BUNNYTHORPE–HAYWARDS CONDUCTOR RELACEMENT

Major Capex Proposal

Attachment C

OPTIONS AND COSTING REPORT

Keeping the energy flowing




TRANSPOWER

Transpower New Zealand Limited The National Grid

1| Introduction

This document is an Options and Costing report for the Bunnythorpe-Haywards A and B lines conductor replacement investment proposal.

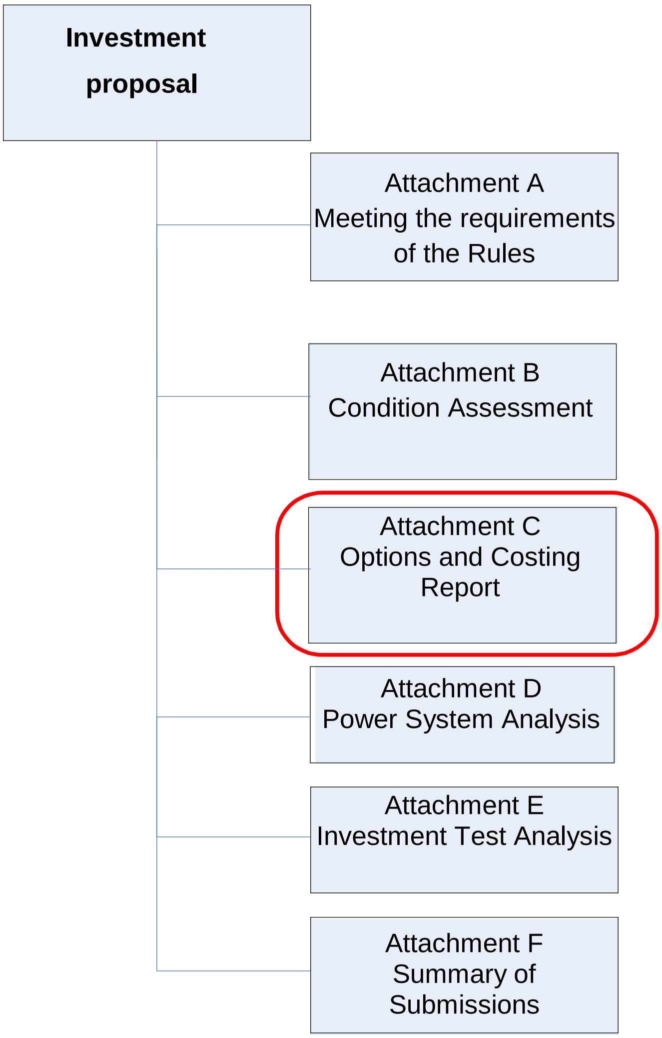
1.1 Purpose

The purpose of this report is to:

- explain the long list to short list process
- identify the short List options that address the identified need
- provide summarised costs for all short list options

1.2 Document Structure

This report forms part of the Bunnythorpe-Haywards A and B lines conductor replacement investment proposal, as set out in the diagram below:



2| Moving from a long list of options to a short list

The long list of options that are alternatives to the project fall into seven broad categories:

- Generation solutions to reduce or eliminate the need for a transmission investment i.e. installing new generation such as diesel peaking plant, or new wind farms coming online.
- Demand-side alternatives to decrease or eliminate the need for a transmission investment through the use of such things as smart metering, demand response schemes etc.
- Replacing the conductor on the lines and keep the same capacity. In this case the “like for like” option will be a simplex Goat conductor (ACSR/AC) at 80°C.
- Replacing the conductor on the lines and increasing the capacity. This could either be a larger conductor, a like for like conductor that is duplexed or a different conductor in a duplex configuration. In assessing this option we also looked at various conductor types that could be used.
- Building a new line. This could be a new additional line between Bunnythorpe and Haywards or rebuilding the two single circuit tower lines as a single circuit or double circuit tower line for a part or the full length of the line.
- Using underground cable instead of over-head lines. For either the entire line length or partially in selected line sections.
- Integrating operation of the lines with HVDC controls or the HVDC runback option. Fast response from the HVDC controls may allow the 220 kV Bunnythorpe–Haywards lines to be operated above the usual N-1 security standard for the core grid.

