Before a Board of Inquiry

Under	the Resource Management Act 1991
In the matter of	Notices of requirement for designations and resource consent applications for the Transmission Gully Proposal
Between	**NZ Transport Agency** Requiring Authority and Applicant
And	**Porirua City Council** Local Authority and Applicant
And	**Transpower New Zealand Limited** Applicant

Statement of evidence of Helen Louise Yorke for Transpower New Zealand Limited

18 November 2011

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INTRODUCTION

1. My name is Helen Louise Yorke. I am a Technical Director specialising in High Voltage ("HV") transmission lines for Beca Carter Hollings & Ferner ("Beca").

2. I have the following qualifications and experience relevant to the evidence I shall give:

   (a) I have a Bachelor of Engineering (Hons) Civil Engineering from Aston University, Birmingham, UK;

   (b) I am a member of the Institute of Civil Engineers (MICE) UK and I have been a Chartered Engineer since 1993;

   (c) I am a member of the International Council on Large Electric Systems (CIGRE NZ) and convenor of the Overhead Lines Interest Group;

   (d) I have worked within the HV transmission line industry for 20 years, spanning construction, design, project management and Engineer to Contract roles, initially working with the contractor Balfour Beatty (UK), and then two consultancy's Kennedy & Donkin, and PB Power both in the UK, before moving to New Zealand and joining Beca in 2004;

   (e) I have a wide range of experience in working on HV transmission line design and route selection, both internationally and in New Zealand;

   (f) Beca is one of Transpower's preferred Consultants and therefore a high proportion of the Projects I have worked on in New Zealand, have been for Transpower. Three relevant recent Projects I have worked on either in the role of Project Director or Project Manager are as follows:

      (i) Roxburgh to Islington (Livingston section) a 220 kV solution study for line uprating (increase of line capacity), part of the works included an assessment of strengthening on existing towers;

      (ii) As part of the North Auckland and Northland ("NAaN") upgrades, detailed design for 110 kV and 220 kV tower relocations at Penrose substation; and

(iii) Preliminary investigations for the diversion of three 220 kV lines for a mine extension in the North Island. This included the assessment of alternative alignment options and preliminary investigation of tower strengthening or replacements.

(g) Projects for other clients include the route selection for 220 kV transmission line connecting the proposed HMR wind farm project in the Waikato to the National Grid and numerous other feasibility transmission connection studies for Generator Clients both in the North and South Islands; and

(h) Overseas, route selection and detailed design for Batangas 1000MW CCGT power plant connection to the National Grid in Luzon Philippines, specifications and design reviews for Mossafah to Uan-Al Wathba Junction, Abu Dhabi 200 kV transmission line and numerous projects in the UK, including line design and tower placement selection for 400 kV line between Harker and Strathaven Scottish border.

3. I confirm I have read the Code of Conduct for Expert Witnesses as contained in the Environment Court Practice Note 2011, and I agree to comply with it as if this Inquiry were before the Environment Court. My qualifications as an expert are set out above. I confirm that the issues addressed in this brief of evidence are within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

SCOPE OF EVIDENCE

4. The NZ Transport Agency is proposing to construct, operate and maintain a 27km section of state highway from Linden to MacKays Crossing. Parts of Transpower's Paekakariki – Takapu Road A (PKK-TKR A) 110kV electricity transmission line between MacKays Crossing and the Pautahanui Substation ("the Line") need to be relocated to enable the state highway project to proceed. Transpower is therefore applying for resource consent for the necessary relocations of the relevant parts of the Line ("the Line Relocation Works").

5. My role is Beca's Project Director for the engineering assessment of the Line Relocation Works. Beca was commissioned by Transpower to assess the engineering implications of relocating the PKK–TKR A line. To that effect I led the team that undertook the preliminary design. The findings

from this preliminary design were included in a report produced for Transpower, the key findings are included in my evidence below.

6. My involvement started with assisting in the planning phase of the project with regards to producing geotechnical constraints maps and engineering assessments of alternative tower locations and alignments. Once the alignment had been selected the engineering team under took the preliminary design. If consents are granted for the Line Relocation Works, detailed design is required, to confirm assumptions and assessments made at the preliminary design stage.

