Before a Board of Inquiry
Transmission Gully
Notices of Requirement and Consents

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under: the Resource Management Act 1991

in the matter of: Notices of requirement for designations and resource consent applications by the NZ Transport Agency, Porirua City Council and Transpower New Zealand Limited 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 rebuttal evidence of Pathmanathan Brabhaharan (Brabha)(Geology and Geotechnical Engineering) for the NZ Transport Agency and Porirua City Council

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Dated: 20 January 2012

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STATEMENT OF REBUTTAL EVIDENCE OF PATHMANATHAN BRABHAHARAN (BRABHA) FOR THE NZ TRANSPORT AGENCY AND PORIRUA CITY COUNCIL

INTRODUCTION

1 My full name is Pathmanathan Brabhaharan (Brabha).

2 I have the qualifications and experience set out at paragraphs 2, 3 and 7 of my statement of evidence in chief, dated 18 November 2011 (*EIC*).

3 I repeat the confirmation given in my EIC that I have read, and agree to comply with, the Code of Conduct for Expert Witnesses (Consolidated Practice Note 2011).

4 In this statement of rebuttal evidence, I:

4.1 Respond to the evidence of:

(a) Donald Richard Wignall, on behalf of Kapiti Coast District Council (*KCDC)*;

(b) Travis Marshall Wood, on behalf of KCDC;

(c) Tracey Jean Grant, on behalf of Greater Wellington Regional Council (*GWRC*);

(d) Brian Arthur Handyside, on behalf of the Director-General of Conservation;

(e) Leslie Robert Basher, on behalf of the Director-General of Conservation; and

4.2 Respond to the section 42A report – Part 1, provided by John Kyle of Mitchell Partnerships (*the section 42A report*).

5 The fact that this rebuttal statement does not respond to every matter raised in the evidence of submitter witnesses within my area of expertise should not be taken as acceptance of the matters raised. Rather, I rely on my EIC and this rebuttal statement to set out my opinion on what I consider to be the key geology and geotechnical engineering matters for this hearing.

6 For the purposes of this evidence, I will refer to the NZ Transport Agency (*the NZTA*) Project[1] and the Porirua City Council (*PCC*)

[1] The 'NZTA Project' refers to the construction, operation and maintenance of the Main Alignment and the Kenepuru Link Road by the NZTA.

Project[2] collectively as the "Transmission Gully Project" (and hereafter, *the TGP* or *the Project*).

SUMMARY OF EVIDENCE

7 I have read all of the statements of evidence provided by submitters and the aspects of the section 42A report related to my area of expertise. The evidence from the submitters and the section 42A report has not led me to depart from any of the opinions expressed in my EIC, and I re-confirm the conclusions reached in my EIC.

8 I have provided additional information in my rebuttal evidence in response to issues raised by submitters and in the section 42A report.

9 In particular, I am of the opinion that:

9.1 While a local road between State highway (*SH*) 1 at Paekakariki and MacKay's Crossing would provide a marginally improved overall resilience in operational incidents such as traffic accidents, it does not provide significant improvements in resilience in significant natural hazard events such as large earthquakes and storms. The lack of an alternative parallel local road between MacKay's Crossing and SH1 at Paekakariki will not, in my view, undermine the resilience of the proposed TGP route.

9.2 The earth loading from the TGP is not likely to cause any appreciable change in the water yield from either the existing or planned second KCDC Paekakariki water supply bores.

9.3 The groundwater drawdown associated with the proposed TGP will have no significant adverse effects on the environment or land use.

9.4 Only localised dewatering is likely to be required for the construction of the TGP, and this is unlikely to cause significant adverse effects on the environment or land use.

9.5 It is important to take into consideration the geology and geotechnical conditions expected along the TGP route and experience from the construction of major earthworks projects in the Wellington Region in similar geological conditions, when assessing the TGP's predicted erosion and sediment generation. From this experience, I consider that the sediment generated from the earthworks associated with

[2] The 'PCC Project' refers to the construction, operation and maintenance of the Porirua Link Roads (being the Whitby Link Road and the Waitangirua Link Road) by PCC.

the TGP, is likely to be significantly less, compared to major earthworks projects in the Auckland region.