Each of these long-list options has been assessed by considering their applicability to resolving the need, the likelihood they will be cost competitive with other equivalent options and the timeliness of the possible implementation. Table 2-1 summarises our assessment of the long list options:

Table 2-1 - Assessment of Long List Options

Long List		Short Listed	Comments
Non Transmission Options	Local Generation	X	The need (based on condition assessment and risk of conductor failure) is for a replacement conductor. As such, this option is not viable.
	Demand-side alternatives	X	Local demand has limited impact on the need for capacity on the BPE-HAY lines. It does not impact on the need for replacing the conductor. As such, this option is not viable.
Transmission Options	Replacing the conductor with the same (or modern equivalent) capacity	✓	This has been included in the short list.
	Replace the conductor with one of a higher capacity	✓	This has been included in the short list. The types of conductors that have been short listed are discussed below.
	Build a new line / duplexing existing	X	This option has been discarded based on the cost being higher than other options. In addition it cannot be delivered in the time required
	Partially or wholly undergrounding line sections	X	This option has been discarded based on the cost being higher than other options. In addition it cannot be delivered within the time required
	Integrated Operation with HVDC controls	X	This option has not been included in the short list as the need is to replace the conductor.

A further assessment was then carried out on a range of options for replacing the conductor. Our analysis has shown that the costs of the larger conductor options would be twice as much as the short-listed options since the larger conductor options would effectively require the line to be rebuilt as a new line. They have not been included in the short list. The conductor types considered that fall into this category were Pheasant, Moa and Chukar (AAAC).

We considered duplexing the lines (replacing a single conductor with a double conductor). Once again this would result in significant tower reconstruction, as the resultant loads are higher than the Pheasant, and Chukar conductors, putting the cost well above the alternatives in the short list.

We also considered dismantling one line and upgrading the other remaining line as part of the short-listing process which were not considered further. Modelling of the towers has shown a need to upgrade a large number of towers based on the existing simplex arrangement. If we were to string duplex conductor on one of the lines, we would anticipate that many more towers would require replacements or further strengthening, an expensive increase in property, easement and consenting costs as well as longer outage durations.

New technology conductors were included in our high level assessment of conductor options. These were not included in our long list because of a combination of high losses and an unproven record in a high corrosive marine environment. These conductors have similar characteristics to the existing ACSR cionductor type and would require a similar number of tower height increases as the other short-list options. However these conductors have a higher procurement and installation cost than the short-listed conductors, therefore the use of these conductors was not considered further.

As noted is section 0 below, we consider these alternative conductors as potential options when reconductoring other transmission lines in the future. We propose to install and trial small sections on the Bunnythorpe–Haywards A and B lines to enable long term performance to be monitored.

Given the need is driven by condition of the existing conductors a non-transmission solution did not meet the need so was not short listed.

We are required to calculate the expected market benefits resulting from the investment meeting the Grid Reliability Standards (GRS). This requires us to essentially calculate the costs of a "do nothing" option. In this case, it is reasonable to assume that the dismantling of the lines is an appropriate "do nothing" option in this proposal.

The long list was reduced to the following short-listed options:

Table 2-2: Short List of Options

Long List category	**Short List Option**	**Conductor Rating (Summer/Winter)**
-	Dismantle A & B lines	-
Replace the conductor keeping the same (or modern equivalent) capacity	Simplex Goat ACSR/AC at 80°C	319/348 MVA
Replace the conductor keeping the same (or modern equivalent) capacity	Simplex Zebra ACSR/AC at 65°C	316/357 MVA
Replace the conductor and increase the capacity	Simplex Zebra ACSR/AC at 75°C	354/390 MVA
Replace the conductor and increase the capacity	Simplex Zebra ACSR/AC at 85°C	387/419 MVA

3| Short List Option Costs

The cost of each short-listed option includes:

- the work required at each substation
- the rectifications and strengthening required at each tower
- an assessment of how stringing the new conductor will be carried out taking into account aspects such as terrain, length of line, impact of circuit outages, resources etc
- equipment and materials required to complete the works
- the extent of any ancillary work, including access tracks to tower sites, foundation work for heavy lifting equipment, bridge strengthening (if transport is required) and additional work required for road, rail and other utility crossings
- an assessment of the uncertainty involved in each of these aspects, for example ground conditions and the strength of existing towers (dependant on the steel type and condition of the foundations)
- risks of delay due to weather conditions.

Assumptions about each of these components have been made in order to compare options and the assessment of uncertainty is used to establish a proposed Major Capex Allowance (MCA)

3.1 Improvements in Cost Estimates

Since we submitted a Grid Upgrade Plan to the Commerce Commission (Commission) in December 2011, we have completed more detailed work on the conductor replacement options. This includes site visits along the length of the line which have allowed comprehensive scoping of access, site preparation and construction works required for each option.

