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 Timothy Simon Richmond Fisher (Sediment Yield Peer Review) for the NZ Transport Agency and Porirua City Council

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Dated: 27 January 2012

REFERENCE: John Hassan (john.hassan@chapmantripp.com)
Nicky McIndoe (nicky.mcindoe@chapmantripp.com)

Chapman Tripp
T: +64 4 499 5999
F: +64 4 472 7111

10 Customhouse Quay
PO Box 993, Wellington 6140
New Zealand

www.chapmantripp.com
Auckland, Wellington, Christchurch

CHAPMAN TRIPP

STATEMENT OF EVIDENCE OF TIMOTHY SIMON RICHMOND FISHER FOR THE NZ TRANSPORT AGENCY AND PORIRUA CITY COUNCIL

INTRODUCTION

1 My full name is Timothy Simon Richmond Fisher.

2 I am a Senior Water Engineer and Director at Tonkin & Taylor Limited (*T&T*), environmental and engineering consultants of Auckland. I practise as a civil engineer with specialism in water and environmental engineering. I am a member of the Institute of Professional Engineers New Zealand and am a Chartered Professional Engineer.

3 I have a Bachelor of Civil Engineer (1st Class Honours) and Masters of Civil Engineering (Distinction) from the University of Canterbury and a PhD in Civil Engineering from the University of British Columbia, Canada, specialising in environmental hydraulics. I have a Diploma in engineering management.

4 I have 17 years of experience in engineering research and consulting spanning the transport, mining, hydropower, land development, urban water infrastructure and river management sectors. I have specialist expertise in hydrology, hydraulics, stormwater, modelling, water quality and sediment transport.

5 I have extensive experience in the stormwater management, streamworks and the water quality assessments for major roading projects and other projects involving large earthworks. Recent projects that I have been involved with include:

5.1 Huntly Section of the Waikato Expressway (SH1) where I was the lead author of the stormwater and streamworks assessment for the scheme assessment report (2011).

5.2 Puhoi to Warkworth (SH1) where I was the peer reviewer of water reports (hydrology, stormwater, water quality and erosion and sediment control (*ESC*)) at the scheme assessment stage (2011).

5.3 Mt William Mine where I was the reviewer for West Coast Regional Council of water quality assessment reports at the pre-lodgement and notification stages (2011).

5.4 Waterview Connection Project (SH20/16) where I was the stormwater team leader, expert witness for stormwater, streamworks and flooding issues, and reviewer of modelling undertaken to assess the effects of sediment on the Waterview Inlet (2008-2010).

5.5 Northern Gateway Toll Road[1] (*NGTR*) (SH1) where I was stormwater team leader and stormwater treatment designer for the 7.5 km motorway. I was onsite for the four years of construction and was involved in technical advice to support the design and operation of ESC systems (2004-2009).

5.6 Manukau Harbour Crossing (SH20) design of stormwater treatment for resource consents (2007-2008).

5.7 Design and construction of the Mangakotukutuku Stream diversion[2] (1.4 km length) for Solid Energy (2005-2006).

5.8 Water management for the mining industry including Rotowaro, Maramarua and Ohai mines for Solid Energy, design and consents for Drury Quarry backfill and stream diversion for Stevensons, and review of consent applications for Holcim cement plants/quarries for Otago Regional Council.

5.9 I am currently undertaking reviews of water aspects (hydrology, stormwater, flooding and ESC) of the MacKays to Peka Peka (SH1) project for the Environmental Protection Agency.

6 I offer the Board my advice based on my extensive experience with water aspects of larger roading and earthworks projects and with the advantage of my overview across all the water assessments in my role as peer reviewer for the NZ Transport Agency (*NZTA*).

7 I am the reviewer of water aspects of the Project for NZTA that were summarised in Assessment of Water Quality Effects Report (Technical Report 15) and Assessment of Hydrology and Stormwater Effects (Technical Report 14). I am the author of Transmission Gully Project – Peer Review of Sediment Yield Aspects (19 December 2011). I was the author or reviewer of four working review reports provided to NZTA during the development of Technical Reports 14 and 15.

8 My evidence is given in support of the NZTA and Porirua City Council (*PCC*) Project components of the Transmission Gully Proposal (together the *TGP* or the *Project*). It does not relate to the Transpower Project.

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1 Winner of Association of Consulting Engineers Innovate Gold award for projects that show excellence in technical skills, interaction with the client and team members and innovation. Winner of IPENZ Arthur Mead Award (Merit) for projects that best exemplify sustainable management of resources and care for and consideration of environmental values.

2 Winner IPENZ Arthur Mead award. Winner of Innovate Silver Award.

9 I am familiar with the area that the Project covers and the streams, Porirua Harbour and topography in the vicinity of the Project. I have visited the site.

10 I have read the Code of Conduct for Expert Witnesses as contained in the Environment Court Consolidated 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 expressed.

SCOPE OF EVIDENCE

11 My evidence will deal with the following:

11.1 Executive summary;

11.2 Background and role;

11.3 Existing sediment yield;

11.4 Construction sediment yield;

11.5 Managing uncertainty and risk; and

11.6 Proposed conditions.

12 My statement of evidence responds to submitters evidence by:

12.1 Dr Basher on behalf of Department of Conservation (*DOC*);

12.2 Mr Handyside on behalf of DOC; and

12.3 Ms Helen Kettles on behalf of DOC.

13 Those witnesses refer to my Peer Review of Sediment Yield Aspects (19 December 2011) and peer reviews of earlier draft documents. In order to present a complete picture, this statement describes my work carried out, but only on sediment yield aspects.

