection at Bombay				
8: Split the 110 kV network	SPS or DR	Four options each involving dismantling parts of the network, cabling, interconnection and upgrading Wiri supply transformers.				

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P50 option costs

Brief description of the approach used to estimate capex, and, if applicable, opex	A high-level assessment of the costs of each development plan, using a generic 'building block' approach, was used to determine the preferred option. We then estimated a site specific cost for the preferred option. The approach and key assumptions used to compile the site specific estimate for the preferred option were: • the project scope and likely location of the new assets are determined from a desktop review of aerial photographs, site layout drawings, underground services drawings, and available cable ducts; • the scope assessments are used to estimate materials and work quantities; • the component costs for material and work quantities are taken from TEES (cost estimation software); • material and plant costs are determined with reference to period supply contracts currently in place and historic installation costs respectively; • civil and earthworks costs are extrapolated from historic costs; and • installation costs are informed by similar historic projects and or current quotes from service providers and applied based on the requirements of the site. Further information regarding our approach to cost estimation is provided in the AM03 - Planning Lifecycle Strategy. The costs include customer costs where applicable, but these costs will not be included in our base capex.

Capital Cost comparison

	Description	Refer to Transmission Development Plan table for investment timing
1	Otahuhu - Wiri 110 kV cable	SPS = $1.5m 110 kV Cable = $25.9m (transformer costs funded through customer contract) Replacement of Wiri T1 = $4.2m 110 kV bus at Wiri = $2.7m
2	Otahuhu - Wiri 33 kV cable	SPS = $1.5m 33kV Cable = $24.7m (transformer costs funded through customer contract) Replacement of Wiri T1 = $4.2m 110 kV bus at Wiri = $2.7m
3	Reconductor Otahuhu - Wiri	SPS = $1.5m Reconductoring = $11.9m Upgraded Wiri supply transformers = $5m (funded through customer contract) Upgrade conductor: Wiri transformers to Wiri tee = $3.2m
4a	Interconnection at Bombay	SPS = $1.5m Bombay interconnection = $13.1m Upgraded Wiri supply transformers = $5m (funded through customer contract)

		Upgrade conductor: Wiri transformers to Wiri tee = $3.2m
4b	Interconnection at Bombay, no SPS	Bombay interconnection = $13.1m Upgraded Wiri supply transformers = $5m (funded through customer contract) Upgrade conductor: Wiri transformers to Wiri tee = $3.2m
5	New GXP to offload Wiri	SPS = $1.5m New GXP = $35m Replacement of Wiri T1 = $4.2m Bombay interconnection = $13.1m
6	New GXP to offload Bombay	SPS = $1.5m New GXP = $35m Bombay interconnection = $13.1m Upgrade conductor: Wiri transformers to Wiri tee = $3.2m Replacement of Wiri T1 = $4.2m
7	Circuit Bonding	SPS = $1.5m Bonding = $5m Bombay interconnection = $13.1m Upgraded Wiri supply transformers = $5m (funded through customer contract) Upgrade conductor: Wiri transformers to Wiri tee = $3.2m
8a	Dismantle Otahuhu - Wiri	SPS = $1.5m Dismantling = $2m Cabling = $24m Bombay interconnection = $13.1m Upgraded Wiri supply transformers = $5m (funded through customer contract) Upgrade conductor: Wiri transformers to Wiri tee = $3.2m
8b	Dismantle Bombay - Wiri	SPS = $1.5m Dismantling = $2m Reconductoring = $11.9m Bombay interconnection = $13.1m Upgraded Wiri supply transformers = $5m (funded through customer contract) Upgrade conductor: Wiri transformers to Wiri tee = $3.2m
8c	Dismantle all Bombay - Hamilton	SPS = $1.5m Dismantling = $2m Bombay interconnection = $13.1m 2nd Bombay interconnection = $12m Upgraded Wiri supply transformers = $5m (funded through customer contract)

		Upgrade conductor: Wiri transformers to Wiri tee = $3.2m
8d	Dismantle Bombay--Hamilton 1 and 2 only	SPS = $1.5m Dismantling = $2m Bombay interconnection = $13.1m Upgraded Wiri supply transformers = $5m (funded through customer contract) Upgrade conductor: Wiri transformers to Wiri tee = $3.2m 110 kV bus at Wiri = $2.7m 2nd Bombay interconnection = $12m

Benefits and outputs

Expected benefits	All eight development plans are long term solutions which enable us to meet Wiri and Bombay GXP demand growth and GRS requirements until 2028. The supporting report[5] presents the benefits for each of the eight options above. All eight options avoid unserved energy which is estimated to fall between $13.7million and $38 million. In addition, all these plans will remove the need for load management during planned maintenance outages for the forecast period. Some plans reduce the need for further investment either later in the forecast period or beyond. The main differences in the benefits for the development plans are: • varying potential for reducing network losses; and • varying network flexibility for future planned outages and for future development of the network. The table below provides a comparison of the benefits for the most economic options.

Comparative benefits

Development plan	Comparative benefits for options 3 and 4
3: 110 k V reconductoring	✓ Reduced losses. Initial investigations suggest loss savings may be as much as $0.2m a year.
4a and 4b: Bombay 220 / 110 kV interconnection	✓ Greater network flexibility leaves option for permanently splitting the 110kV network. ✓ Reduced losses. Initial investigations suggest loss savings may be as much as $0.9m a year.