EVIDENCE OF SUBMITTERS

Evidence of Donald Wignall

10 Mr Wignall suggests there is a need for a local route parallel to the TGP route between SH1 at Paekakariki and MacKay's Crossing (paragraph 4.1). He considers that there are a number of reasons as to why such a road is necessary, including for route resilience reasons. I respond to the route resilience aspect of his reasoning (paragraphs 4.6 to 4.10).

11 As stated in my EIC (paragraphs 114-115), I agree that, in principle, an additional local route between SH1 at Paekakariki and MacKay's Crossing would provide increased resilience, by providing an adjacent parallel local road. However, in my opinion this only provides a marginal increase in resilience for the reasons set out below. The lack of an alternative parallel local road will not, in my view, undermine the resilience of the proposed TGP route.

12 I consider that the addition of a parallel local road will only give a marginal improvement in resilience, because:

a) The local connection will provide improved resilience in the event of operational incidents such as traffic accidents along the TGP route, by enabling southbound traffic to leave the Main Alignment at MacKay's Crossing, and join the existing SH1 north of Paekakariki. However, given the wide expressway corridor proposed for the Main Alignment this is likely to only occur with large incidents on the southbound carriageways.

b) The local connection will make little difference for northbound traffic, as such traffic can easily travel along the existing SH1 and join the Main Alignment north of Paekakariki via the on-ramp proposed as part of the TGP;

c) A local connection would also provide connection for southbound traffic to divert onto SH1 at MacKay's Crossing, in the event of slips onto the southbound carriageway of the TGP route, from the hillside to the east along a 0.8 km section between SH1 at Paekakariki and MacKay's Crossing, in moderate storm events. However, in moderate events such slips are likely to be able to be cleared to allow access within a day or so. Slips are unlikely to close the carriageway in small storm events;

d) I note that slips are also possible on the existing narrow and now redundant section (see paragraph 17 below) of the

former State highway extending south from MacKay's Crossing, which is proposed by Mr Wignall to form part of the local road connection;

e) In larger storm or earthquake events, any slips along this section of the Main Alignment are likely to be insignificant compared to slips through the Te Puka and upper Horokiri Stream valley sections of the TGP route, or indeed slips through Paekakariki to Pukerua Bay on the SH1 route, which are likely to close those routes for longer durations; and

f) The local road connection would itself also be vulnerable to damage in large earthquake events, as discussed in paragraph 17 below.

13 Mr Wignall states (at paragraph 4.8) that the effect of seismic events on the section of the TGP route between MacKays Crossing and Paekakariki will be severe, with a potential outage of up to 3 months in an Ohariu Fault event. Mr Wignall refers to the Transmission Gully Route Security Study of June 2009[3] (*June 2009 Study)* in reaching this conclusion. I consider that Mr Wignall has incorrectly interpreted the June 2009 Study in reaching his conclusion on expected closure timeframes.

14 The Outage State map (which forms part of the June 2009 Study) shows the likely duration of the level of availability resulting from an Ohariu Fault event. The level of availability is shown on the Availability State map. The June 2009 maps represent the preferred TGP alignment proposed in the Scheme Assessment Report[4]. The consequences of an Ohariu Fault earthquake event would be difficult access[5] (availability state) for a period of 2 weeks to 3 months (outage state) for a section of road between MacKay's Crossing and SH1 at Paekakariki. The TGP route is not expected to be closed at this location.

15 I note that the TGP route has been changed from that shown in the June 2009 report, and the Availability and Outage State maps were therefore updated in December 2011 to reflect the current Main Alignment of the TGP. The updated maps (Figures 2-5) are attached in **Appendix A**. The updated maps also show difficult access (availability state) for a period of 3 days to 2 weeks (outage state) along this section, see Figures 4 and 5 (**Appendix A**).

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[3] Opus International Consultants (2009). Transmission Gully & State Highway 1 Coastal Route Route Security in Earthquake Events, June 2009.

[4] Opus International Consultants (2008). Transmission Gully Scheme Assessment Report.