14 Related to that, my statement of evidence also considers the evidence by:

14.1 **Ms Malcolm** (both evidence in chief and rebuttal);

14.2 **Mr Gough** (evidence in chief and rebuttal); and

14.3 **Mr Pathmanathan Brabhaharan** (rebuttal).

15 I have reviewed the conferencing statements relevant to my area of expertise, and comment on these where appropriate.

16 While I have reviewed Dr Hicks Section 42A Report dated January 2012, I have not had sufficient time to thoroughly comment on that report in this evidence. Nor have I had an opportunity, at the time of preparing this statement, to consider the Section 42A Report which I understand is being prepared by Gregor McLean. I understand there will be opportunities for me to comment on these reports either in future evidence or at the hearing itself.

SUMMARY OF EVIDENCE

17 My evidence discusses the sediment yield aspects of Technical Report 15.

18 The revised estimate of construction sediment yield[3] provides a better estimate than that provided in Technical Report 15 because greater detail was considered in the assessment of USLE factors. I consider the revised construction sediment yield to be suitable for the assessment of effects. On the basis that the revised construction sediment yield is higher than the estimates in Technical Report 15, the values used in the assessment of ecological effects are appropriate, subject to consideration by ecologists of the uncertainty and the change of effects in the Kenepuru and Pauatahanui catchments.

19 There remains uncertainty with regard to the estimates of baseline and construction sediment yield estimate. This uncertainty is better understood as a result of the rebuttal evidence of **Ms Malcolm**, which includes statements on the uncertainty, sensitivity, and potential conservatism in the construction sediment yield.

20 This uncertainty is inherent in sediment assessments for construction projects and not different to other roading/earthworks projects and consent applications that I have seen.

21 To manage remaining uncertainty, the focus needs to be on consent conditions that:

21.1 Confirm the basis for the consent application (assumed sediment yield and effects);

21.2 Minimise the uncertainty and risks by applying best practices for ESC; and

[3] SKM (20 January 2012) Revised Analysis attached to Expert Conferencing Joint Report to the Board of Inquiry – Earthworks & Sediment Control Conferencing, 20 January 2011.

21.3 Require monitoring and adaptive management that ensure that specified performance from construction and sediment and erosion practices are achieved.

22 I recommend additional consent conditions to manage the uncertainty and provide confidence to the Board of Inquiry.

BACKGROUND AND ROLE

23 NZTA engaged T&T in 2010 to undertake peer review of SKM and DHI work on water aspects of the Project. These reviews covered the full suite of water assessments that form the basis of Technical Reports 14 and 15. Reviews were undertaken in October 2010 of early assessment reports and then in May 2011 of draft versions of Technical Reports 14 and 15. These peer reviews are listed below as they are at times referred to by other witnesses:

23.1 T&T "Peer review of Draft modelling of sediment in the streams and harbours" (20 October 2010);

23.2 T&T peer review "Transmission Gully – Workstream 12 – Peer Review" (29 October 2010) which reported on review of "Erosion and Sediment Control Philosophy", "Sediment Yield Calculations" and "Construction and Erosion and Sediment Control" reports;

23.3 T&T "Transmission Gully – Peer Review of Water Quality Assessment of Effects" (Draft, 5 May 2011); and

23.4 T&T "Transmission Gully – Peer Review of Hydrology and Stormwater" (Draft, 13 May 2011).

24 In December 2011 NZTA asked me to finalise the peer review of the sediment yield aspects of Technical Report 15. The purpose of the peer review was to provide an independent opinion to NZTA on the specific sediment yield aspects including sediment modelling and sediment retention/ control assumptions. The report gave consideration to the evidence of **Ms Malcolm** and **Mr Gough**, Submitter 43 (Department of Conservation) and the expert caucus statement 7/8 December 2011. This peer review is titled:

24.1 T&T "Transmission Gully Project – Peer Review of Sediment Yield Aspects" (19 December 2011).

25 In anticipation of the need to prepare this evidence I participated in the conferencing of Earthworks & Sediment Control experts on 20 January 2012.

EXISTING SEDIMENT YIELD

USLE method

26 The USLE[4] method was used as the basis for the sediment yield assessment. The method has a number of limitations including that it is not calibrated for New Zealand conditions, it estimates average annual sediment loss rather than events or unusual wet/dry seasons, and is not able to accurately estimate the absolute sediment yield. Its strength is in identifying hotspots for sediment generation and where ESC efforts should be directed.

27 Despite the limitations with the USLE method, it remains the most commonly applied method in New Zealand for assessing the sediment yield and for designing sediment and erosion control systems for engineering/development projects involving earthworks.

28 Dr Basher[5] expresses considerable concerns with the USLE as it does not represent landslides and bank erosion, it was not developed for such steep terrain and it predicts average annual soil loss that then requires temporal downscaling. These points are all valid and I have made similar points in the past (T&T, 29 October 2010). However, by scaling to the SSYE[6] estimate as has been done for the Project, the USLE essentially becomes a SSYE estimate. The perseverance with the underlying USLE model enables the change in sediment estimate due to construction activities to be assessed.