7. The engineering team led by me consisted of transmission line design engineers, lead geotechnical engineer Mr Philip Clayton and lead civil engineer Mr David Callan. We worked closely with Transpower's senior transmission project engineer Mr Craig Mcghie.

8. In this brief of evidence I will:

   (a) Provide an overview and describe the function of the Line and its constituent parts;

   (b) Describe the proposed changes to the PKK-TKR A Line;

   (c) Describe the electrical and physical engineering considerations relevant to the design of the Line Relocation Works and key findings from the preliminary design; and

   (d) Address matters raised in submissions that are relevant to my evidence.

EXECUTIVE SUMMARY

9. The relocation of the 110 kV PKK TKR A line, is required to enable the Transmission Gully Road to be constructed. The transmission line would need to be relocated before the construction works on the road commenced.

10. The alignment changes are directly related to avoiding the proposed envelope of the road construction works. The biggest deviation away from the existing alignment is for Towers 9A, 10A and 11A - the Western By-pass of the Wainui Saddle. This deviation is proposed as a result of the potential issues identified for locating the road and the transmission line in the narrow gully between existing Towers 9 and 11.

11. As a result of the engineering investigations undertaken a large proportion of the transmission line towers in this section of the Line, between Tower 1 and Pauatahanui substation will require some kind of work, relocation, removal or strengthening.

12. Neither voltage nor current are changing as a result of this project, therefore the electrical characteristics of the line are remaining the same.

THE PKK-TKR A 110KV LINE

13. The section of the Line that is affected by the proposed state highway is Paekakariki (Tower 1) to Pauatahanui substation (Poles 49 and 49a), approximately 15.4 km. Refer to Volume 4, 9.1 Transpower Line Relocation Plans TP01 – TP12 for the plan of the relocated towers and proposed road layout with the existing transmission alignment.

14. The majority of the structures on the Line are double circuit lattice steel towers, except for the last two structures at Pauatahanui substation which are single circuit poles. The Line voltage is 110 kV and the Line was originally commissioned in 1924. The conductors were replaced in 2002.

15. The Line supplies the entire Kapiti Coast via Paraparaumu substation. Under normal conditions it is the sole supply for the Kapiti Coast. It is not part of the National Grid 'backbone' that conveys energy to other regions.

Tower and line components

16. The existing and proposed relocated towers are a mixture of strain and suspension type lattice steel towers. The typical tower outlines are shown in figures 3.3 to 3.6 in the AEE.

17. The suspension type towers are used at locations where the line is running straight or for small deviations in angle. The conductors hang from single vertical insulators attached to each crossarm. The suspension tower heights (existing and proposed) range from 15.7 m to 41.5 m (maximum height existing Tower 4).

18. The strain type towers are used at locations where there is either a deviation in angle or in any situation where the loads from the conductors would exceed the allowable design for a suspension type tower. The conductors are attached to the crossarms via horizontal strain insulators. The strain tower heights (existing and proposed) range from 17.1 m to 35

m (maximum height proposed tower 22A, including the 5 m tolerance, which I discuss in paragraph 35 below).

19. There is no change to the conductor configuration due to the proposed Line Relocation Works. A single Wolf ACSR/AC conductor is attached to each cross arm. There are three cross arms on each side of the tower. This arrangement is known as a double circuit arrangement. It is proposed that new conductor will be installed on the relocated sections of the Line (refer to Mr Jon Mason's evidence with regards to the re-stringing process). There is no earthwire in this section of line.

20. The insulators primarily consist of glass with some silicon rubber (composite) type.

21. The existing foundations are predominantly grillage (buried steel) and some tower foundations have been previously strengthened with concrete backfill. The proposed foundations are yet to be confirmed, but are expected to be predominantly bored pile type or pad and pedestal type foundations.

PROPOSED CHANGES TO PKK-TKR A LINE

22. Prior to the engineering assessment on the proposed line relocation, an assessment of the alternative options and selection of the preferred alignment was undertaken by Beca Planning. This assessment took into account all constraints including ecology, visual, geotechnical, archaeological and property. Refer to Ms Lesley Hopkins evidence for a discussion on the assessment of alternative options.

