

BEFORE THE BOARD OF INQUIRY

IN THE MATTER of the Resource Management Act
1991

AND

IN THE MATTER of applications for resource consent
and notices of requirement by
Transpower New Zealand Limited for
the North Island Grid Upgrade Project

**STATEMENT OF EVIDENCE OF JOHN NICHOLAS OLIVER COAD ON BEHALF
OF TRANSPOWER NEW ZEALAND LIMITED
(Project description/overview)**

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INTRODUCTION

Qualifications and role

1. **MY** name is John Nicholas Oliver Coad. I am employed as the Acting Grid Programme Manager working in the National Grid Division of Transpower New Zealand (**Transpower**). I have been in this role since April 2006. Immediately prior to that I was the Transpower Asset Development Group Manager for two years, responsible for the engineering and design input to build new transmission line and substation projects, including this project.
2. I hold the following qualifications:
 - (a) Bachelor of Engineering (Mechanical) from Auckland University;
 - (b) Master of Engineering from Auckland University; and
 - (c) I am a Member of the Institution of Professional Engineers New Zealand (IPENZ).
3. **MY** present role at Transpower is to ensure that all the engineering, environmental, property, financial, legal, contractual, resourcing and other decisions associated with the Upgrade Project are identified, coordinated, managed appropriately within Transpower's organisation, communicated and completed to budget and timetable. To do this I manage nine project management staff directly, and through the Transpower organisation, have up to a further fifteen people working substantially on this project.
4. **THERE** are three project managers working for me who are directly responsible for key components of the Upgrade Project:-
 - (a) Mr Richard Joyce, the underground cables project manager;
 - (b) Mr Robert Bell, the substations project manager; and
 - (c) Mr Peter Rasul, the transmission line project manager.

All three project managers will be presenting evidence.

5. I confirm that I have read the Code of Conduct for Expert Witnesses in the Environment Court Consolidated Practice Note (2006). I have approached the preparation of this evidence in the same way that I would for the Environment Court.
6. **ACCORDINGLY**, except where I state that I am relying on the specified evidence of another witness, my evidence in this statement is within my area of expertise.

Scope of evidence

7. **IN** this brief of evidence, I provide a broad outline of the Upgrade Project in order to provide a framework and context for other more detailed evidence. I discuss:
 - (a) the background to and aims of the Upgrade Project;
 - (b) the overall Upgrade Project, and in more detail the matters before the Board of Inquiry for which we are seeking designations and consents (**Upgrade Project**);
 - (c) the components of the Upgrade Project that are included in each designation;
 - (d) the staging of the Upgrade Project across time;
 - (e) the risks associated with the Upgrade Project and how these are managed, and the overall timetable.

Terminology

8. A number of technical terms will be used in my evidence, and the evidence of other witnesses. I note that a glossary of terms has been prepared and is contained in the **Common Bundle of Exhibits, tab 1**.

OVERVIEW OF THE UPGRADE PROJECT

9. **THE** common objective of the Upgrade Project is to ensure the continued security and certainty of electricity supply to Auckland, Northland, and parts of the Coromandel and Waikato. This security and certainty will be achieved by

constructing and operating a new transmission link (including substations and ancillary facilities), and upgrading existing assets. The Upgrade Project will be constructed over time to meet the forecast increased electricity needs. The project objectives of the NoRs will be addressed in further detail in the evidence of Ms Allan, Ms Hunter and Ms McGovern.

10. **THE** Upgrade Project is designed to ensure the continued security and certainty of supply to the upper North Island in the short, medium and long term (ie. up to 30 years). The project will not achieve this aim on its own. It has therefore been designed in a staged manner which involves investment in a timely manner, and taking into account the timing of other National Grid improvements which have similar objectives (ie works on other lines and connections particularly into the major Otahuhu system hub).

Brief history of the Upgrade Project

11. **IN** 2002 as part of routine system planning work, Transpower identified and began investigating the need for major transmission reinforcement to the upper North Island. It first publicised this need in 2003 in a routine planning document entitled "*Future of the National Grid*" and subsequently in more detail in two documents entitled "*Security of Supply into Auckland, Assessment of Alternative Solutions*" and "*Supply into Auckland, Assessment Methodology for Alternative Solutions*". In September 2004, to assess if there were alternatives to transmission solutions, a "Request for Information" entitled "*Alternatives to transmission investment for meeting future electricity supply requirements for Auckland and North Isthmus*" was issued by Transpower and the responses considered and included in the analysis.
12. **THIS** work collectively determined that the critical issue driving the need for new investment is the potential for voltage instability to occur at times of high system load with the consequences being a partial or total losses of supply to the Auckland and North Isthmus regions. Under the current security standards, demand in excess of 2190 MW will not be able to be supplied by the existing transmission system even with all local existing and committed generation in the region operating reliably. This analysis is discussed in the evidence of Mr Boyle.