29 I accept Dr Basher's opinion that other sediment generation models, such as GLEAMS, are better than the USLE method, particularly because of their temporal modelling e.g. direct modelling of events or long term simulations. I have made a similar point in the past (T&T, 29 October 2010). Although, it is important to note that other sediment models also have their limitations as is recognised by Dr Basher[7] and Dr Hicks[8] and limits on their suitability for this Project (e.g. GLEAMS requires more detail).

30 **Ms Malcolm**[9] makes the point that the USLE modelling approach is pragmatic and suitable for a construction design that is not fully developed as is the case for the Project. USLE is suited for such an approach, whereas alternative models such as GLEAMS require more detail of the construction methodology and ESC practices.

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4 Universal Soil Loss Equation.

5 Dr Basher evidence in chief paragraphs 7, 29-35.

6 Suspended Sediment Yield Estimator developed by NIWA.

7 Dr Basher evidence in chief, paragraph 60.

8 Dr Hicks Section 42A Report dated Jan 2012 Section 3.4

9 **Ms Malcolm** evidence in chief, paragraph 119.

31 The Project has adopted a broad approach to construction design of defining the maximum working areas, outlining the ESC philosophy and broad plans. Examples of what the erosion and sediment plans might look like are detailed in six separate Site Specific Environmental Management Plans (*SSEMPS*). In general I agree with this approach because it has been my experience with large earthworks projects that detailed environmental management plans and ESC plans change as a result of detailed design and construction methodologies that a contractor brings to the project[10]. I consider that prescribing a detailed construction methodology via the consent process will reduce the ability of the contractor to optimise and innovate to reduce Project cost and improve performance (including that of ESC systems). My agreement to this approach is conditional on the adequacy of the ESC philosophy, assumed treatment efficiencies and the example SSEMPs to set a benchmark for construction and to prove that ESC standards in difficult areas can be achieved.

32 I accept **Ms Malcolm's** point[11] that a lumped model rather than one that resolves all of the processes is suitable. The USLE and SSYE in the way that they are applied are essentially lumped models estimating sediment yield at point (harbours).

33 The caucusing statement of 7/8 December 2011 recognises that the USLE is the best method for estimating the sediment yield from construction for the Project[12][13].

34 It is my opinion that, on balance, the USLE (scaled to the SSYE) sediment model can provide suitable sediment estimates and is adequate for the assessment, provided that specific technical inputs such as USLE factors are correctly applied and reasonable assumptions are made for staging and ESC practices.

Existing sediment yields

35 The simulation of existing sediment yields and transport/distribution was undertaken to provide a context (baseline) for the assessment of construction effects due to sediment.

36 Overall, the modelling provides a suitable estimate of the existing sediment yields and the transport/distribution of sediment in the receiving environments. This is achieved largely by scaling the USLE estimates to be similar to those estimated by the more

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10 **Mr Gough** notes similar experience and cites similar views from **Ms Rickard** and Mr Handyside. Refer to **Mr Gough** rebuttal evidence, paragraph 19.

11 **Ms Malcolm** evidence in chief, paragraph 106.

12 Expert Conferencing Joint Report to the Board of Inquiry – Earthworks & Sediment Control Conferencing, 7&8 December 2011, paragraph 14.

13 Caveats to this statement are made by Dr Basher in his evidence in chief paragraph 71d.

accurate NIWA suspended-sediment yield estimator (SSYE). I have confidence in the estimate of existing sediment yields due to the following key steps in the modelling methodology:

36.1 The sediment yield model based on the USLE model was scaled[14] to the SSYE by adjustment of the sediment delivery ratio (*SDR*). The SSYE is considered to be the best available tool for estimation of suspended sediment for catchments in New Zealand. The caucusing statement of 7/8 December 2011[15] recognised that the SSYE is the best model for providing the baseline sediment estimates.

36.2 The sediment yield model was validated using Healy (1980) observations with reasonable explanations for differences. The limitations of this validation are noted by Dr Basher,[16] and I accept he is correct in noting this.

36.3 The sediment rating curves were created to temporally distribute the sediment to allow for subsequent analysis (event and long-term simulations). These were validated by comparison to observed suspended sediment data for Horokiri, Pauatahanui and Porirua catchments. The caucusing statement of 7/8 December 2011[17] states agreement that the sediment rating curves are a good fit to observed data for the Horokiri and Porirua catchments and appear to overestimate (conservative) for the Pauatahanui catchment. I note Dr Basher's concerns[18] with the methodology and implementation of this step and **Ms Malcolm's** rebuttal[19] of these issues.

36.4 The hydrological models that were used to create the sediment rating curves were also calibrated.

36.5 Stream modelling was undertaken with HEC RAS[20] models using calibrated inflows but with not hydraulic calibration. Observations of natural bed material were relied on for qualitative verification. I note that the sediment yields used

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14 It is more appropriate to describe this process as scaling than calibration as pointed out by Dr Basher (evidence in chief paragraph 71a) as measured data is required for calibration.

15 Expert Conferencing Joint Report to the Board of Inquiry – Earthworks & Sediment Control Conferencing, 7&8 December 2011, paragraph 10.

16 Dr Basher evidence in chief, paragraph 71b.

17 Expert Conferencing Joint Report to the Board of Inquiry – Earthworks & Sediment Control Conferencing, 7&8 December 2011, paragraph 13.