23. One area of particular concern from an engineering perspective was the narrow gully between towers 8 and 13 known as the Wainui Saddle. The integrity of the transmission system could be compromised by locating the transmission structures in close proximity to the road, due to road construction and for the on-going operation of the transmission line. Locating the towers and road in the narrow gully was not considered feasible from an engineering perspective for the following reasons:

    (a) The existing transmission towers 10, 11, 12 and 13 are in the proposed road construction area and would need to be moved to enable the road to be constructed;

    (b) The geotechnical constraints maps produced as part of the planning phase indicated that there would be a high instability risk adjacent

to the road construction area on the steep hill sides between towers 8 and 13 requiring significant stabilisation works and construction of tower platforms;

(c) An engineering review at the planning phase assessed the possibility of constructing towers 10 and 11 on or adjacent to the road fill platform. This would require a significant by-pass line in order to not disrupt the power supply to the Kapiti Coast;

(d) The foundations of relocated tower 10 would need to be constructed on the road fill platform adjacent to the edge of seal. The piled foundations would need to be founded into solid rock bed. The construction of these piles would likely be difficult considering the uncertainties of ground characteristics, the size of the pile and having to be built in conjunction with the road construction;

(e) A by-pass line would be required for the duration of the road construction and it is estimated that it could be required to operate for at least five years. The eastern ridge was discounted for a number of reasons, but primarily due to the native bush on the eastern slopes and lack of access. Therefore a by-pass on the western ridge was the preferred option. Due to the terrain and high wind condition in the vicinity of the Wainui Saddle, the by-pass line would need to be a double circuit tower line; and

(f) For an alignment in the gully between towers 10 and 11 native bush clearance would be required due to blowout ("swing") of the conductors.

24. Two alternative alignments were considered in this area, Wainui saddle – Eastern By-pass and Wainui saddle - Western By-pass. After high level analysis undertaken by Transpower and reviewed by me, the eastern option was also not preferred from an engineering perspective, due to the difficult terrain with stream gullies and steep slopes, and the lack of existing access tracks through the bush area to possible tower locations. This option would also require tower sites and tracks in native bush areas. The preferred option is therefore the Western By-pass Option.

25. Though the Western By-pass is the preferred option, the construction of towers 9A, 10A and 11A will be challenging due to the steep terrain and helicopters may be required for foundation and tower construction. However, there is good 4WD access along the top of Gas Line Ridge. Due to the large change in elevation between towers 8A and 9A, with the long span and deviation angles on both towers, it may be necessary to use

heavier towers, with larger base widths, than the standard proposed 110 kV strain towers.

26. Summing up, the section of the Wainui Saddle presents engineering challenges that is not representative for the rest of the tower relocations, which are comparatively more straightforward.

27. A summary of the proposed changes to the PKK-TKR A line are as follows:

    (a) A total of 25 existing towers are to be removed;

    (b) Replacing those, 24 new towers are to be constructed; and

    (c) 10 existing towers, adjacent to the new towers, may require strengthening works.

28. The tower schedule of the proposed changes and existing towers is included in the application as Appendix B[1].

29. In addition to the 10 affected adjacent structures, I understand that once detail design is underway it will be possible to make a further assessment whether any of the other towers (of those that remain in their present locations) will require strengthening works as a result of the Project. As covered in Ms Hopkins' evidence, the National Environmental Standard for Electricity Transmission Activities provides for some strengthening works as a permitted activity, and if strengthening works are required that go beyond the permitted activity allowances, then relevant consents will be sought at that time.

30. The proposed Line Relocation Works will need to be undertaken without disrupting the supply. The construction works would therefore need to be undertaken with single circuit outages (switching one circuit off at a time, whilst the other circuit is still transmitting power).