13. **ON** 30 September 2005, Transpower submitted an Initial Grid Upgrade Plan to the Electricity Commission, under the Electricity Governance Rules 2003 (**Rules**) for a 400kV transmission line to Auckland (**Original Proposal**).¹ The Original Proposal was reviewed by the Electricity Commission, resulting in a draft decision to decline the proposal in April 2006. The Commission began consultation on that draft decision and in May 2006 Transpower requested the Electricity Commission to suspend consideration of the Original Proposal, as Transpower intended to amend the proposal. The Commission agreed to this suspension.
14. **TRANSPOWER** submitted the Amended Proposal to the Electricity Commission in October 2006. The Electricity Commission issued a Notice of Intention to Approve in January 2007, and a final majority decision to approve in July 2007.
15. **THE** evidence of Mr George will provide further evidence about the Rules framework, the need for the Upgrade Project, the alternatives considered and the process of analysis by Transpower and The Electricity Commission. The principal changes between the Original Proposal and the Amended Proposal will be also be outlined in Mr Boyle's evidence.
16. **AT** a high level, the analysis showed that:
 - (a) there is a need for increased supply to the upper North Island, whether this was met by transmission, generation or demand side management;
 - (b) alternatives to transmission did not economically provide capacity at sufficient reliability or were not committed to the extent they could be relied on to provide for this capacity increase;
 - (c) as a result, the preferred solution was to reinforce the existing transmission system by constructing new transmission capacity or upgrading existing transmission capacity into the Upper North Island;

¹ Rules found at **Common Bundle of Exhibits, tab 2.**

- (d) of the available transmission options, a 400kV capable transmission link best met the need through the economic and appropriately reliable provision of transmission capacity that also minimised transmission corridors over a long period;
- (e) staging the preferred 400kV option by the implementation of some short term projects, that deferred the need date till 2013, met the need and was economically beneficial;
- (f) operating the 400kV capable line from 2013 at 220kV until the capacity of the line at 220kV was no longer sufficient, provided flexibility to meet changing demands and was economically beneficial through deferral of the 400kV equipment capital cost; and
- (g) that installation of 400kV equipment and operating at 400kV from an estimated date of 2033 best met the long term need.

The context of the Upgrade Project in relation to other projects in Auckland

17. **THE** National Grid is an electrically connected set of assets that are designed and constructed to transport bulk electricity at high reliability. The National Grid consists of over 12,000 route kilometres of transmission lines, about 25,000 towers, 16,000 poles, and 173 substations. This infrastructure is supported by information technology and telecommunications equipment.

18. **THE** Upper North Island is supplied through the existing 220 kV and 110 kV networks, with the primary supply from the 220kV system via two separate power system paths linking Huntly to Otahuhu Substation and Whakamaru to Otahuhu Substation. The path from Huntly consists of three 220 kV circuits and the path from Whakamaru, generally to the East of the Huntly circuits, consists of a further three 220 kV circuits. The 220kV supply is supported by two 110kV circuits from Bombay and a 110 kV circuit from Arapuni. However, the contribution of these circuits to the transmission supply capacity is minor (i.e. less than 10% of the total power flow) compared to the 220 kV circuits. The 110 kV circuit from Arapuni (the ARI PAK A line) will be removed as part of the construction of the Grid Upgrade Project. More details are provided in the evidence of Mr Boyle and schematics of the transmission system supplying the Upper North Island, both before and after the commissioning of the new line, are included in the plan book.

19. **ENHANCEMENT** of the National Grid to maintain reliable bulk supply of electricity is a continuous activity, and at present there are a number of interrelated projects underway or planned that:

- (a) provide additional capacity to Auckland;
- (b) provide additional capacity across Auckland and to Northland; and
- (c) enhance diversity and security of supply within Auckland.

For clarity, it is worth briefly describing the other projects to provide some context, and in order to be clear about what works are within the scope of the Upgrade Project before the Board of Inquiry.

20. **THE** Upgrade Project, for which designations and associated resource consents are sought, is the major part of the set of works designed to provide additional capacity to the upper North Island. There are closely associated works that are part of the solution to achieve this, but are not before the Board. Collectively the Upgrade Project and these associated projects are known as the **North Island Grid Upgrade Project**, for which approval was sought and obtained from the Electricity Commission.

21. **GENERALLY** these associated works, which are not covered by the proposed designations and therefore not before the Board, are intended to provide sufficient transmission capacity within the existing grid, which will provide a window to complete the more substantive works included in the Upgrade Project. These associated works are:

- (a) the upgrade of the Otahuhu to Whakamaru C line;
- (b) the construction of additional reactive support in Auckland through the installation of up to 350MVar of capacitors at Otahuhu Substation; and
- (c) the construction of a new Switching Station at Drury.