18 Dr Basher evidence in chief, paragraph 51-56.

19 **Ms Malcolm** rebuttal Appendix B.

20 HEC- RAS (Hydrologic Engineering Centers River Analysis System) is a 1-D hydraulic model produced by the United States Army Corps of Engineers.

for the stream modelling are those for the end of streams (at harbours), but believe this to be appropriate[21] as the USLE estimates (scaled to SSYE) do not account for any retention of sediment in streams. The results from the stream modelling are not used for the harbour modelling.

36.6 Harbour modelling undertaken with the DHI MIKE suite of models provide current best practice for the hydrodynamic modelling. The harbour modelling was reviewed by T&T (20 October 2010) and T&T (05 May 2011). The harbour model was reasonably calibrated to field observations (although with some limitations noted, which are considered to be reasonable). Verifications are based on qualitative comparison to observed historical sedimentation.

36.7 The sediment modelling suite (all models) predicts accumulation in the harbours that is comparable to historically observed sedimentation rates with reasonable explanations for differences. . Therefore, the sediment modelling suite provides an adequate simulation of the baseline to enable the effects of the Project to be modelled.

CONSTRUCTION SEDIMENT YIELD

37 The most critical aspect of all the water assessments I have reviewed is the estimation of sediment yields from the construction sites[22]. The addition of sediment from the Project, over and above the existing catchment sediment yields, is the change that causes the greatest potential for effects on the environment. This was agreed in the expert caucusing of 20 January 2012, where "the key issue for all participants of the meeting is the difference between the baseline and construction yield estimates"[23].

38 The process I followed for my peer review of the construction sediment yield and repeat here is to review the suitability of the method, review the underlying assumptions, check the sediment yields are reasonable and comment on the uncertainty. I comment

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21 In my peer review report 19 December 2011, I noted that the sediment estimate used for the stream modelling may be an underestimate due to in stream process. This was used by Dr Basher in his evidence in chief paragraph 71c as support for his view that there was an underestimation of sediment supply to streams. I now recognise that the sediment estimate (USLE based scaled to SSYE) does not account for any sediment retention in the steam because this process is not included in the SSYE, so that the sediment estimate used for the stream assessment is appropriate.

22 T&T Peer Review 29 October 2010 page 3.

23 Expert Conferencing Joint Report to the Board of Inquiry – Earthworks & Sediment Control Conferencing, 20 January 2012, paragraph 7.

on how these issues have been addressed in the USLE Revised Analysis[24] and the revised sediment estimate in that report.

USLE Methodology

39 The suitability of the USLE methodology was covered above. The application of the method is covered here. In Technical Report 15 the USLE was applied broadly for the Project, for example, earthwork areas were based on a 75 m working corridor. In the USLE Revised Analysis the land area and factors were calculated every 10 m, for example the earthworks areas were based on the design widths with allowances for coincidental works to construct stream diversions, access roads and fill sites. The allowance for earthworks to construct the stream diversions was based on 20 m width (**Mark Edwards**, caucus meeting 20 January 2012). The greater detail that was used for the revised sediment estimate results in a better estimate[25].

USLE Assumptions

40 The USLE assumptions and factors have a significant impact on the estimates of average annual sediment yield. Issues identified by the review process are now covered.

41 K factor (soil erodibility) used in the USLE model is based on surface soil types. The caucusing statement of 7/8 December 2011 recognised that the K factor in the construction scenario is conservative because in the construction scenario there is less erodible material[26]. In my peer review I highlighted that some of the earthworks will occur in rock, which would likely reduce the sediment yield estimates. In the USLE Revised Analysis the proportion of the earthworks in rock is accounted for in the K factor. **Mr Brabhaharan** assisted by providing much more detailed information on the rock component of the earthworks material. Overall, 70% of the estimated available cut volume is estimated to be in rock. This significantly reduces the K factor and acts to reduce the revised sediment estimate.

42 LS factor (length slope and steepness factor) has been more accurately assessed in the USLE Revised Analysis based on design cross-sections. There are a couple of limitations on how the LS factor has been applied. The first limitation is that the design cross-section for the finished road was used, whereas in reality there are multiple, different cross-sections that occur during construction. The second limitation is the arithmetic averaging that is used to

[24] USLE Revised Analysis (20 Jan 2012) by SKM attached to Expert Conferencing Joint Report to the Board of Inquiry – Earthworks & Sediment Control Conferencing, 20 January 2012

[25] Expert Conferencing Joint Report to the Board of Inquiry – Earthworks & Sediment Control Conferencing, 20 January 2012, paragraph 8.

[26] Expert Conferencing Joint Report to the Board of Inquiry – Earthworks & Sediment Control Conferencing, 7&8 December 2011, paragraph 17.

determine a LS factor for each 10 m cross-section may skew the LS factor. These simplifications are pragmatic and appropriate for the accuracy of the USLE method. The USLE Revised Analysis report says that the revised LS factors are generally similar to the Technical Report 15 factors, although the revised LS factors have a greater range of variability.

43 C factor (cover) is unchanged in the USLE Revised Analysis with the exception of Ration, which is assumed to only have earthworks for nine months. P factor (erosion control practise) was unchanged in the USLE Revised Analysis.

44 The application of SRE (erosion removal efficiencies) is confused in Technical Report 15 due to inconsistencies and contradictory information. This has been clarified in the USLE Revised Analysis, which says that that Technical Report 15 estimates did not allow for erosion control, but only included sediment removal that was applied to remove 70% in the Q2 and Q10, and 40% of sediment in the Q50.