ELECTRICAL AND PHYSICAL ENGINEERING IN THE DESIGN OF THE RELOCATION WORKS

Physical considerations for relocating towers

31. The safe operation of the line and the safe construction of the road is paramount in designing the relocation of the structures. To achieve this the following physical considerations are required by Transpower in

[1] Linden to MacKays (Transmission Gully), Volume 6: Transmission Line Relocation Project, Appendix B.

locating its towers and lines in close proximity to the proposed state highway:-

(a) Strain stop structures to be used either side of road crossing;

(b) Ideally structures are to be located a distance of at least one times the structure height away from edge of road;

(c) Where the requirements of (b) are not possible then a minimum of 20m (from edge of road) and in all cases a minimum of 12m away from edge of works (eg cut or fill batters);

(d) Where the conductors are parallel to the road, the conductor blow out (movement) under "everyday" (100 Pascal) wind does not require traffic mitigation measures for future works; and

(e) Conductor clearance to the road surface, under the maximum operating temperature is not to be less than 10m.

32. The conductor electrical clearances to obstacles and ground need to comply with the NZ code of practice[2]. In accordance with this requirement and considering additional Transpower measures, the minimum required ground clearance used for determining the height of the towers is 7 m (6.5 + 0.5 m construction tolerance). The ground clearance is increased over the proposed road to 10 m. The clearance to vegetation is 4.5 m vertically and 4 m horizontally. The minimum horizontal clearance from vegetation, ground and/ or buildings along with the design blow out of the conductor, is used to determine minimum easement widths.

33. The Vector high pressure gas pipe line runs through Transmission Gully. At the north end the pipeline stays on top of Gas Line Ridge. The pipeline then comes off the ridge at Battle Hill Regional Park and the pipeline easement is in close proximity to towers 40A and 41A. The relocated towers must be outside of the gas pipe line easement. Also where construction traffic is to cross the pipeline, then specific engineering checks will be required, to confirm if any protection of the pipe line is required.

Tolerance for tower locations and heights

34. The new tower locations for which consents are sought are based on current information with regards to the road location, capability of the towers, electrical clearances, geotechnical site observations, and a desk

[2] NZECP 34:2001 New Zealand Electrical Code of Practice for Electrical Safe Distances

top study. If the consents are granted then there will be further geotechnical site investigations and detailed design, which may result in slight shifts in tower locations. I have allowed for a maximum shift tolerance of a 20m radius from the centre peg. It is not expected that tower locations will move much, unless the results of soil investigations or any new or additional information is received, that dictates otherwise. This tolerance is reduced in four tower locations due to localised constraints, for towers 31A, 32A, 33A and 40A[3].

35. The heights of the proposed towers also include an additional 5m tolerance. This is to account for any earthworks that might be required to form the tower working platform, which would locally reduce the ground level, i.e. the actual design heights for the proposed towers are 5m less than stated in the tower schedule included in the application as Appendix B.

Structure loading analysis

36. Preliminary tower loading calculations were carried out and compared against the existing tower capacities to determine if strengthening would be required. This analysis was undertaken for both the existing towers (adjacent to the proposed relocated towers), and the proposed relocated towers to the latest Transpower design standards. The results indicated that the majority of the adjacent towers will need strengthening.

Foundation Design

37. Mr Philip Clayton, Beca's Senior Geotechnical Engineer, undertook the preliminary foundation design. His design is based on the use of bored cast in-situ piles, one pile per leg (tower corner). The final foundation type and depth will be determined by the soil investigation at each site, undertaken at the detailed design stage.

38. The preliminary sizing resulted in pile diameters of 0.9 m and 1.2 m for suspension and strain towers respectively. The pile lengths are based on the depth to rock, and typical soil profile and foundation load, but would range from 6 m for a suspension tower to 17 m for the large strain tower. In some locations slope instability is seen as a risk and additional stabilisation measures are proposed as part of the foundation design. Stabilisation measures considered for moderate instability would be piles tied together with a ground ring beam, or for high instability risk areas ground anchors and soil nailed battered slope.

[3] The other constraints include stability issues, visual effects, and preservation of vegetation, as addressed in section 3.4.1 of the Transpower's AEE.

39. Mr Clayton is an experienced geotechnical engineer, and I have relied upon his assessment of the slopes and ground conditions in the Transmission Gully area for the present consenting purposes. Based on this, I do not expect that the pile depths will fall outside of the parameters given above.