22. **ALL** these works need to be completed by 2010 and, when in place, will provide sufficient interim capacity to allow the completion date of the first stages of the Upgrade Project to be 2013.

23. **IN** addition to the above works that provide the construction window till 2013, there is some limited substation work required on the terminations of the existing 220kV transmission line connecting Otahuhu and Pakuranga. This line is constructed to operate at 220kV and has been consented for operation at 220kV. As the Pakuranga site has to date only required 110kV supply, this line has been operated at 110 kV and some reconnection at either end is required to enable operation at 220kV.
24. **THE** combination of the Upgrade Project and the above associated works connects the existing substations at Pakuranga, Otahuhu and Whakamaru, and enables the bulk transmission of alternating current high voltage electricity. This also provides for the transformation of electricity from other voltages to initially 220kV, and then when demand requires it to 400kV at two new substations at Whakamaru North and Brownhill Road, and for the conveyance of electricity north or south, initially at a voltage of 220kV, and at a future voltage of 400kV according to demand.
25. **THE** works necessary to enhance diversity and security within Auckland, which are outside the Upgrade Project, are known as the Otahuhu Substation Diversity Project. The works necessary to enhance security and diversity across Auckland and to Northland are known as the North Auckland and Northland (**NAaN**) project. Transpower also has all necessary consents for its Otahuhu Diversity Project and works are under way on this project. Approval is being sought for the North Auckland and Northland project from the Electricity Commission at present.
26. **THE** Otahuhu Substation Diversity Project is for the construction of a separate substation within the boundary of the existing Otahuhu Substation, to provide increased reliability and security of supply through the provision of physical diversity at the site. It also provides for the removal of line crossings that can cause significant disruption in the event that one circuit physically breaks and falls across another circuit, as occurred in June 2006 and resulted in a loss of power supply to much of Auckland for a day. This project involves a new GIS substation on the Otahuhu site, physically separate from the existing substation, and cabling existing overhead lines to remove crossings. Approximately half of the incoming and outgoing transmission line circuits to this substation site will be terminated in this new substation and the remainder

terminated in the existing substation, so that an event affecting one circuit will not disrupt supply to all of Auckland, Northland and North Auckland. Mr Boyle discusses the Otahuhu Diversity Project and its relationship to the Upgrade Project in more detail in his evidence.

27. **THE** NAaN project will connect the modified Pakuranga Substation to the existing Penrose substation and then through to substations on the North Shore. With present infrastructure, the North Auckland and Northland regions will be securely supplied until winter 2013, when Northland regional load is forecast to peak at 957 MW. From that date, the further transmission reinforcement provided by this project will be required to ensure secure capacity is available.
28. **DETAILS** of how these works interact to provide capacity to and across Auckland are provided in the evidence of Mr Boyle.

SCOPE AND DESCRIPTION OF THE UPGRADE PROJECT

29. **DESCRIBED** from north to south, the Upgrade Project involves:
- (a) At the existing Pakuranga and Otahuhu Substations, some new substation equipment, modifications to existing equipment, and modifications to existing connections. I understand the two existing substations are not designated at present. Accordingly, the Notices of Requirement (**NOR**) include the existing substation activities.
 - (b) An approximately 10.6 kilometre long 220kV double circuit underground cable between the Pakuranga Substation and a proposed substation site at Brownhill Road.
 - (c) An approximately 9.9 kilometre long 220kV double circuit underground cable between the Otahuhu Substation and a proposed substation site at Brownhill Road.
 - (d) A new substation at Brownhill Road, which will initially be built as a transition station, where the cable emerges from the ground. This transition station will involve appropriate equipment and overhead structures and this will connect the cables to the commencement of the proposed 400kV capable overhead line. At a later date additional

equipment will be added including switching equipment and eventually 400kV transformers and substation equipment. I describe the proposed staging of the Upgrade Project later in my evidence.

- (e) An approximately 185 kilometre long section of principally double circuit 400kV capable overhead line, including towers, supporting insulators, conductors and earth wires.
 - (f) Additions to the existing substation at Whakamaru and a new substation at Whakamaru North. The NOR includes the existing designated substation and would replace that designation, if confirmed. Other witnesses describe the designated works in more detail.
30. **THE** Upgrade Project involves construction works, and operational and maintenance activities. It also includes ancillary activities, such as accesses when they are within the designated area, fencing, safety and directional signage. It also includes the decommissioning, dismantling and removal of the existing Arapuni to Pakuranga A double circuit 110kV line (**ARI-PAK A line**).
31. **THE** works span 7 districts, and 2 regions. A total of 13 notices of requirement have been lodged, as well as applications for regional resource consents for the cable routes and overhead line.
32. **ALTHOUGH** this project has distinct components at different sites, and spans a time period till 2033, it has been developed as a single concept with each component being an integral part of the overall solution to maintain reliable bulk electricity supply for the Upper North Island.
33. **WHILE** a more detailed description of each of the components of the Upgrade Project is described by other witnesses, the next section of my evidence provides further details of the works where necessary to explain the overall context of the project.