45 The USLE Revised Analysis accounts for both erosion control and sediment controls. Erosion control is applied by proportioning the earthworks areas as being stabilised, under erosion control or as active earthworks. Sediment control is applied to erosion control and active earthworks areas. The net effectiveness of the erosion control and sediment controls is demonstrated in **Table 1**. The inclusion of erosion control measures acts to decrease the revised sediment estimate.

Table 1: Net effectiveness of erosion and sediment control measures.

			Erosion Control		
			Active Earthworks	Erosion Control	Stabilised
			0% erosion control	75% erosion control	100% erosion control
Sediment Control	Chemical Treatment Ponds 3%	70% Q2 and Q10 removal rate	70%	92.5%	100%
	Other Sediment Devices	30% removal rate	30%	82.5%	100%

46 A SDR factor (sediment delivery ratio) of 0.17 was applied in Technical Report 15 to scale the USLE sediment yield to that predicted by the SSYE. I accept the process of global scaling of the USLE estimate to be similar to the SSYE estimate. However, using the SDR for this scaling is problematic as this global scaling accounts for processes other than "sediment delivery". This becomes a problem for the construction sediment estimate, when a different SDR may be appropriate for the construction areas versus the unchanged areas of the catchment. Ideally a new separate global factor should have been introduced to separate the global scaling of USLE to SSYE to the SDR factor representing sediment delivery "processes". Technical Report 15 describes how very little sediment is retained in the streams, suggesting a high SDR factor would have been appropriate, if separated from the global scaling.

47 Dr Basher[27] is critical of the downscaling using the SDR because the same SDR value is used for construction areas. As a minimum he believes that the modelling should be re-run using a more conservative SDR factor of 0.5 or 0.7 depending on slope steepness[28]. The caucusing statement 7/8 December 2011 recognised that using the same scaling factor that has been applied to the overall catchment to the construction area does not account for the higher connectivity of construction sites to receiving environments[29]. In my peer review[30] I suggested that values lower than 0.5/0.7 would be justified to allow for sediment losses (detention) in streams[31]. I accept that there is little sediment detention in the streams based on evidence to this effect in Technical Report 15 and that values of 0.5/0.7 are appropriate for earthworks areas. Therefore, the Technical Report 15 estimates of sediment yield from construction areas from the SDR assumption alone are likely to be low.

48 Auckland Council[32] suggests for earthworks sites SDR values of 0.5 should be used, increasing to 0.7 for slopes steeper than 10%. The USLE Revised Analysis uses SDR values of 0.5 and 0.7 for steeper catchments. This increase in the SDR factor acts to increase the revised sediment estimate.

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27 Dr Basher evidence in chief paragraph 8-10, 39-50.

28 Dr Basher evidence in chief paragraph 17.

29 Expert Conferencing Joint Report to the Board of Inquiry – Earthworks & Sediment Control Conferencing, 7&8 December 2011, paragraph 15.

30 Dr Fisher peer review of sediment yield aspects, 19 December 2011, Section 3.3.3.

31 This view was challenged by Dr Basher in his evidence in chief, paragraph 71.e.

32 Auckland Council (2011) Module 3 – Erosion and sediment control: Workshops for plan preparers. Prepared by Erosion Management Ltd and Environmental Communications Ltd.

49 The revised sediment estimate that results from the USLE Revised Analysis is lower overall than the Technical Report 15 estimate. While, the higher SDR factors have increased the sediment yields, the lower K factors and inclusion of erosion control measures cause the revised sediment estimate to be lower overall.

50 The total of the Q10 estimates[33] for the revised approach is 27% lower than the Technical Report 15 estimate. For the Kenepuru and to a lesser extent the Pauatahanui the revised sediment estimates are higher, which **Ms Malcolm** addresses in her evidence[34]. On this basis, the assessment of ecological effects that uses the higher Technical Report 15 values is appropriate, subject to consideration of uncertainty and the change of effects in the Kenepuru and Pauatahanui catchments.

Sediment yields

51 The sediment yields from construction areas should ideally be validated against measured sediment data from other locations. However, there is a lack of measured data in the Wellington region and sediment yields do vary widely with different site conditions, which make validation difficult. **Mr Brabhaharan[35]** says that based on his experience in the Wellington region and knowledge of the Project geology that "...the sediment generated from the earthworks associated with TGP, is likely to be significantly less, compared to major earthworks project in Auckland." I make comments below on the use of monitoring during construction to validate the estimated sediment yields.

Uncertainty

52 Uncertainty in the sediment estimates was identified in my peer review. In his evidence Dr Basher considers this uncertainty to be a major issue. The caucusing statement of 20 January 2012 recognises that the revised sediment estimate provides a better estimation and a reduced uncertainty in the USLE parameters[36]. However, uncertainty remains, which is inherent in the methods used and more generally in sediment science.

53 I consider that the uncertainty in the sediment modelling suite detailed in Technical Report 15 occurs in a number of areas:

53.1 SSYE baseline

53.2 USLE method and factors

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33 **Ms Malcolm** rebuttal evidence, Table 1.

34 **Ms Malcolm** rebuttal evidence, paragraphs 21 and 25.

35 **Mr Brabhaharan** rebuttal evidence paragraph 9.5.

