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 evidence of Michelle Kathleen Malcolm (Water Quality) for the NZ Transport Agency and Porirua City Council

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Dated: 22 November 2011

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STATEMENT OF EVIDENCE OF MICHELLE KATHLEEN MALCOLM FOR THE NZ TRANSPORT AGENCY AND PORIRUA CITY COUNCIL

QUALIFICATIONS AND EXPERIENCE

1 My full name is Michelle Kathleen Malcolm.

2 I am a Senior Environmental Consultant at Sinclair Knight Merz (*SKM*). I have a BSc with Honours in Physical Geography from Victoria University of Wellington. I am a Certified Environmental Practitioner with the Environment Institute of Australia and New Zealand.

3 I have 15 years experience working in urban catchment management, stormwater treatment, water quality effects assessments and flood risk assessment. My involvement in these areas spans policy, modelling, design and monitoring.

4 I have specialist expertise in stormwater management and water quality effects assessments, which are key aspects of the Transmission Gully Project. Recent projects I have been involved in include:

4.1 Kapiti Coast Stormwater Discharge Consents Monitoring. I developed a water quality monitoring programme for 18 catchments within the Kapiti Coast District, and assisted that Council to obtain resource consents for all of its stormwater discharges to both freshwater and marine receiving environments. I am also involved in the ongoing management of these consents. My work includes routine monitoring, the development of water quality investigations and the design of water quality mitigation projects. Recently, I have been involved in the design of a retrofit wetland, to treat runoff from an existing industrial catchment.

4.2 SH20 - Manukau Extension. I was the Project Manager for the hydraulic aspects of the motorway design. I was involved in the development of 1D models (using the model MIKE 11) of the Puhinui stream. These models were used to estimate flood levels and velocities for the Stream, which were then used to design the motorway bridge and culvert crossings of the Stream. I was also the internal technical peer reviewer of the design of the stormwater management ponds to treat the operational stormwater discharges, to meet the water quality standards.

4.3 Review of Development Impacts on Stormwater. I undertook an assessment of the vulnerability of Kapiti Coast District Council's proposed urban intensification areas to surface

water and groundwater flooding, as well as the adverse hydraulic and water quality effects this urban intensification could have on the existing stormwater networks and streams. I identified options for each of the urban intensification nodes to mitigate the adverse effects of development.

4.4 North Shore City Council Bioretention Guidelines. I developed guidelines for the design, construction and maintenance of bioretention stormwater devices for North Shore City Council. Bioretention devices are used to improve water quality and manage the changes in hydrological effects associated with increased impervious areas. These were adopted by the Council and are widely used throughout the Northshore.

4.5 I have undertaken assessments of environmental effects for a number of resource consents for the discharge of stormwater from industrial premises, including Higgins concrete batching plant in Ngauranga, Wairoa Lumber processing and Blacktop Construction in Manukau.

5 On 15 August 2011 the NZ Transport Agency (*NZTA*), Porirua City Council (*PCC*) and Transpower NZ Limited (*Transpower*) lodged Notices of Requirement (*NoRs*) and applications for resource consent with the Environmental Protection Authority (*EPA*) in relation to the Transmission Gully Proposal (*the Proposal*).

6 The Proposal comprises three individual projects, being:

6.1 The 'NZTA Project', which refers to the construction, operation and maintenance of the Main Alignment and the Kenepuru Link Road by the NZTA;

6.2 The 'PCC Project' which refers to the construction, operation and maintenance of the Porirua Link Roads by PCC;[1] and

6.3 The 'Transpower Project' which refers to the relocation of parts of the PKK-TKR A 110kV electricity transmission line between MacKays Crossing and Pauatahanui Substation by Transpower.

7 My evidence is given in support of the NZTA and PCC Projects (together the *TGP* or the *Project*). It does not relate to the Transpower Project.

8 I am familiar with the area that the Project covers and the State highway and local roading network in the vicinity of the Project. I

[1] The Porirua Link Roads are the Whitby Link Road and the Waitangirua Link Road.

have visited the site for a drive-over of the whole alignment and have also visited stream monitoring sites at locations near the road alignment. I am also familiar with the wider hydrological environment in the surrounding region.

9 I am the co-author and lead reviewer of the Transmission Gully Assessment of Water Quality Effects Report (Technical Report 15) which formed part of the Assessment of Environmental Effects (*AEE*) lodged in support of the Project.