Brownhill to Whakamaru North transmission line

34. **THE** proposed 400kV capable line (**proposed line**) will be approximately 185 kilometres in length and involve 429 towers from the proposed Brownhill Substation to the proposed Whakamaru North Substation. I understand that some towers are technically included within the proposed substation designations.
35. **THE** proposed line generally follows the route of the existing ARI-PAK A line, although there are two areas of significant departure which will be described in the evidence of others. As noted earlier in my evidence, this line will be decommissioned and dismantled, as part of the Upgrade Project.
36. **THE** proposed line crosses approximately 315 properties. Transpower is seeking to obtain easements over these properties (or in some cases to purchase these properties outright). Easements will have a minimum width of 65 metres to allow for the operation and maintenance of the proposed line. The evidence of Mr Miles will explain the easement purchase process, and Mr Lake will explain how the easement width is established in his evidence.
37. **THE** line is predominantly constructed using double circuit steel lattice towers. Four single circuit towers are proposed at two transposition sites along the line, and two single circuit towers at Brookby ridge where there is a height restriction associated with Auckland International Airport. Mr Boyle in his evidence will explain the need for transposing the line, and Mr Noble will explain how this is achieved in his evidence.
38. **EACH** electrical phase will have three conductors, with this arrangement commonly called a triplex bundle.
39. **IN** addition to the main conductors, each tower will carry two earthwires of approximately 15 mm diameter principally to protect the conductors from lightning strikes. One earthwire will contain optical fibres to provide communications capacity for the operation of the proposed line and the grid.

40. **TOWER** weights are dependent on the purpose of the tower and the associated mechanical loadings. Weights will vary from approximately 12 tonnes for a light suspension tower to approximately 54 tonnes for a heavy strain tower.
41. **TOWER** heights are principally set by the minimum clearance to ground and the underlying topography. The maximum height of the towers is 70 metres, with the average height being approximately 60 metres.
42. **DETAILS** of the tower design, conductor design and the selection of tower locations will be provided in the evidence of Mr Lake, Mr Khot and Mr Noble respectively.

Brownhill to Pakuranga and Brownhill to Otahuhu underground cables

43. **THE** Upgrade Project includes four underground cable circuits. There were a number of reasons for undergrounding into Otahuhu and Pakuranga Substations, including that:-
 - (a) any route into Pakuranga or Otahuhu Substations traverses dense urban areas, or areas identified for future urban development. It is generally accepted that the cost of purchasing a clear transmission line easement and building a transmission line in such an urban area is nearly equivalent to an underground cable option; and
 - (b) route options in urban areas for transmission lines are constrained by existing infrastructure and the ability to reduce the visual impact by siting the line appropriately is minimal.
44. **THE** location of the termination point between the transmission line and the cables was principally established based on the expected Manukau City urban development boundary. However, other factors also set the total length of a transmission circuit that could be installed as underground cable, with the most significant of these being the cost difference between overhead transmission lines and underground cables as described in the evidence of Mr Joyce and Mr Wildash, and the effects on power system reliability of significant lengths of cable as described in the evidence of Mr Wildash.

45. **THE** installed costs of underground cables are generally reported as between five and fifteen times more expensive than the equivalent capacity overhead lines. For this project the evidence of Mr Wildash shows the cost difference to be generally more like 15 times that of an equivalent overhead transmission line.
46. **LONG** sections of cable have a potentially detrimental effect on system reliability and security. While underground cables have a high reliability (long mean time to failure), when they fail, they have a long repair period, and the net effect is that even with optimistic assumptions on cable failure rates and outage durations necessary to repair cables, the availability of a long cable circuit will be significantly worse than for an equivalent length of overhead line. The evidence of Mr Boyle describes the value and importance of reliability, and the evidence of Mr Wildash and Mr Joyce will discuss cable reliability, and how the present cable proposal meets the reliability criteria set for the Upgrade Project in more detail.
47. **SYSTEM** reliability and diversity is also a significant reason for including the proposed underground route from Brownhill Substation to Pakuranga, both in general terms and in the route that was eventually chosen. This route is separate from the Brownhill to Otahuhu cable route and provides route diversity between the Otahuhu and Pakuranga cables which reduces the chances of common mode failures and enhances system security.
48. **EACH** cable circuit comprises three separate 130 mm-160 mm diameter cables, with associated fibre optic communications and temperature sensing cables. Each circuit also includes buried water pipes of approximately 50mm diameter for cable cooling, which will be implemented at a later stage. Each cable circuit will be buried in a trench of approximately 1.5 metres width, and 2.2 metres depth for most of the route, except for a short section where one circuit will be installed in an existing cable tunnel.
49. **DETAILS** of cables and the cable routes will be provided in Mr Wildash's evidence. Mr Taylor describes the basis for the choice of routes.