Electric and Magnetic Field Values

40. Electric fields (EF) of a transmission line are largely affected by operating voltage of the line. Magnetic fields (MF) are affected by the amount of current flowing down the conductors. Neither voltage nor current are changing as a result of this project, therefore there is no proposed change to these line parameters. Electric and Magnetic fields are strongest close to the source and become rapidly weaker the further away one gets, therefore the values for EF and MF assume minimum ground clearance (worst case). The values for both EF and MF are well within the limits published by the International Commission on Non-Ionising Radiation Protection (ICNIRP) for public exposure for 50Hz alternating current, and are as follows:

    (a) Electric Field (pre contingency) 0.6 kV/m (the ICNIRP limit is 5 kV/m); and

    (b) Magnetic Field (pre contingency) 2.5 microteslas (the ICNIRP limit is 100 microteslas).

Civil works / Access tracks

41. Mr David Callan, Beca's Senior Civil Engineer, undertook a high level assessment of the civil works required to access transmission towers. It is proposed to utilise existing tracks, the gas pipe line track and the proposed road maintenance track to minimise the construction of new access tracks and where terrain allows, access to towers via open pasture. It is proposed to provide access tracks with a minimum width of 3.5 m

42. As part of detailed design, the gradients of potential access tracks will be examined, to investigate ways of mitigating gradients (for safety, utility and stability) or proposing suitable alternative construction techniques such as use of helicopters.

43. It is acknowledged that earthworks consents will be required and will be sought once detailed design is available. The earthworks consent process is expected to provide an appropriate forum to examine and test these aspects of the Works.

RESPONSE TO SUBMISSIONS

Submission 19 Eberhard Deuss and Submission 57 Poppe Family Trust

44. I have read the submissions of Mr Deuss (submission 19) and the Poppe Family Trust (submission 57), both of which promote a change to the proposed state highway alignment. They assert that a consequence of their proposed change is that neither Tower 31 nor Tower 33 would need to be moved.

45. Based on the proposed alignment change, the road crossing would be in span Tower 31 to Tower 32. However once the road construction cut areas are determined, it is highly likely that Tower 32 would have to move, as it would either be too close to the cut face or in the construction area of the Road. Tower 32 may also need to increase in height to provide the required clearance to the road from the conductors and will need to be a strain tower, because it would be a road crossing tower. Tower 31 may also need to be changed to a strain tower and/or increase in height, as this would be a road crossing tower. The angle on Tower 33 could be kept to a minimum and this tower could potentially remain where it is with strengthening.

Submission 23 Kapiti Coast District Council

46. I have read the submission of Kapiti Coast District Council giving consideration to the following;

    (a) Moving proposed Wainui Saddle (Western by-pass) Towers 9A, 10A and 11A; and

    (b) Moving proposed relocated Tower 2A to the eastern side of the road.

47. As discussed in my evidence in paragraph 23 relocating Towers 9A to 12 A back on to an alignment in the Wainui Saddle (after construction of the road) would not be feasible. A by-pass line would need to be designed for the high wind loads in this area and be in operation for a minimum of five years. This would result in the same tower construction, as for a permanent line. A high level engineering review to assess the feasibility of relocating towers in the saddle was undertaken at the planning stage, and as discussed above not considered as feasible due to having to construct the tower foundations for towers 10 and possibly 11 at the same time as the road fill is placed.

48. The conductors would blowout ("swing") over the road between Towers 10 and 11 which would likely necessitate taller towers to provide the clearance to the road. The proximity to the native bush in span 10 to 11 would also require vegetation clearance.

49. I was involved in selecting the tower locations for Towers 8A, 9A, 10A, 11A and 12A in conjunction with Mr Lister and Transpower engineers. Taking into consideration the visual, engineering and constructability aspects, in my opinion, of the options assessed, the selected Western By-pass is the best locations for the proposed towers.

50. It would not be feasible to site Tower 2A at the location of the shed to be removed on the eastern side of the road, as it is too close to a large cut. In order to locate Tower 2A on the eastern side of the road in this area, it would require, as a minimum, an additional tower between Towers 1 and 2 with a large angle crossing to the high ground to a location south of the shed, in an area of pine trees and then another large angle back to Tower 3A which will also require an angle. The pine trees are within falling distance of the conductor and at tower site would need to be felled. For those reasons, in my opinion the current location of Tower 2A is preferable.

Helen Yorke
18 November 2011