[5] Single lane accessible by only 4x4 off road vehicles, or severe weight restriction on bridges, with access for special vehicles only, as defined in the Availability State for access tabulation from the June 2009 report which is reproduced in Appendix A, Figure E of my EIC.

16 This 3 days to 2 weeks period of difficult access along this section of the TGP route between SH1 at Paekakariki and MacKay's Crossing would not be significant taking into consideration the lesser levels of availability and longer periods of outage of sections of the TGP route through Te Puka Stream Valley, and the predicted closure of SH1 through Paekakariki to Pukerua Bay for a period of over 6 months.

17 Mr Wignall suggests (paragraph 4.10, Indicative Plan 1 and Annexure) that the proposed local road should be constructed to the west of the TGP route. I note that this local road would be located over low lying swampy ground (marine and alluvial deposits), and is likely to be vulnerable to damage from slumps, liquefaction and consequent subsidence and lateral spreading. As noted above, the northern section of this proposed local road will also be along a now redundant section of road which was previously part of the state highway, and is vulnerable to slips from the slopes to the east of this road. Therefore, the proposed local road connection will also be prone to difficulty of access after major earthquake events.

18 In summary, I am of the opinion that, while a local road between SH1 at Paekakariki and MacKay's Crossing would provide a marginally improved overall resilience between Kapiti and Porirua in operational incidents such as traffic accidents, it does not provide significant improvements in resilience in significant natural hazard events such as large earthquakes and storms. **Mr Edwards** and **Mr Kelly** comment on the other reasons raised by Mr Wignall for a local road.

Evidence of Travis Wood

19 Mr Wood explains in his evidence that KCDC currently supplies potable water to Paekakariki from a groundwater bore which is located adjacent to the existing SH1 at MacKays Crossing (*existing Production Bore 1*) (paragraph 4.1). Mr Wood is concerned that " …*the Council's existing bore supply may be adversely impacted by the proposed nearby earth loading. The existing bore is shallow and earth loading may impact on the Council's water yield from the existing bore*." (paragraph 5.5). The nearby earth loading referred to by Mr Wood is the highway embankment proposed as part of the TGP.

20 I have carried out a study of the effect of the highway embankment, and I understand that a copy of the Geotechnical Paper from this study has now been provided to KCDC by the NZTA.[6] In my opinion, the loading from the highway embankment is not likely to have any significant impact on the existing Production Bore 1.

[6] Opus International Consultants (2011). Transmission Gully. Paper GA16. Issue 2. Geotechnical Effects Associated with the Paekakariki Water Well. December 2011.

21 The proposed highway embankment in the vicinity of the existing Production Bore 1 is 12 m high, with the edge of the embankment located some 65 m from the bore. The toe of the embankment is located about 40 m from the bore. The log of the ground at the bore (WTPW1) provided by KCDC indicates the ground strata penetrated by the bore to be loose coarse gravel to 13.5 m depth and a 1 m thick compact clay layer underlain by about 3.5 m thickness of loose gravel (grit) within which the well screen (the section over which water is abstracted through the bore lining) is located. This aquifer layer is underlain by bedrock.

22 The construction of the highway embankment is likely to lead to consolidation of the clay layer overlying the aquifer reducing its permeability and improving its effectiveness as a confining layer. The compression of the gravel aquifer layer between about RL 2.8 m and RL -0.9 m (14.6 m and 18.3 m depth below ground level) is unlikely to be significant enough to cause any appreciable change in the water yield from the existing bore[7]. Therefore in my opinion, there is unlikely to be any significant effect from the earth loading associated with the TGP embankment on the water yield from the existing Production Bore 1.

23 KCDC also proposes a second water bore. The proposed second water bore will be located in predominantly gravel soils, further away at a distance of 125 m from the toe of the proposed TGP highway embankment. Therefore, the embankment is also not likely to have any appreciable effect on the proposed second water bore.

Groundwater Drawdown – Evidence of Tracey Grant and the section 42A Report

24 Ms Grant states that there is uncertainty around the potential impact of the Project on groundwater (paragraph 34), and that technical detail is required around the location of any groundwater diversion.