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 Background and role;

11.2 Existing water quality;

11.3 Effects of the Project's construction on water quality;

11.4 Effects of the Project's operation on water quality;

11.5 Recommended mitigation;

11.6 Response to submissions;

11.7 Conclusions.

SUMMARY OF EVIDENCE

12 My evidence discusses the water quality effects associated with the Project's construction and operation on the nine receiving streams, Porirua Harbour and the Kapiti Coast.

Construction

13 The increase in total suspended sediment (*TSS*) that is predicted to occur in all catchments during rainfall events may result in a small temporary decrease in visual clarity and a noticeable change in colour in affected streams and the Porirua Harbour, but I would not expect this to persist beyond storm events.

14 While the TSS is expected to increase, the overall contaminant concentration is not expected to alter; therefore I would expect no change or a small change in scums, foams, oil, grease, odour, stock drinking water quality, biological growths and bathing water quality.

15 During construction, additional deposition of sediment on stream beds is predicted to occur in all streams. This additional sediment is predicted to accumulate at shallow depths. This additional sediment deposition is not expected to be sufficient to alter the stream channels' characteristics or the ability of streams to convey flows.

16 With respect to Porirua Harbour, the sediment transport and deposition model of the Porirua Harbour indicates that there will be little impact on sediment deposition patterns in a 2 year Annual Recurrence Interval (*ARI*) rainfall event.

17 In most of the wind and rainfall scenarios modelled to estimate the effects on sedimentation patterns during a 10 year ARI event, much of the additional sediment was deposited in the deeper central basins of the Harbour in areas already experiencing high levels of deposition. However, two of the modelled events had a greater impact on the more ecologically vulnerable intertidal zone, as discussed in **Dr De Luca's** evidence.

18 The long term model results of the Porirua Harbour indicated that, after 20 years from the start of construction of the Project, there would be almost no detectable increase in sedimentation rates in the Onepoto Arm of the Harbour and only an average increase of between 0.1 and 0.2mm/yr in the Pauatahanui Inlet, as a result of the Project.

19 In the very long term (i.e. 20 years plus), the mitigation planting that is proposed as part of the Transmission Gully Project will have a small potentially positive benefit by slightly slowing the rate of Porirua Harbour infilling. In time this will compensate for the increase in sediment generated during the construction period.

Operation

20 During the Project's operation, my analysis indicates that the proposed stormwater treatment devices will be effective in removing contaminants.

21 The increases in contaminant loads in streams and the Pauatahanui Inlet are only expected to result in very small changes in water quality, with no change or only a small increase in scums, foams, oil, grease, visual clarity, colour, objectionable odour, stock drinking water, biological growths and bathing water quality.

22 The predicted change in traffic is likely to result in a slight decrease in the contaminant loads being discharged to the Onepoto Arm of

the Porirua Harbour and to the Kapiti Coast. Therefore, I would expect either no change or a slight positive effect in these areas resulting from the ongoing operation of the Project.

BACKGROUND AND ROLE

23 NZTA engaged SKM in 2009 to assess the water quality effects of the Project. I am the co-ordinator of this technical work.

24 I have been actively involved with the assessment of water quality effects of the Project. My involvement included the initial scoping phase and development of Project methodology, through to modelling, analysis and effects assessment. I have attended Project workshops, and site visits.

25 I coordinated the technical work undertaken to assess the water quality effects, drawing together expertise from various specialists within SKM, in the areas of water quality monitoring, erosion modelling, hydrological modelling, river modelling, and coastal modelling.

26 As noted above, I am the lead reviewer and co-author of Technical Report 15. That report summarises all the technical work that was undertaken as part of the assessment of water quality effects.

Links to other evidence

27 My evidence should be considered together with the evidence of **Mr Edwards, Mr Martell, Mr Gough, Mr Kelly, Mr Roberts, Dr Sim, Dr Keesing** and **Dr De Luca.**

28 My assessment has relied on the outputs of **Mr Edwards'** construction approach, **Mr Martell's** hydrological modelling and operational stormwater management performance assumptions, and **Mr Gough's** erosion and sediment control performance assumptions. I have also relied on the traffic modelling reported by **Mr Kelly**. My work has inputs into the harbour modelling discussed in **Mr Robert's** evidence and the statistical analysis discussed in **Dr Sim's** evidence. The ecological assessment of effects on freshwater has been undertaken by **Dr Keesing** and relies in part on my modelling and analysis. The ecological analysis of effects on coastal areas has been undertaken by **Dr De Luca** and relies in part on my analysis of the Harbour modelling discussed by **Mr Roberts.**

29 **Figure 1** illustrates the relationship of the analysis and evidence for assessing the water quality effects during the construction phase. **Figure 2** illustrates the relationship of the analysis and evidence for assessing the water quality effects during the operational phase.