36 Expert Conferencing Joint Report to the Board of Inquiry – Earthworks & Sediment Control Conferencing, 20 January 2012, paragraph 8.

53.3 Construction methodologies and ESC effectiveness

53.4 Transformation of sediment yields to harbour and stream models

53.5 Assessment models (HEC RAS stream models and MIKE21 harbour model).

54 **Ms Malcolm** addresses the uncertainty in her rebuttal evidence[37]. More data would help to confirm the SSYE baseline and I recommend that this should be done prior to construction. However, the uncertainty would still remain in many components of the construction sediment estimate. I comment further on managing this uncertainty in the following section.

MANAGING UNCERTAINTY AND RISK

55 All the sediment experts recognise the uncertainty with the construction sediment estimates based on the USLE method. I consider that there is uncertainty in the assessment and risk of poor performance during project delivery and I treat these separately.

56 As a general comment the focus needs to be on management (of mitigation measures), monitoring and responses to manage/reduce the uncertainty. These need to be captured in consent conditions. I agree with Dr Basher that if the applications for construction of TGP were to be granted then conditions for ESC would need to be very stringent and monitoring of performance, reporting and potential for reviewing management approaches swiftly and comprehensively[38].

Uncertainty in the assessment

57 Uncertainty is inherent in the estimation of sediment yields in general and more so for construction sites. This uncertainty is common to all similar projects and consent applications. A precautionary approach is required for the Project given the scale of the earthworks and the sensitivity of the receiving environments. However, the Project has gone as far as any project that I have been involved with to quantify the sediment loads and the uncertainty associated with these. There is not much more that can be done using the methods that SKM have employed for Technical Assessment 15 and the additional work detailed in the Revised USLE Analysis and uncertainty/sensitivity assessments in the rebuttal evidence of **Ms Malcolm**. The risk that the sediment yields and effects are different to those that have been assessed can be managed by the conditions of consent that have been proposed and with additional consideration of the conditions that I propose in my evidence.

37 **Ms Malcolm** rebuttal evidence, Appendices A and B.

38 Dr Basher evidence in chief, paragraph 17.

58 I would recommend pre-construction monitoring of sediment in the key streams affected by the construction of the Project to confirm the existing sediment loads and the baseline environmental conditions. Dr Basher[39] agrees with this approach and says that the checks should be in relation to the sediment rating curves as this is all that can be checked. The checks should be to ascertain whether the sediment rating curves are in the right "ball park" and should focus on the catchments for which sediment rating curves were derived without the benefit of local field measured data.

59 Concern has been expressed by myself and Mr Handyside during caucusing about the ability of sediment ponds to remove 70% of sediment during the Q10 event. I note **Mr Gough's** replies to this issue[40]. While there is sufficient evidence in Moores and Pattison (2008) and the general literature to support the 70% pond removal efficiencies for normal events used for the SRE, there is no data to quantify the removal efficiencies for extreme events.

60 On this basis, the sediment estimates for the 10 year return period events and higher have greater uncertainty and may be higher than estimated. If this is an area of uncertainty then the consequence of this should be understood, which is the point of **Ms Malcolm's** sensitivity assessment[41]. The adaptive management approach and performance monitoring as described below are the best and only course of action to manage the uncertainty regarding this issue of pond performance.

61 **Mr Gough** advises that the sediment control efficiencies of sediment control devices other than ponds (e.g. super silt fence, biosock and decanting earth bunds) will have removal efficiencies that are greater than the 30% than has been assumed in the USLE Revised Analysis. Therefore, the revised sediment estimate may be conservative in this area, although this only affects 5-20% of the Project by area[42].

62 The Project proposes extensive monitoring of ESC systems. These are detailed in Appendix 15.L of Technical Report 15 (which is also attached to the draft[43] Construction Environmental Management Plan in volume 5 of the application documents). The proposed monitoring includes inspections of erosion control, surface water control and sediment control, which are standard practices. The Project also proposes performance monitoring of sediment control

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39 Dr Basher evidence in chief, paragraph 71f.

40 **Mr Gough** rebuttal evidence, paragraph 25.

41 **Ms Malcolm** rebuttal evidence, Appendix A.

42 USLE Revised Analysis (20 January 2011), Table 11.

43 The consent conditions require draft plans to be updated and finalised.

devices and at catchment control points, which are significant additional measures that I have not seen on a project before.

63 The performance monitoring measures are part of an adaptive management approach that the Project proposes[44]. But these have the secondary benefit of confirming the assumptions in the assessment of effects. Should the measured sediment yield be greater than that assumed in the assessment of effects, then measures would need to be implemented to assess the actual effect or to reduce the sediment yield. Such measures to reduce the sediment yield could include more stringent ESCs including improvements to the sediment pond designs (larger or changes to chemical systems) or provisions for reduced earthworks area.

64 To respond to concerns raised by Dr Basher and Mr Handyside, I understand the NZTA and PCC propose that a Sediment Management Peer Review Panel be established using independent professionals to support NZTA and the Greater Wellington Regional Council in the management of ESC practices. A role of this panel would be to review pre-construction monitoring and construction performance monitoring. I have seen such panels successfully operate in respect of mining operations (where water quality was also a critical issue) and would support this proposal. I understand that **Ms Rickard** will draft and circulate consent conditions for consideration as part of the upcoming combined planner and sediment engineering conferencing session. I have provided some thoughts to Ms Rickard on the drafting of this.