25 The section 42A report also seeks information about where groundwater will be diverted to and whether there will be any adverse effects on the receiving environment or other users from any changes that will result (page 23). The Section 42A report (page 23) correctly observes the recommendations of Technical Report 3 regarding the importance of drainage measures to improve the stability of slopes by drawing down the groundwater.

26 My EIC (at paragraphs 105-109) provides some description of the groundwater effects associated with the Project. There is no

[7] Opus International Consultants (2011). Transmission Gully. Paper GA16. Issue 2. Geotechnical Effects Associated with the Paekakariki Water Well. December 2011.

reference to this by Ms Grant in her evidence, and I understand that the section 42A report was completed prior to the lodgement of my EIC.

27 Firstly, I note that groundwater drawdown is the correct technical description of the effect of the drainage measures to improve stability of the slopes. There is no intention to divert the groundwater.

28 The Project involves the construction of cuttings for the formation of the roads. The excavation of ground to form cuttings will inevitably lead to drawdown of groundwater around these cuttings as groundwater is able to drain to the newly formed surfaces. Drainage measures are proposed as part of the TGP (and which are common to such earthworks projects) to lower the groundwater pressures in the ground in a zone immediately behind the cuttings. The reduction in the groundwater pressure leads to an improvement in the stability of the slopes formed, reducing slips, landslides and erosion from groundwater seepages, all of which provide security to the new roads, but also lead to significantly reduced erosion and slips and hence sedimentation of the water courses and receiving environments.

29 In the ground conditions encountered along the TGP route and typically in the region, groundwater pressures may be reduced in a zone extending a distance equivalent to about half to full height of the cuttings. Cuttings proposed for the TGP are typically up to 30 m high, but in some places are up to 65 m high.

30 The extent of drawdown of groundwater will depend on the permeability of the ground. The groundwater drainage measures will be implemented in generally low permeability ground conditions – either fractured bedrock or alluvium comprising low permeability soils of silts and clays to gravelly silts and silty sandy gravels. The extent of groundwater drawdown is generally not likely to extend far beyond the extent of drainage measures. Generally, the groundwater drawdown is likely to be entirely within the Project designation boundaries. However, it is possible that in some areas, the drawdown may extend into rural private land.

31 The cuttings are located in rural hilly areas and groundwater draw down will be in areas of low intensity land use - hillsides or paddocks used for grazing. There are no commercial or residential buildings in the land that will be subject to groundwater drawdown. Because of the generally low permeability of the ground surface the vegetation would be largely dependent on rainfall and surface water. Also the groundwater levels are already generally low in these areas, and the ground is of very low compressibility, and therefore the lowering of the groundwater at depth is not likely to have a significant effect on the ground surface.

32 In her evidence Ms Grant refers to Rule 9B of the Regional Freshwater Plan, which is the permitted activity rule for groundwater diversion (paragraph 33). As Ms Grant notes, one of the conditions of the permitted activity rule is that there shall be no adverse effects on water supply other than for a temporary period during construction of no more than 24 hours (paragraph 33.1).

33 I have reviewed the locations of the groundwater bores along the TGP corridor supplied by GWRC from their bore database, and the recorded groundwater bores are all located well away from the proposed TGP cuttings, and are thus not likely to be affected by groundwater drawdown. The identified KCDC water production bore discussed above is located on low ground, well away from any of the cuttings where groundwater drawdown could occur. Therefore, there are no known adverse effects on water supply.

34 Ms Grant also refers to the permitted activity rule condition which requires there to be no flooding of land on any neighbouring property (paragraph 33.2). While the groundwater pressures in the ground will be reduced significantly to enhance stability, the volume of groundwater flows will be generally very low (less than 0.2 to 2 litres per minute). The discharge will be small compared to the natural surface run-off. Occasionally somewhat larger groundwater flows (few to several litres per minute) may be intercepted, particularly where the drainage measures tap into natural fault zones or open joint systems in bedrock. From my experience, typically these flows reduce after the first weeks to months of the installation of the drainage, and then with a low intermittent flow, depending on the rainfall. The generally small discharge from the drainage systems will in any case be collected through road side drains, storm water drains, and discharged to natural water courses. Being groundwater, the effects on the quality of water in water courses and on the environment will be negligible. Given the low flows and the proposed collection and disposal through stormwater drainage systems, I would not expect there to be any flooding of land on neighbouring properties.