Decision regarding Brownhill to Pakuranga cable route options

50. **THE NOR** for the Brownhill to Pakuranga cable route originally contained two options:
- (a) Option 1 which crossed private property via Regis Lane, Redoubt Road and Ormiston Road (before joining a common route); and
 - (b) Option 2 which incorporated Brownhill Road, Whitford Park and Sandstone Road.
51. **INVESTIGATIONS** and community consultation have been carried out by Transpower, and consultants working for Transpower, on these alternative routes. This investigation work looked at geotechnical issues associated with creating a stable cable route, the practicability of installation, the impact on other services, and the system reliability consequences of a short section of cable route to Otahuhu and Pakuranga being shared. Transpower proposes to proceed with Option 2 and notified the Minister of its decision prior to the public notice of the call in, but regrettably this was not specified in the public notice. The reasons for this decision are:
- (a) the increased impact of Option 1 on private property, including a recently consented subdivision;
 - (b) the extent of earthworks required to create a route for Option 1 for 4 cable circuits on potentially geotechnically difficult terrain;
 - (c) the increased system security provided by a diverse route; and
 - (d) the property and consenting costs of Option 1 (these costs were however offset by the costs of the additional 1.2 kilometres of cable for Option 2).
52. **A** further factor considered was community concerns about the upgrade of Brownhill Road that was associated with the laying of the cable route. While this factor was recognised, it was accepted that this upgrading is required in any event by 2020, to enable the construction of the switching station, with further work before 2032 to allow the 400kV transformers to be transported to the Brownhill Substation site. The evidence of Mr Wildash discusses this decision in more detail and the evidence of Mr Burns outlines the work required on Brownhill Road.

Brownhill Substation

53. IT was initially proposed that the Brownhill Substation utilise Air Insulated Switchgear (**AIS**). Extensive feedback was received from Brownhill residents during the consultation process regarding the likely impact of the substation, in particular the visual impact, and the initial proposal was reviewed in detail. In addition, Transpower's consultants did not favour the AIS option.
54. IT is now proposed that the Brownhill Substation be constructed using Gas Insulated Switchgear (**GIS**), where the switchgear is located inside a building rather than in than outside in open air. This decision, made in April 2007, also results in a much smaller site coverage, and consequently reduced earthworks which in turn reduces earthwork costs and makes the cost difference between AIS and GIS smaller. As with the Brownhill-Pakuranga cable route options, despite the decision being notified to the Minister, the public notice in relation to the Upgrade Project did not accurately reflect the fact that this decision had been made.
55. **THERE** are three main stages of development at the Brownhill Substation site:
- Stage 1: Earthworks necessary to form the platform for all developments planned at the site, the construction of a cable transition station including on-site towers and support structures. The connection of the overhead transmission line to the underground cables to Pakuranga Substation is to be achieved through the transition station, which is to be commissioned by 2011.
 - Stage 2: Installation of the third and fourth cable circuits from the site, on a separate route to Otahuhu Substation, and the construction of the necessary switching station through the installation of Gas Insulated 220kV Switchgear. The new cable circuit and switchgear are to be commissioned by 2023.
 - Stage 3: Conversion of the Switching Station to a Substation through installation of 400kV to 220kV transformers and associated 400kV and 220kV switchgear. This substation is to be commissioned by 2034.

Pakuranga Substation and Whakamaru Substations

56. **THERE** is one stage of work at the existing Pakuranga Substation. The Upgrade Project involves converting the Pakuranga Substation from 110kV operation to 220kV operation. To achieve this, a new 220kV AIS Switchyard will be constructed and a new 33kV GIS Switchyard may be constructed with all redundant existing 110kV and 33kV switchyard decommissioned and removed. The existing Otahuhu to Pakuranga 220kV line, presently operated at 110kV, will be commissioned at 220kV. The substation will be commissioned at latest during 2011, but probably earlier in order to ensure secure supply to Pakuranga.

57. **THERE** are three stages of work at Whakamaru and Whakamaru North Substations:

Stage 1: A new AIS switching station will be built at Whakamaru North, and connected to the existing Whakamaru Substation through either a new double circuit tie line with two new line bays constructed at Whakamaru Substation, or a double circuit tie line created by deviating existing circuits into Whakamaru North and avoiding new line bays at Whakamaru. This work is discussed in more detail in the evidence of Mr Deller and Mr Bell. This switching station/connection will be commissioned during 2011.