Further design work has also included geotechnical assessments at a number of sites, again providing better clarity around the scope of works. In addition, our site visits and consultation with regional authorities have also provided better clarity around the level of protection required for road and rail crossings. Lessons learnt from NIGUP and the Wairakei Ring project with respect to the cost of these crossings and stringing of conductor have been incorporated into the revised costs.

While there is increased certainty around our costs, there has been a significant increase in the approval amount that we are seeking - an increase of $31m to $161m. This is directly attributable to site-specific field visits and creating a better understanding of actual scope requirements. A significant amount of expensive work needs to be undertaken for reconductoring to take place.

In this section we describe our approach to costing each of the options, covering:

- the materials, equipment and physical work involved
- an expected cost for each option.

The various risks associated with each of these elements are described through each section.

3.2 Material, equipment and physical works

This section discusses key components of the conductor replacement costs:

1. Towers - structural work required on the towers and tower foundations
2. Stringing - running the new conductor on the towers
3. Substations - enabling works at the Haywards and Bunnythorpe substations to connect the new conductor.
4. Property and environmental costs
5. Community Care Fund
6. Conductor trial

3.2.1 Towers

Our proposal to use Zebra[1] ACSR conductor will result in an estimated 114 of 640 towers requiring increases in height to bring the clearances up to required statutory levels (NZECP 34). These height increases would also be required if we were to restring with the existing Goat conductor type.

Table 3-1 shows a summary of the work required on the towers for the four short-listed options. It shows the estimated number of height increases required for each option. Work required to replace the conductor itself is common across all the options, with virtually no differences between the options.

Table 3-1 – Number of towers requiring height increases*

Option	1.5m	3m	4.0m (+)	Total
Goat 80°C	82	32	0	**114**
Zebra 65°C	50	7	0	**57**
Zebra 75°C	82	32	0	**114**
Zebra 85°C	65	64	1	**130**

*The exact number and type of rectification is dependent on final design and so is subject to change.

The full extent of tower strengthening is subject to detailed design; however, from the design work conducted to date, it is estimated that 512 towers out of the 640 will need strengthening to ensure they meet modern design standards regardless of the option chosen. In addition approximately 171 tower foundations will require strengthening based on additional loadings, and a further 22 sites, some of which have old timber driven piles, will also need upgrading/ replacing due to both the inadequate strength and condition of the foundations.

Our detailed engineering assessment has found the need for an increase in volume, cost and scope for foundation strengthening compared with the original 2011 GUP costs. This reflects greater concrete volumes based on assessed soil conditions and the need to shore many sites. The number of towers requiring an increase in height has also increased due to tension limits set to ensure vibration is not prevalent, and statutclearance requirements are met.

[1] Zebra and Goat are names for two sizes of Aluminium Conductor Steel Reinforced (ACSR) transmission line conductor.

3.2.2 Stringing the new conductor

While the cost of the conductor itself differs between Goat and Zebra, the work involved to string the new conductor is common between the options; it makes very little difference which conductor is used.

There are numerous road, rail and other utility crossings along the line route.Replacing the conductor over these crossings will require careful management to ensure public safety. Typically these crossings will involve construction of safety-nets and supporting structures with dismantling following the stringing of the new conductor. As such they are a relatively costly component of the project. There are two major crossings of the Bunnythorpe–Haywards lines involving State Highway One and the North Island Main Trunk Railway, plus other main roads. Historically these crossings have cost in the order of $0.8m to $1m each. For this project we have estimated a total cost of $14.2m for all the crossings. Public protection for the section through Waikanae township will necessitate use of hurdles, nets and covered walkways. We are investigating the use of catenary support systems which may reduce these costs.

The uncertainty associated with the stringing work is relatively low as the length of the line and route is well known. The primary area of uncertainty is the condition of access tracks and the ability to move equipment into the areas required. This is particularly relevant for the hill section of the line between Haywards and Paraparaumu. This access is steep in nature and prohibits heavy vehicle use such as cranes.

Recent lessons learnt from our NIGUP project and the Wairakei–Whakamaru-C work have been incorporated into this costing. Higher levels of technical management are required to ensure the new conductor is installed within the limited available design envelope.

3.2.3 Substations

Substation work required due to changing the conductor is relatively minor.