35 A further condition of the permitted activity rule is that there shall be no lowering of water levels in any river, lake or wetland (paragraph 33.3 of Ms Grant's evidence). The drains will lower groundwater levels in hilly areas, and therefore this groundwater drawdown will not lead to lowering of the water levels in any river, lake or wetland.

36 Finally, Ms Grant refers to the permitted activity rule condition requiring no lowering of water levels on any neighbouring property (paragraph 33.4). As discussed in paragraphs 28 to 30 above, the groundwater drawdown is likely to be generally located within the designation boundaries. However, it is possible that drawdown may extend into private rural land. However, such drawdown in private

rural land is not likely to cause any significant adverse effects on private land use or the environment.

37 I note that the historic brick fuel tank located adjacent to the Te Puka Stream is located close to and above the level of the stream. Given the proximity of the tank to the stream, the groundwater level is likely to be low and close to stream level, with the cuttings well above stream level. In this case there is not likely to be any lowering of the groundwater level caused by the TGP cutting in the vicinity. Given the alluvial gravel terrace on which it is located and its low compressibility, even in the event of higher groundwater levels at the tank site and any drawdown of groundwater as a result of the formation of the cuttings, such drawdown is unlikely to cause any appreciable subsidence sufficient to cause damage to the brick fuel tank.

38 I have been involved in the construction of earthworks for a variety of projects, particularly in the Wellington Region. These have inevitably involved interaction of the construction with the groundwater regime. Urban projects such as the Wellington Inner City Bypass had a very strong influence on the groundwater regime, with potential for significant impact on the built and natural environment. This was recognised, designed for, mitigated, instrumented, monitored, and successfully managed carefully through the design and construction process.

39 I have also been involved in the construction of earthworks involving large cuttings in urban and rural areas with the implementation of drainage measures similar to those proposed for the TGP. These projects including, the SH58 realignment, SH1 Newlands Interchange, SH2 Kaitoke to Te Marua realignment, SH2 Rimutaka Hill Muldoons Corner realignment (currently nearing completion) and Project West Wind, had cuttings in similar ground conditions. Drainage measures were installed and groundwater was successfully drawn down to improve stability, and the water discharged with no significant adverse effects on the environment or land use.

40 In summary, I am of the opinion that the groundwater drawdown associated with the proposed TGP will have no significant adverse effects on the environment or land use.

Dewatering of Groundwater – section 42A Report

41 The section 42A report queries (at page 23) whether dewatering is required as part of the construction stage of the Project.

42 No major dewatering is envisaged as part of this Project. Localised dewatering during construction is likely to be required to prepare the foundations for embankments or road structures or in order to remove unsuitable foundation materials. This could be required

between MacKays Crossing and SH1 at Paekakariki (Station 750 m to 2,000 m), SH58 interchange, Kenepuru Link Road near the railway and Porirua Stream, and in gullies or stream crossings along the TGP route. Such localised dewatering is only likely to cause lowering of groundwater levels within the construction zone within the designation boundary, and hence is unlikely to cause any significant effects on the environment.

43 Vertical drains installed for preloading soft areas, such as may be required between MacKays Crossing and SH1 at Paekakariki (Station 750 m to 2,000 m), will not lead to dewatering, but would rather minimise increases in porewater[8] pressures that would otherwise occur in the ground under structures such as embankments.

44 In summary, only localised dewatering is likely to be required for the construction of the TGP, and this is unlikely to cause significant adverse effects on the environment or land use.

Sediment Generation - Evidence of Dr Leslie Robert Basher and Mr Brian Arthur Handyside

45 Since the completion of my EIC, I have been asked to provide information on the geology and geotechnical conditions of the TGP route for use in the review of sediment generation by **Ms Malcolm**.