Stage 2: The NOR proposes that Stage 2 involves the construction of a second double circuit tie line between Whakamaru and Whakamaru North Substations, to increase transfer capacity, with associated new line bays at both substations, commissioned between 2022 and 2024. However, if existing circuits are utilised as described above, this work would not be necessary. Instead, Stage 2 works are likely to involve the connection of a proposed new, separately consented transmission line from Wairakei to Whakamaru North and the connection of one of the existing Tokaanu to Whakamaru circuits into Whakamaru North, with this work expected to take place some time between the completion of stage 1 works in 2011 and the stage 3 works in 2032.

Stage 3: The Whakamaru North Switching Station will be converted to a substation through the installation of 400kV to 220kV transformers and associated 400kV and 220kV switchgear. This substation will be commissioned by 2033.

Otahuhu Substation

58. **THERE** are two phases of work at Otahuhu Substation:

Stage 1: The movement of the termination of the existing Otahuhu to Pakuranga line from the 110kV bus to the 220kV bus in order to commission Pakuranga Substation at 220kV. This work will need to be completed by 2010 to allow construction at Pakuranga to be completed to enable commissioning of the overall link during 2011.

Stage 2: Termination of two 220kV underground cable circuits from Brownhill Substation into the existing Otahuhu 220kV substation.

59. **THE** extent of works at Otahuhu Substation for the Upgrade Project are minimal. However, a designation is being sought at Otahuhu for the whole site as part of the Upgrade Project. Mr Taylor and Ms Hunter will discuss the reasons for seeking a designation for the whole substation site.

60. **DETAILS** of the construction works, and equipment proposed at all substation sites at each stage will be provided in the evidence of Mr Bell and Mr Deller.

UPGRADE PROJECT TIMETABLE

61. **THE** Amended Proposal identifies 2013 as the date by which the transmission line and underground cables must be commissioned to connect Whakamaru Substation to Pakuranga Substation to meet projected system needs. To provide a window until 2013 requires three short term projects being completed as discussed earlier in my evidence. The Amended Proposal also identifies delivery risks which could potentially affect the ability to deliver by 2013. The project delivery risks identified are:

- (a) property acquisition timelines;
- (b) construction timelines;
- (c) procurement lead times, and

(d) consenting timelines.

62. **THE** potential delivery risks have resulted in Transpower setting a target project completion for the initial stages during 2011, which leaves approximately two years of project float to cover the stated risks. Mr George's evidence will describe how the system need date of 2013 was determined.
63. **THE** project delivery risk was assessed by identifying likely short timescales, long timescales and intermediate timescales for each risk, and identifying the effect on the project delivery date. This analysis showed that the earliest likely completion date was October 2011. The latest completion date, assuming the longest timetable in all categories of risk, was assessed as being mid 2014. The majority of possible completion dates fell in 2012. Transpower continues to plan for mid 2011, knowing that delays in some of the risk categories may not be manageable through recovery plans, such as increasing construction resources, or advancing equipment delivery dates through shorter procurement processes or increased payments.
64. **PLANNING** for 2011 allows a prudent 2 year schedule float for the Upgrade Project. In other words, the Upgrade Project has a 2 year "buffer" before potential delays would impact on the ability to reliably and securely deliver electricity to the Auckland and North Auckland regions.
65. **IN** addition to the three short term projects identified that extend the need date to 2013, there are other projects that could improve supply to Auckland, but which are not cost effective and hence would not normally be implemented. These have been identified in the Amended Proposal to the Electricity Commission, and planning is underway to design the solutions, seek any necessary consents and property rights and construct these projects if it becomes necessary to manage unexpected or contingency events. These projects generally involve the installation of phase shifting transformers in some substations, and/or the re-conductoring of some existing transmission lines.
66. **TO** achieve the targeted completion date of mid 2011, key activities undertaken to date are as follows:

Table 1- Key project dates (2002 – 2007)

Key project dates	
Work begins on identifying system need and possible solutions	2002
First publication of issues and potential solutions	Early 2004
Identification of Area, Corridor and Route for the transmission lines and cables and sites for substations	May 2004-October 2004
Public announcement of Original Proposal and consultation begins	October 2004
Interim decision on preferred route, submissions and final route decision	May 2005-July 2005
Formal consultation on the proposed transition station site (Original Proposal)	August 2005-January 2006
Consultation on underground cable route and Otahuhu and Whakamaru Substations and public announcement final cable route	August 2005-November 2005
Submission of Original Proposal to Electricity Commission	September 2005
Public announcement of the final centre-line, tower locations and easement requirements, and transition station location	January 2006
Electricity Commission Draft Notice of Intention to reject the Original Proposal	April 2006
Public announcement of the Amended Proposal	October 2006
Consultation on Pakuranga Substation, cable routes, Brownhill Road transition station/substation proposal	October-December 2006
Electricity Commission Draft Notice of Intention to Approve the Amended Proposal	January 2007
Update to landowners advising intention to finalise preferred substation and transition station sites, and to finalise cable routes and substation equipment at Pakuranga after further consultation	February 2007
Consultation on cable route sub-option from the Brownhill Road transition station/substation site	March-April 2007
Final announcement on Brownhill Road transition station/substation and cable route sub-option from Brownhill Road site	April 2007 (and ongoing)
Electricity Commission announce final decision to approve Amended Proposal	July 2007