Specifically, some minor substation equipment which has the potential to limit the capacity of all the conductor options (including the modern equivalent option), will need to be replaced. The estimated cost to replace this equipment is $360,000 in total. It is common between options so does not influence option selection.

3.2.4 Property and environmental costs

Most of the work falls within allowable activities under the National Environmental Standards for Electricity Transmission (NES)[2] and Electricity Act. We have made an initial estimate of consents and easements required for a new conductor. This estimate will be further refined through the detailed design phase and on discussion with affected landowners.

Environmental costs cover council consenting fees, stakeholder consultation for Resource Management Act purposes, internal Transpower management of consenting processes and the development of consenting documentation by planning consultants and any consent hearinngs if required.

[2] The NES sets out a national framework of permissions and consent requirements for activities on existing electricity transmission lines. Activities include the operation, maintenance and upgrading of existing lines.

3.2.5 Community Care Fund

Included in the property and environment costs is funding for our CommunityCare Fund (CCF). In 2006, we established the CCF, which recognises our need to offset the impact on communities of grid investment projects and continue to contribute to communities where we operate and who host our assets that benefit the entire country.

The CCF has been developed along similar models used by other power companies in New Zealand and overseas and aims to ensure that the benefit the community receives reflects the impact of our work in that community.

Our community funding approach is aligned with project approval. In the case of line work, it is based on a funding formula derived from an impact analysis and the number of kilometres of line in an impact area, multiplied by the cost of the line per kilometre.

The impact scale is determined based on the type of work undertaken and the consequent impact on the community. For line works like replacing conductor, the impact is considered to be ‘medium’ and the impact value is capped at 0.5%. For the Bunnythorpe–Haywards conductor replacement project $676,000 has been added. This is a cap, and the costs will be recovered as they are incurred. Once the Investment Proposal is approved by the Commerce Commission, community organisations in the affected area may apply to the CCF for nominated projects that meet specific funding criteria.

The CCF is managed in accordance with the guidelines established by the Office of the Auditor General.

3.2.6 Conductor trial

We are recommending ACSR conductor for this proposal, but there are several new conductor technologies which could have a longer life in the corrosive and windy environment to which the Bunnythorpe–Haywards lines are exposed. Our proposal includes $3 million for testing the performance of new conductor types and technologies such as ACCR, ACCC and ACSS. We are proposing to put up a short section using different conductors on a rural section of one of the lines. This will not impact on the overall performance of the two lines but will provide valuable performance and cost information for future projects. The evaluation will include high temperature conductors that also have potential application elsewhere on the grid. Our submission to the Commerce Commission for Regulatory Control Period 2, due later this year, will fully describe our future plans for innovation, including the investigation of new conductor types, however we are seeking approval for these works now to ensure the work can be specifically integrated into this project.

Prior to constructing the test sites, we will reach agreement with the land owners involved for the trial.

4| Short-list Options' Expected Cost

The total cost estimate for each option is set out in Table 4-1. This is the result of combining the estimated quantities, unit rates, labour estimates, and property and environmental costs involved in the project. The cost estimates include a scope allowance but do not include inflation, financing costs, or any allowances for uncertainties. These cost estimates are the expected cost in current year dollars.

Table 4-1 – Expected cost breakdown of each option, $ million

Cost Category	Goat 80°C	Zebra 65°C	Zebra 75°C	Zebra 85°C	Dismantle Lines
Conductor and other hardware	9.2	10.8	10.8	11.0	-
Steel for towers	1.3	0.9	1.3	1.6	-
Labour costs for tower work	24.2	17.3	24.2	29.8	-
Foundation Strengthening	13.0	11.9	13.1	14.2	-
Cost of Road and Rail Crossings	14.5	14.5	14.5	14.5	-
Labour for replacing the conductor	28.5	28.5	28.5	28.5	-
Construction Overheads	20.7	19.7	20.7	21.4	-
Substation works	0.4	0.4	0.4	0.4	-
Design and project management	12.7	12.6	12.8	12.9	-
Environmental and property	3.0	4.6	5.4	6.5	-
Conductor Trial	3.0	3.0	3.0	3.0	-
Dismantle Lines	0.0	0.0	0.0	0.0	30.0
Total	**130.5**	**124.1**	**134.6**	**143.9**	**30.0**

Some elements of the cost are well known and unlikely to change, such as the price of conductor and hardware that attach to the towers. Other cost elements carry more uncertainty, the primary component being contractor labour costs as they are subject to resource availability (with work for labour both in New Zealand and internationally). For the purpose of the expected cost we have assumed a medium to low implementation cost as a majority of the line is over flat or rolling country side and it is simplex conductor (rather than duplex).