46 I set out below some comments based on my experience in large-scale earthworks projects in the Wellington Region, and my understanding of the geology and geotechnical conditions along the TGP route, which will have an influence on the quantity of sediment generated during the proposed construction of the Project.

47 My Handyside refers to (in the context of his discussion on the Te Puka Site Specific Environmental Management Plan) the "…*considerable ground improvement and subsurface drainage works for geotechnical reasons very early on in construction*" (paragraph 42). I can provide some indication of the type of such work that is likely to be required, to provide comfort that these measures are not likely to give rise to erosion and sediment control issues.

48 The ground improvement and sub-surface drainage that is likely to be required for the Project is:

a) Undercut to remove unsuitable soft cohesive and loose cohesionless soils to provide a suitable foundation for soil and rockfill embankments, reinforced soil embankments and culverts, and where necessary placement of a gravel drainage blanket and / or geogrid reinforcement layers to provide a base for the embankments and culvert structures. Where groundwater levels are high, localised dewatering using sump

[8] Porewater is the groundwater between soil particles.

pumps are typically used to facilitate construction. The groundwater pumped is typically disposed of through sedimentation ponds. Such measures are common on earthworks projects.

b) Drainage layers may also be installed in fill embankments, particularly in the low permeability soils in the Battle Hill Farm Forest Park (*BHFFP*) to SH 58 section of the TGP, to allow dissipation of porewater pressures during earthworks construction. These are not likely to lead to erosion and sedimentation issues.

c) Installation of vertical composite drains to facilitate dissipation of porewater pressures that develop in the foundation soils. These are typically installed by crane or piling rig type plant from a gravel foundation drainage platform. On the TGP, this is likely to be required in the section of the Main Alignment between MacKay's Crossing and the SH1 crossing at Paekakariki near the north end of the Te Puka Stream Valley, and may be required in the Kenepuru Link Road area. These are also not likely to cause any erosion and sedimentation issues.

d) Sub-horizontal drainage holes, subsoil trench drains and or counterfort drains may be installed in the cuttings during excavation to relieve groundwater pressures, as discussed above. Because of the low permeability of the soils and rocks, the flows are typically expected to be very low, with occasionally higher flows, and will be disposed of as part of the stormwater systems. These are also common measures for earthworks projects and are not likely to cause erosion and sedimentation issues.

e) Other ground improvement measures will involve a range of slope stabilisation measures such as rock bolting, rock anchors, soil nails, mesh and occasionally shotcrete. These are not likely to cause any erosion and sedimentation issues.

49 Dr Basher comments on the projected quantum of sediment yield and compares the values calculated for the TGP with estimates for the Auckland area, which are in the order of 168 t/ha/yr (paragraph 45). I draw attention to the considerably different geology of the Wellington Region, including the TGP route, and the need for caution in making such comparisons.

50 The TGP earthworks will be constructed through different geological conditions, which can be summarised as follows:

a) Station 1,000 m – 2,000 m of the Main Alignment, and Kenepuru Link Road: low lying alluvial[9] fan and swamp deposits, with partial undercut of soft deposits as discussed in paragraph 48 (a), and construction of embankments.

b) Station 2,000 m – 3,000 m of the Main Alignment: Predominantly cuttings through older alluvium comprising sandy gravel.

c) Station 3,000 m to 13,000 of the Main Alignment: Predominantly cuttings through greywacke bedrock overlain by a thin colluvium[10] layer, and rockfill embankments on alluvium.

d) Station 13,000 m to 18,000 m of the Main Alignment and the Whitby Link Road: Predominantly cut and fill on rolling country comprising older alluvium comprising silt and sandy silt overlying sandy and silty gravel overlying bedrock.

e) Station 18,000 m to 27,000 m of the Main Alignment and Waitangirua Link Road: Predominantly cuttings through greywacke bedrock with a small completely weathered layer, and rockfill embankments across alluvial gullies.