30 The unit hydrograph hydrological modelling generated storm peak flows and volumes for various return period events. This work was

used for the development of the sediment rating curve and provided stream flows for the hydraulic modelling of streams and the Porirua Harbour. The methodology of this work is discussed in Section 4 of Technical Report 14: Assessment of Hydrology and Stormwater Effects, and is presented in **Mr Martell's** evidence.

31 The design and effectiveness of the proposed erosion and sediment control devices to mitigate the effects of stormwater discharges during the construction phase provided my assessment with a set of performance assumptions for these devices that I used in the sediment yield modelling. This work is discussed in Section 9 of Technical Report 15, and is further defined in the SSEMPs and in the Construction Environmental Management Plan, Erosion and Sediment Control Plan, the Chemical Treatment Plan and the proposed consent conditions. This work is presented in **Mr Gough's** evidence.

32 The design and effectiveness of the proposed operational stormwater management devices provided my assessment with a set of performance assumptions which I used for contaminant modelling. This work, is discussed in Section 15 of Technical Report 15, and presented in **Mr Martell's** evidence.

33 Mitigation planting assumptions used to predict the effect of planting on long term sediment yield were based on the work undertaken by Boffa Miskell, and discussed in section 10 of Technical Report 11. This work is presented in **Mr Fuller's** evidence.

34 Technical details about the development of the Porirua Harbour model, to supplement the discussion of Harbour modelling methodology and results provided in my evidence, is presented in **Mr Robert's** evidence.

35 The results of the water quality characterisation analysis, the sediment yield modelling, the stream sediment transport modelling and the Porirua Harbour sediment transport modelling have been used to inform the assessment of ecological effects. These effects will be discussed in the evidence of **Dr Keesing** (freshwater ecology) and **Dr De Luca** (marine ecology).