Many of the costs are common. Examples of costs which are common to all options include:

- total cost of conductor installation - $28.5m
- cost of crossings – $14.5m
- substation works – $0.4m for the installation of replacement equipment
- costs associated with works supervision, access tracks and other works required to establish work sites.

We are investing in a tower jack as an innovation to avoid constructing costly accessways for cranes to reach the towers. Our proposal reflects these cost savings. If successful this tower jack will be used for other reconductoring projects.

For many of the other costs, differences between the options are insignificant. Incremental differences occur due to the number of towers needing work. This also impacts on the project management costs. The cost estimates associated with property and environment costs are dependent on the specific circumstances surrounding each tower site and span.

4.1 Additional works

While we are undertaking the re-conductoring the increased loadings on towers means certain additional works are brought forward by default. It is cost effective for all consumers that this additional work is done at the time of the project. This makes particular sense when we are working on the towers located in difficult terrain and our equipment is there on site. In addition, some work is most effectively done at the same time as conductor stringing. All of these works are included regardless of the conductor chosen. Doing this work now will reduce costs in the future. There is $12m in works being undertaken now as part of the reconductoring project that will not need to be done later. These works include grillage work, latchway antifall devices, partial line reinsulation and EPR mitigation.

4.2 Cost of dismantling the lines

We have calculated a $30 million cost estimate for dismantling both of the Bunnythorpe–Haywards A and B transmission lines. We will use this cost for the ‘do nothing’ option and to calculate the expected market benefits of all options.

5| Major Capex Allowance

Transpower is seeking approval from the Commission to recover the lesser of the actual costs or the estimated Major Capex Allowance (MCA) of the proposal.

Transpower estimates the expected cost of the proposal to be $134.6 million in current (2013) dollars. With the addition of inflation and financing costs the total cost becomes $151.0 million in 2020 when the conductor replacement is completed.

The MCA we are seeking approval for is $161.0 million. This effectively establishes the maximum "book value" for the regulatory asset base.

The relationship between the expected cost of the project and our Major Capex Allowance is shown in Table 5.1.

Table 5-1: Derivation of Major Capex Allowance

Expected Cost (2013 $m)	Inflation	Financing costs	Expected Cost (2020 $m)	Major Capex Allowance (2020 $m)
134.6	12.0	4.4	151.0	161.0

6| Maintenance cost differences

Ongoing maintenance costs for the Bunnythorpe–Haywards A and B lines differ slightly between the short-list options because the number of towers raised and foundations strengthened between options differ.

A comprehensive programme of tower refurbishment work has been developed for both lines over the next 10 years – this will occur irrespective of conductor replacement.

512 towers out of the 640 will need strengthening regardless of the option chosen and this is not part of this investment proposal. The tower refurbishment work includes selective upgrading of foundations, replacement of steel components and bolts on each tower as well as painting of some towers to ensure the tower steel remains adequately protected. There are already 150 towers out of the 640 that have been painted as the original galvanising no longer adequately protects the tower steel from corrosion.

For example, needing to upgrade tower grillage components now as part of the project removes the need to upgrade them in the future. So more tower components upgraded as part of the project result in less tower components requiring work as part of our future maintenance work.

A detailed desktop assessment has been made of maintenance costs for the Bunnythorpe–Haywards A and B lines, for each short-list option until 2033, which is as far as reasonable cost information was available. We have then estimated a further $4m per annum for maintenance of both lines for the 2034-2050 years. These are summarised in Table 6-1 below.

Table 6-1 – Maintenance cost breakdown of each option, $ million

Maintenance cost differences

$ million

	PV diff	PV	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034- 2050
Goat 80		50.9	4.5	3.4	4.9	4.0	4.7	3.7	3.5	2.2	1.6	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Zebra 65	**0.2**	51.1	4.5	3.4	4.9	4.0	4.8	3.7	3.6	2.3	1.6	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Zebra 75	**0.0**	50.9	4.5	3.4	4.9	4.0	4.7	3.7	3.5	2.2	1.6	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Zebra 85	**-0.2**	50.6	4.5	3.4	4.9	4.0	4.7	3.7	3.5	2.2	1.5	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0