67. **SUBJECT** to the Board of Inquiry hearing process and ultimate approval, indicative key project dates for the remainder of the Upgrade Project are presently proposed to be as follows:

Table 2 – Key project dates (2008-2011)

Key project dates	
Transmission Line Alliance contract signed and design commences.	May 2008
Cable contract signed and design commences	November 2008
Transmission line material procurement commences	August – November 2008
Transmission line preliminary construction and enabling works commence	October 2008 – February 2009
Substation equipment procurement commences	November 2008
Substation construction contract signed and construction commences	February 2009
Cable manufacture commences	November 2009
First cable delivery	June 2010
Cable installation commences	July 2010
Last property access gained through compulsory acquisition	Early 2011
Substation construction complete	May 2011
Cable installation complete	October 2011
Transmission line construction complete	October 2011
Upgrade Project commissioned	October 2011

68. AS explained earlier, the staging of the Upgrade Project will involve the initial works that are necessary to meet the immediate requirements by 2011. Subsequently, monitoring of demand growth will occur, and adjustment of the timing of subsequent stages would occur, if necessary. However, the order of works will not change. The order of the works incorporated in the designations and the anticipated timing of commissioning of each of the components of the overall project is set out in **Table 3** (below). Construction periods precede these dates, and may encompass up to two years.
69. I note that **Table 3** differs from the table in the NOR (Part II, Table 1, page 16) as the NOR table assumes:-
- (a) that the proposed Brownhill Substation would be AIS instead of the now proposed GIS, and
 - (b) a second tie line would be needed between Whakamaru and Whakamaru North, which is now likely to be provided by deviating existing circuits.

Table 3 – Upgrade Project NOR components and anticipated commissioning dates (2011-2034)

Date	NOR location	Work
By end 2011	All	Acquire all land necessary for substations, and acquire all easements for transmission lines and underground cables (not part of NOR).
	Pakuranga	Modify the existing Pakuranga Substation from 110kV operation to 220kV operation through the construction of a new 220kV AIS, and the decommissioning and removal of the original 110kV and possible removal of 33kV switchyard equipment.
	Otahuhu	Modify existing substation equipment at Otahuhu Substation to allow connection of Otahuhu and Pakuranga at 220kV.
	Pakuranga	Connect the new Pakuranga Substation to the existing Otahuhu Substation through operation at 220kV of the existing transmission line currently operated at 110kV. This line is constructed and currently consented for 220kV use. (not part of NOR).
	Underground cable route (Pakuranga to Brownhill)	Connect the new Pakuranga switchyard to a new AIS cable termination station at Brownhill by two new 220kV underground cable circuits.
	Overhead line route (Brownhill to Whakamaru North)	Connect the Brownhill site to a new AIS substation at Whakamaru North through a double circuit lattice steel tower line of approximately 185 km, constructed for 400kV operation, but initially operated at 220kV.
By end 2011	Overhead line route (Arapuni to Pakuranga)	Decommission and dismantle the existing 110kV transmission line.
	Whakamaru North	Construct a new switchyard at Whakamaru North and connect this to the existing 220kV switchyard at Whakamaru by an approximately 800m section of new or existing overhead line.
	All	Operate this set of assets at 220kV.
By end 2022	Underground cable route (Brownhill to Otahuhu)	Install a third 220kV cable circuit from Brownhill, following a different route to the first two cable circuits and terminating in the existing Otahuhu Substation
	Brownhill	Construct a switching station at Brownhill to which this new cable and the existing cables to Pakuranga Substation are connected.
	Overhead line route	Possible installation of series compensation (explained in the evidence

		of Mr Boyle) for the transmission line. Until detailed design is completed the optimum location will not be known, and hence no designation is sought at this stage for this physically small component of the work (not part of NOR).
By end 2023	Underground cable route (Brownhill to Otahuhu)	Install a fourth 220kV cable circuit from Brownhill to Otahuhu Substation (same route as third 220kV cable circuit).
2022 to 2024	Whakamaru and Whakamaru North	Possibly install a second tie line between Whakamaru Substation and Whakamaru North Substation and extra equipment bays, depending on whether a new tie line between the substations was built in 2011 or existing circuits were used.
		Connect a proposed new Wairakei to Whakamaru transmission line and connect the existing Tokaanu Whakamaru circuits (not part of NOR).
By end 2032	Underground cable route (Brownhill to Pakuranga and Otahuhu)	Commission the forced cooling on the Brownhill to Pakuranga underground cables, which involves the installation of cable cooling equipment at sites along the cable route, within the designation (not part of NOR).
During 2033	Brownhill and Whakamaru North	Install the necessary equipment at the Brownhill and Whakamaru North sites to convert electricity between 220kV and 400kV.
In 2034	All	Commence 400kV operation of the substation, lines and cables.