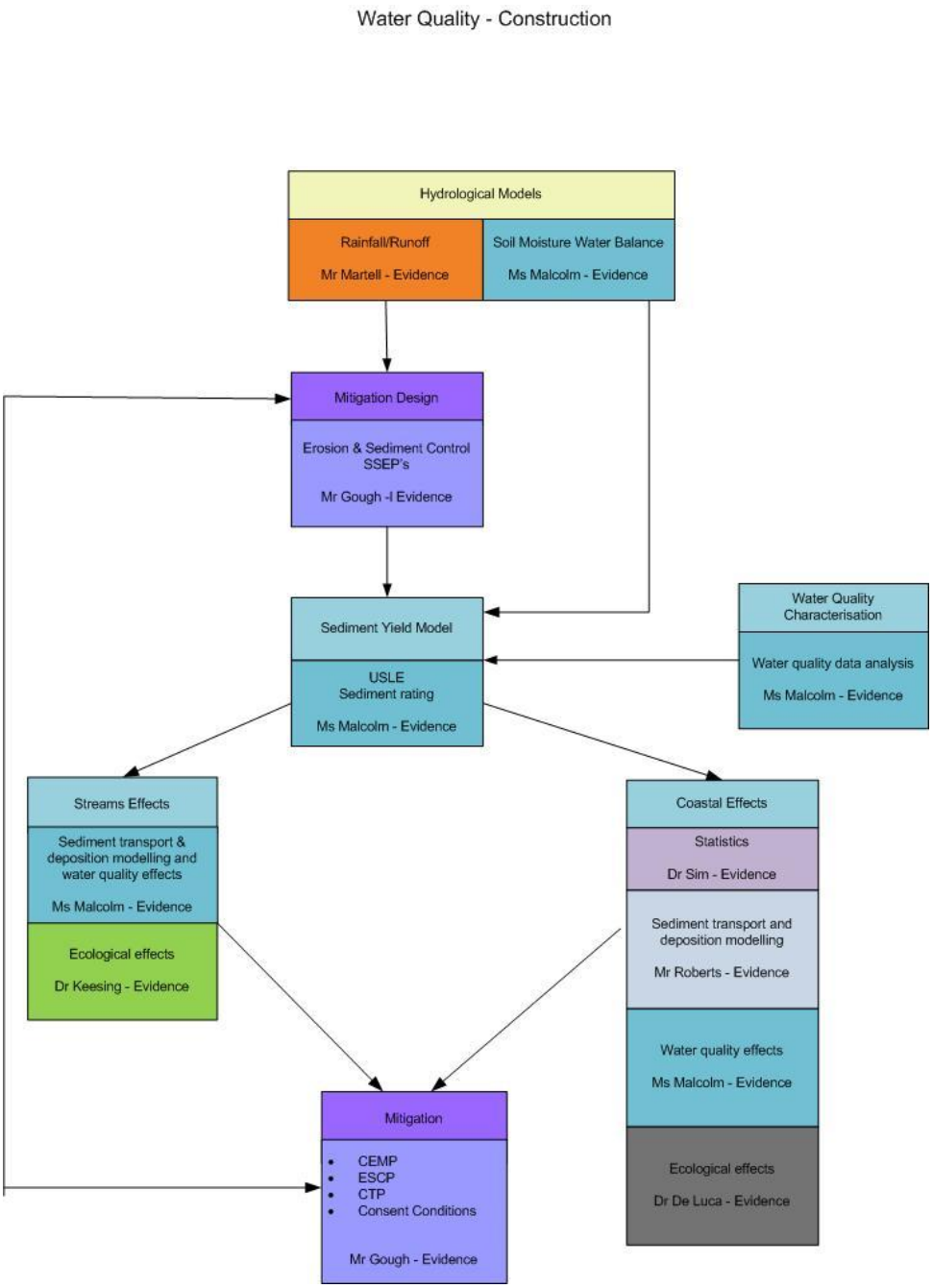

Figure 1: Relationship between the models and data sets used to assess the water quality effects of the Transmission Gully Project from construction.