[5] Section 6, *Options Analysis – Otahuhu-Wiri Transmission Constraint*

Option risk assessment

Introduction	There are risks common to all development plans: • variations in forecast demand may change the need date. There is a risk of an investment being made too early, if demand is lower than forecast; or not being able to meet demand if higher than forecast; • all costs given are P50 costs, so carry a risk of cost variations; and • the cost of SPS implementation could be higher than forecast if a communication infrastructure is needed, and SPSs can be operationally complicated and difficult to manage. The supporting report[6] expands on the risks for each of the eight development plans. The table below provides a comparison of the risks for the two most economic options, reconductoring the Otahuhu-Wiri 110 kV circuits and installing an interconnector at Bombay.

Comparative risks

Development plan	Practicality and consenting risks	Safety risks
3: 110 k V reconductoring	✗Reconductoring in urban areas carries practical problems in consenting, locating and protecting work sites, and public relations issues. ✗ Transport disruption.	✗ Reconductoring in urban areas carries greater safety risks.
4a and 4b: Bombay 220 / 110 kV interconnection	✓With no line work, will have fewer consenting and practical risks.	

[6] Section 6, *Options Analysis – Otahuhu-Wiri Transmission Constraint*

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Preferred option(s)	
What is the currently preferred option / sequence of options / or short-listed options?	Our preferred option is development plan 4b: Bombay 220 / 110 kV interconnection in the early part of RPC2.
Set out the reasons for choosing the preferred **option(s)**.	The three lowest cost options which resolve the constraint problems are Development Plan 3 and Development Plan 4a and 4b. Development Plan 4b is the preferred option because it offers greater loss benefits and a more flexible development plan with the possibility of permanently splitting the 110kV network in the future. Development Plans 4a and 4b also carry significantly lower practical and safety risks. Including Interest During Construction (IDC) this leads to a capex of $18.0m. This project has a good likelihood of exceeding the $20 million threshold for base capex E&D, especially if we determine it Is worth installing an SPS, either because the loss benefits are shown to be lower, or the project faces delays. If this turns out to be the case, we will submit the project as an MCP and reduce the amount of the E&D less than $20 million portfolio. There is also a good likelihood that the costs will be less than the $20 million threshold. The costs and timing of expenditure in this POD reflect the situation that the project cost is less than the threshold.
List key **assumptions** used in determining the preferred option(s).	• Loss reductions for Development Plan 4b are expected to provide significant benefits. • Reconductoring costs are likely to be higher due to consenting and practical issues (e.g. can the existing structures support higher capacity conductor, this won't be known until detailed investigations are carried out).
List any **interdependencies** which the preferred option is reliant upon for a successful outcome.	Ability to obtain sufficient outages – both in number and duration – to undertake the work.

Steps to completion	
What are the next step(s) in choosing the solution	This project is currently at the BC1+ stage (as per section 3.6.1 of the AM03 - Planning Lifecycle Strategy). In accordance with our business case process the next steps are: • complete the detailed BC2 investigation to formally select the preferred option; and • obtain internal approval to proceed with the project (BC3). As part of our normal development processes we will set up a customer working group with Vector and Counties Power to confirm the inputs and secure detailed feedback on the options as part of our normal process. We have already discussed this with the customers.

When did / will the steps in the internal approval process occur / take place and where were / will they be documented and described	The timeline will depend on the outcome for the BC2 investigation but we expect to: • complete BC2 investigation to confirm the preferred solution in Q3 2014; and • complete consultation with affected stakeholders in Q1 2015.
Identify the key services and assets that will need to be procured to complete the preferred option	Key services and assets that will need to be procured include all equipment required to install: • a new 220/110 kV 150 MVA interconnecting transformer and all associated installation works and equipment at Bombay; • conductor and associated equipment for Wiri; and • upgraded supply transformers for Wiri (this is a customer cost) We expect to outsource the detailed design services.
Identify the key delivery risks	• Projects that are inadequately scoped can lead to cost and time overruns. During the planning process, we will ensure project scope is defined and it can be implemented within the required timeframe and cost. • We will ensure the project is designed to its specification, the appropriate design reviews are completed and detailed factory inspections are carried out to manage risks. • In the process of procurement, it is essential that we select a supplier that is able to consistently meet quality requirements. Quality must not be compromised in favour of other factors because of the critical influence of quality on risk to safety and the network. • If applicable, we will standardise specifications and procurement of primary equipment to limit diversity and increase inter-changeability. This also allows procurement efficiencies to be attained. • Safety is paramount, the design of all equipment installed must be safe to operate and maintain without compromising performance. Vendors are selected with great care to ensure safe installation and commissioning work and full compliance with all our safety requirements and expectations. • All works required on site will be carried out in full compliance with all of our safety requirements and expectations.

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Supporting Documents and Models	
List of all relevant documents (including relevant policies and consultant reports) taken into account in estimating project costs and describing anticipated deliverability.	AM09 - Annual Planning Report 2014 refer: Chapter 4, Demand Forecasting Methodology; Chapter 5, Generation assumptions Chapter 8, Auckland region AM03 - Planning Lifecycle Strategy Options Analysis – Otahuhu-Wiri Transmission Constraint (supporting report)
Provide a schedule of any models used (including descriptions of model operation and scope).	DigSilent version 14.1.3