51 The combination of the generally much thinner layer of residual soil above bedrock and the steep terrain leading to deeper cuttings, means that much of the earthworks will be in bedrock in the proposed TGP, as compared to similar large earthworks projects in the Auckland area. As the majority of the Project will be constructed in rock, this can be expected to generate far less sediments than the fine grained soils found in the Auckland area. Even the older alluvium between BHFFP and SH58 comprising silt, sandy silt and sandy silty gravel are coarser than the fine grained soils which are predominantly encountered in the Auckland area, and may be expected to generate less fine grained sediments.

52 The earthworks for large infrastructure projects such as the TGP (with the majority of the earthworks occurring in bedrock materials), is also different to residential subdivisions where the smaller earthworks in the shallower ground generally encounter proportionately a greater proportion of soil.

53 I have been involved in the construction monitoring of many of the major earthworks projects in the Wellington Region over the past 22 years, including the SH58 realignment through rock and overlying alluvium in close proximity to the TGP route, the SH1

[9] Alluvial soils are those transported and deposited by water courses.

[10] Colluvium soils are the result of slope movements, slips and slope wash, and generally cover hillsides.

Newlands Interchange and SH2 Muldoons Corner realignments in greywacke rock, the SH2 Kaitoke to Te Marua realignment in predominantly older alluvium comprising sandy and silty gravel, and the MacKays to Waikanae Double Tracking of the railway line in a variety of conditions, such as greywacke rock, colluvium and dune sand. I have also occasionally visited construction sites in Auckland, including the Alpurt motorway extension. This experience informs my view as to the sediment generation expected from the TGP earthworks.

54 In the steep mountainous to hilly terrain in the Wellington Region, earthworks are typically carried out in small fronts, with excavation of rock using excavators, sometimes assisted by ripping, and transportation of cut materials using dump trucks and placement at fill embankment sites. The work areas are therefore predominantly flat areas where fill is placed, with steep excavation faces in rock or dense alluvium. The hillsides generally remain undisturbed until the time of excavation or fill placement, and cut slopes and fill embankment slopes are hydroseeded or otherwise protected soon after construction of each section of slope, see **Photograph 1**.

Photograph 1 – Earthworks construction at SH2 Muldoons Corner

55 Earthworks construction in rock areas generally continues through winter in Wellington (in comparison to Auckland), except in gullies, and I expect this can occur for the TGP. However, given the finer grained soils with high moisture content in the BHFFP to SH 58 section of the Main Alignment, I expect that undertaking earthworks along this section of the TGP would be less efficient and more difficult during winter.

56 The predominant erosion mechanisms in Wellington construction projects have been rock slides and slumps, except in dune sand. The volume of sediment generation which I have observed has typically been small. For example, **Photograph 2** shows a current earthworks site I am involved in (SH 2 Muldoons Corner realignment in the Rimutaka Hill), and **Photograph 3** shows a sediment pond during winter. Although localised erosion of the gravel fill has occurred during storm events, I have not observed widespread rilling or erosion of the cut or fill surfaces at this site, despite the severe weather regularly experienced there.

Photograph 2 – Earthworks at Muldoons Corner site

Photograph 3 – Sediment Pond at Muldoons Corner Site

57 In February 2004, a major Lower North Island Storm occurred during construction of the Kaitoke to Te Marua realignment project, which involved earthworks through older alluvial deposits. Although some rilling of fill embankments in the storm and slumps at some slopes (**Photograph 4**) was experienced during this project, no widespread rilling and generation of sediments was observed.

Photograph 4 – Kaitoke realignment embankments after February 2004 storm

58 Experience from these examples is useful to understand the geology in the Wellington Region and its effect on erosion and sediment generation, when assessing the expected sediment generation for the TGP in similar geological conditions.

59 In summary, in my opinion it is important to take into consideration the geology and geotechnical conditions expected along the TGP route and the experience from the construction of major earthworks projects in the Wellington Region in similar geological conditions when assessing likely erosion and sediment generation for the TGP. From this experience, I consider that the erosion and sediment generation will be much less for projects in the Wellington Region, such as the TGP, as compared to say the Auckland region.

SECTION 42A REPORT

60 My response to the groundwater issues raised in the section 42A report are discussed in paragraphs 4 to 44 of my rebuttal evidence.

Pathmanathan Brabhaharan (Brabha)
20 January 2012