PROJECT DELIVERY STRATEGY

70. **THE** project delivery strategy recognises the delivery risks I have already described and implements appropriate management and contractual strategies to address the risks.
71. **IN** general, Transpower will manage delivery risk through application of robust project management, procurement and commercial management techniques, with periodic audits.
72. **IN** particular, it has been identified that a significant risk is the uncertainty of property acquisition and to manage this it is proposed to enter an Alliance Contract for the completion of the design, procurement and construction of the transmission line. Such collaborative working arrangements allow greater flexibility that provides for inclusion of consenting conditions and flexibility to

manage the possible uncertain property acquisition timelines. Details of the Alliance Contract approach will be provided in Mr Rasul's evidence. The evidence of Mr Patrick will discuss the management of construction effects.

73. **UNDERGROUND** cable procurement and installation have different risks. The strategy is to utilise a design, manufacture and build contract, timed such that any consent conditions will be included in the detailed design stages. Details of this contractual approach and construction management will be provided in Mr Joyce's evidence.
74. **THE** proposed works at the substation sites are not significantly different in scope from those that Transpower has managed in the past, or is presently managing. The risk associated with this project is that these substations are a key component of an interlinked project with tight timetables, and all activities need to be delivered to time, with interfaces to other components of the works appropriately managed. For example, ensuring continuous secure supply from Pakuranga Substation to the local distribution network while the existing substation is dismantled and replaced will require tight coordination between works in the Otahuhu Substation, including the Otahuhu Diversity project, the substation works necessary to operate the existing Otahuhu to Pakuranga transmission line at 220kV, possible works at Penrose being undertaken as part of the NAaN project, and the connection of the Brownhill to Pakuranga cables into the Pakuranga Substation.
75. **TO** address this risk, the substation construction works will be contracted through separate design, procure and build contracts, as is normal for Transpower projects. However, a single project manager will be responsible for all substation works. Mr Bell will describe the substation construction in his evidence.

ISSUES RAISED IN SUBMISSIONS

76. **RESPONSES** to issues raised in submissions will be dealt with in the evidence of other witnesses.

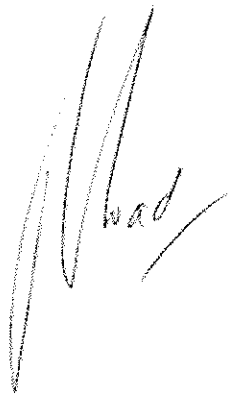
CONCLUSIONS

77. **THE** Upgrade Project has been through an extensive period of analysis to identify the need and identify options to meet the need. Alternatives to transmission and a variety of transmission solutions have been inspected, with the preferred option being a 400 kV capable transmission link between Whakamaru and Pakuranga and later Otahuhu.
78. **THE** 400kV capable transmission link was selected as it maximises the use of the transmission corridor, whilst delivering electricity to the upper North Island at the required reliability, and minimising the total capital cost across a 30 year plus planning window. A considerable number of alternatives, both transmission and non-transmission, were considered and analysed, but the 400kV option was preferable on a range of matters including cost, flexibility, diversity, reliability, security, and environmental considerations. This was confirmed by the Electricity Commission in its decision to approve the investment.
79. **THE** process followed in identifying and assessing the various options was open and transparent, and resulted in an exhaustive consideration of alternatives. The Electricity Commission process also enabled rigorous review and testing of information, assumptions, and sensitivities such that there should be a high level of confidence that the selected 400kV option is an appropriate solution.
80. **ENVIRONMENTAL** considerations were included in the analysis from the initiation of the project, and a rigorous process was undertaken to select the area, then corridor, then route, and finally the easement for the transmission line.
81. **SUBSTATIONS** and underground cable routes were also subject to a detailed analysis in terms of network diversity, security and reliability, not to mention environmental considerations.
82. **THE** 400kV solution can be constructed to budget and in time to meet the need. Sufficient project timetable float has been allowed to manage

unexpected delays. The project delivery strategies have been selected to manage environmental effects as well as ensuring delivery to the timetable.

83. **THE** 400kV option has been appropriately integrated with a series of short term projects that defer the need date till 2013.

84. **THE** Upgrade Project is staged across time to reduces project costs and provide flexibility to meet changing demand. Given my role on this project, I look forward to the possibility of the Upgrade Project being commissioned as planned, subject of course to the approval of the Board through this process.

A handwritten signature in black ink, appearing to read 'J. Coad', with a large, stylized initial 'J' on the left.

John Nicholas Oliver Coad

29 January 2008