65 There was concern expressed during caucusing of 20th January 2012 that the sediment generation from stream diversions is not well quantified. More information is available on the stream diversions in the report Diversion Staging Physical Design Parameters & Adaptive Management that is appended to the Ecological Management and Monitoring Plan.

66 **Ms Malcolm** addresses the issues of sediment generation from stream diversions in her rebuttal evidence[45]. I agree with her that the earthworks activities associated with the stream diversion are included in the revised sediment estimate. I agree with her that the sediment generated from the stream works within wetted stream channels cannot be estimated using the USLE method and I know of no reliable method to estimate the sediment from this source.

67 I consider that the sediment generation from stream works within wetted stream channels to be relatively minor (compared to Project earthworks activities), provided that the new stream channel is

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[44] Refer to the Ecological Management and Monitoring Plan page 35 for the principles of the adaptive management approach.

[45] **Ms Malcolm** rebuttal evidence, Appendix B.

properly stabilised and the diversion of the stream into the new stream channel is quickly and carefully orchestrated. My view is based on my experience with stream diversions made for the Mangakotukutuku Stream diversion and for temporary diversions to allow for the construction of culverts on the NGTR. In the case of the Mangakotukutuku Stream diversion some suspended sediment was added to the stream water due to earthworks to open the upstream end of the diversion and from dust washed out of the rocky substrate forming the bed of the new stream channel. This suspended sediment discharge was relatively minor and equivalent to the sediment concentrations experienced during high flows in the stream, but it occurred for a much shorter duration (less than one hour).

68 I have reviewed the proposed consent conditions that cover the physical quality, sediment management and implementation of streamworks including G.15(A), G.15(D), WS.1, WS.2, WS.3 and WS.4. Based on my experience drafting the streamworks consent conditions for the Waterview Connection project, I believe that the consent conditions controlling streamworks should be more explicit in a number of areas:

68.1 Inclusion of stream diversion plans in the requirements of the SSEMPs, which is implied by the content of the example SSEMPs but the inclusion of this as a consent condition removes all doubt.

68.2 Inspection of the stream diversion by appropriately qualified and experienced engineer and ecologist to certify that the streamworks have been undertaken in accordance with the drawings and plans within three months of completion of the streamworks.

69 **Ms Malcolm**[46] in her sensitivity assessments demonstrates the importance of erosion and sediment control measures working together. In her Scenario 1 the lower performance of sediment controls (e.g. ponds and other devices) is offset by accounting for deployment of erosion control measures when heavy rain is forecast. The effectiveness of additional erosion control measures deployed on the basis of forecast rain was not considered in the Technical Report 15 estimates, or in the revised sediment estimate. Therefore, the sediment yields are conservative in this regard. This approach is a requirement of consent condition E.3(j), which requires that all practicable erosion and sediment control measures are put in place if a stabilisation trigger event[47] is forecast.

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[46] **Ms Malcolm** rebuttal evidence, Appendix A.

[47] The stabilisation trigger event is described in **Mr Martell's** rebuttal paragraphs 21-25.

Risks during construction

70 There is also uncertainty that comes from the implementation of ESC practices. Whilst these are uncertainties, I note that managing these aspects on construction sites is increasingly standard practice.

71 The risks are greater for the Project due to the difficult terrain and sensitive receiving environments. However the proposed consent conditions, including an adaptive management approach based on the proposed performance monitoring, provide strong measures to manage this risk.

72 A specific measure to reduce the risk during heavy rainfall is the deployment of erosion control measures in anticipation of a storm (as mentioned previously in paragraph 69).Requirements for these actions are included in the proposed consent conditions. This approach will partially mitigates the risk of poorer pond performance during extreme events.

73 Uncertainty has been created in the consent application by the lack of ESC detail to support the ESC aspects of the Site Specific Environmental Management Plans. This concern was expressed with regard to Te Puka by Mr Handyside[48] and reiterated by him in caucusing[49][50]. I have recommended to NZTA that additional work is done in this area to report back to conferencing of Earthworks & Sediment Control experts. I believe that extra detail will provide confidence on the practicalities of construction of some of the works e.g. Te Puka stream diversions and provide greater confidence in the assessment of construction sediment load.

74 The adaptive management approach supported by monitoring (both inspection and performance monitoring) provides mechanisms for feedback and continuous improvement of ESC to ensure that they met the performance standards set by condition E.3A. The addition of a Peer Review Panel into the adaptive management framework will provide additional robustness to this process.

75 The greatest risk of excess sediment comes from poor onsite practices, which the controls that are proposed for the Project are designed to prevent. A second risk is from failure of ESC devices that work well for normal conditions, but are unable to cope with extreme events (up to and beyond the design events). This risk increases for steep terrain and for larger sites (as getting the detail right everywhere over a wider area requires extra diligence and vigilance).

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48 Mr Handyside evidence in chief, paragraph 42.

49 Expert Conferencing Joint Report to the Board of Inquiry – Earthworks & Sediment Control Conferencing, 7&8 December 2011, paragraph 20.

50 Expert Conferencing Joint Report to the Board of Inquiry – Earthworks & Sediment Control Conferencing, 20 January 2012, paragraph 12.

76 My experience from the NGTR in similarly steep terrain with 4 million m^3 of earthwork is worth considering. The NGTR is considered to be a case study for good ESC practice, but there were still failures of devices, although without any environmental consequences. Such failures were due to small construction details being wrong, which are only exposed in extreme weather and that can result in a cascading of consequences. For example, a diversion channel overtops due to a low point in the bank or it breaches, which adds more catchment and flow to a pond (over and above what it was designed for) causing flow over the spillway to exceed design flows, and partial washout of the spillway. Careful checking and implementation of ESC practices is required. Consideration of the performance of ESC devices for what could go wrong may lead to better, more robust ESC practices.

77 Inclusion in ESC plans of risk assessments and with consideration of the specific risks to the receiving environment and what could go wrong with ESC systems would add rigor to the ESC planning. It is recommended that risk assessments be included as a requirement of condition E.5.

78 Independent checking of ESC practices is considered to be good practice for earthworks sites. Frequent inspections are necessary, but if these are undertaken by the same individuals, then their benefit may diminish. Periodic review of the ESC practices by independent professionals (with fresh eyes) can identify issues and/or offer alternative approaches. It is recommended that this independent checking role be undertaken by the Sediment Management Peer Review Panel.

79 Education and performance incentives to contractors for good ESC practice also can make a difference. I note and support the condition G.12(A) that **Ms Rickard** has included for training of contracting staff on construction and maintenance of ESC devices and in the details of stream diversions. An example of performance incentives is the construction of the NGTR where a key result area was based on performance scoring by the Auckland Regional Council during its weekly walkovers of the site to inspect the ESC systems. Good performance in this key result area was linked to performance bonuses for the alliance that delivered the project. The use of performance measurements linked to incentives for the NGTR helped to drive the excellent performance of the erosion and sediment systems.

CONSENT CONDITIONS

80 I understand **Ms Rickard** is coordinating revisions to consent conditions for discussion with the Earthworks and Erosion Control Expert Caucusing group. With regard to the conditions of consent

that are appended to her rebuttal evidence I wish to make the following points (some carried down from my evidence above):

81 I recommend before construction that additional baseline monitoring of sediment in the key streams affected by the construction of the Project be carried out to confirm the existing sediment loads and the baseline environmental conditions for performance monitoring control stations.

82 I recommend monitoring of sediment removal efficiencies and sediment discharged to streams at control locations is required to be undertaken to validate the Project assumptions and predicted construction sediment yields. This is already a requirement of the ESC monitoring plan (15L) and is partly covered by conditions G.15(A).b.v and E.14 to E.16, but the differences should be reviewed and reconciled if important.

83 I recommend a Sediment Management Peer Review Panel be established using independent professionals to support NZTA and the Greater Wellington Regional Council in the management of ESC practices. This is considered to be beneficial due to the large amount of monitoring to be undertaken and application of the adaptive management approach, which may at times require independent, expert advice.

84 I support area limits on active earthworks, but recommend that these be changeable based on performance monitoring. This could be achieved by including them in the ESC plans. The changes to these would require review and recommendation from the Sediment Management Peer Review Panel and approved by Council Manager.

85 I support the proposed adaptive management approach (consent condition E.3(l)), but believe that more clarity is required on how this process will work.

86 I recommend inclusion in ESC plans of risk assessments requiring a change to condition E.5.

87 I recommend that consent condition E.19(c) include the specific requirement for bench testing using the proposed flocculants, which I understand to be the intention of the condition but this would make it clearer and avoid doubt.

88 I recommend that the definition for the stabilisation trigger event (e.g. mm of rainfall in a specific period) be defined in the conditions of consent.

89 I believe that the consent conditions controlling streamworks should be more explicit in a number of areas;

89.1 Inclusion of stream diversion plans in the requirements of the SSEMPs, which is implied by the content of the example SSEMPs but the inclusion of this as a consent condition removes all doubt.

89.2 Inspection of the stream diversion by appropriately qualified and experienced engineer and ecologist to certify that the streamworks have been undertaken in accordance with the drawings and plans within three months of completion of the streamworks.

EVIDENCE OF SUBMITTERS

Dr Basher

90 Dr Basher says that lack of data is a major constraint to accurate estimation of sediment yields and he was surprised that more effort was not made to obtain better measurements of current sediment yield[51]. I agree that more data is always better. However, it is my experience of major roading projects in NZ that the water quality monitoring programme that was undertaken to support this consent application is similar or exceeds that of other projects that I have worked on.

91 I have recommended before construction that additional baseline monitoring of sediment in the key streams be undertaken, which Dr Basher agrees with. I have also highlighted the monitoring proposed in Appendix L of Technical Report 15 for sediment removal efficiencies and sediment discharged to streams at control locations. These monitoring activities will validate the Project assumptions and inform the proposed adaptive management approach.

92 Dr Basher has made several comments[52] on my peer review and these have been addressed previously in my evidence.

Ms Kettles

93 Ms Kettles refers to my peer review and issues raised that relate to a potential underestimation of sediment entering the harbour[53]. This issue was the choice of the SDR factor, which has been addressed with the revised sediment estimate.

Timothy Simon Richmond Fisher
27 January 2012

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[51] Dr Basher evidence in chief paragraph 6 and 12

[52] Dr Basher evidence in chief, paragraphs 71a, 71b, 71c, 71d, 71e and 71f.

[53] Ms Kettles evidence in chief, paragraph 13f.