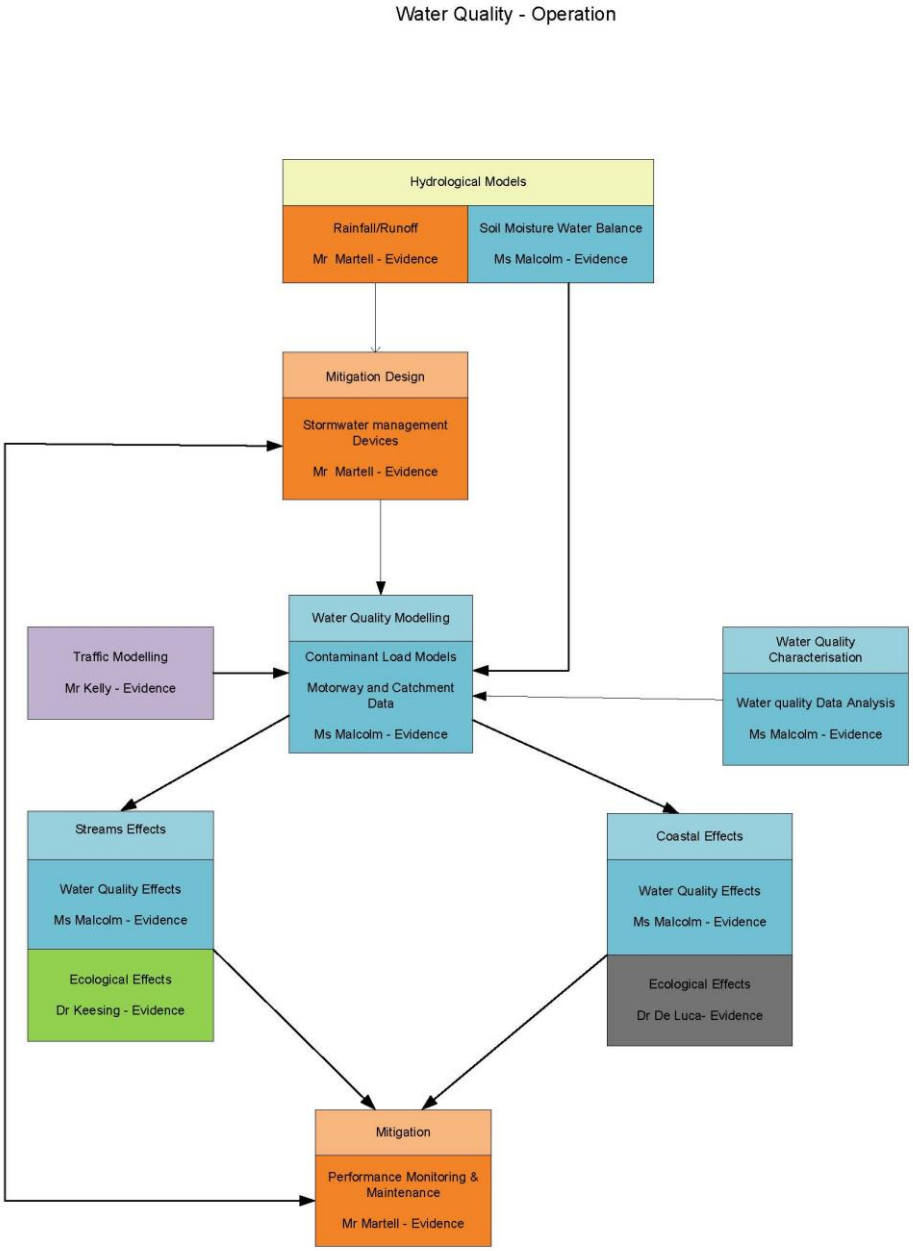

Figure 2: Relationship between the models and data sets used to assess the water quality effects of the Transmission Gully Project from operation.

EXISTING WATER QUALITY – THE RECEIVING ENVIRONMENT

36 Existing water quality was determined using monitoring undertaken at streams during dry and wet weather. This included visual observations, and sampling for heavy metals, nutrients, TSS, turbidity and hydrocarbons. Additional grab and automatic sample testing for TSS and turbidity were taken in larger rainfall events. Automatic turbidity loggers were installed in four locations for one year. Assessment of fine particle sediment deposition on stream beds and substrate was also undertaken.

37 The water quality of streams could be considered typical of streams with similar land use, with the rural streams and upper portions of all streams more impacted by nutrients and the lower sections and more urban streams impacted by metals.

38 Monitoring showed that:

38.1 Existing water quality in the streams within Project catchments is impacted by nutrients, including both nitrogen and phosphorus constituents, with most sites exceeding ANZECC[2] ecological trigger levels. Biological growths occur in some locations in low flow conditions, and are likely to be related to existing nutrient levels. Objectionable odour was not detected at sampling sites.

38.2 Some of the lower reaches of streams, such as Porirua, Kenepuru, Duck, Ration and Horokiri have levels of metals which on occasions exceeded ecological trigger levels. The upper reaches of streams and the more rural streams tend to have levels of metals that are below the ANZECC ecological trigger levels. Poly-aromatic hydrocarbons were not identified at any site at levels which exceed the ANZECC ecological trigger levels.

38.3 The streams generally meet the ANZECC standard for livestock drinking water purposes.

38.4 The streams generally have good clarity in dry weather and small rainfall events, with the exception of the lower reaches of the Porirua, Kenepuru and Pauatahanui Streams. In all streams there was an absence of oil, grease and floatable material. Scums and foams were present at some sites.

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[2] Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000.

38.5 The Wainui/Te Puka Stream, which is the only stream that is managed for fishery purposes, meets the ANZECC standard for fishery and fish for human consumption purposes.

38.6 With the exception of the Ration and Collins Streams, the streams have predominately gravel beds. Most streams have a low percentage of fine sediment. Higher percentages of superficial fines were measured in the Ration and Porirua streams. This helps us understand the sediment transport regime active in the streams under the existing land use conditions.

CONSTRUCTION EFFECTS ON WATER QUALITY

39 This section of my evidence discusses the actual and potential effects of constructing the Project on water quality, including the sediment load discharged in rainfall runoff to streams, and the associated transportation and deposition of increased sediment loads into streams and the coastal environment.

Sediment yield

40 The Universal Soil Loss Equation (*USLE*) was used to estimate the baseline average annual sediment loss for all catchments that drain to Porirua Harbour and for the Wainui/Te Puka and Whareroa catchments. The estimated average annual sediment loss was compared to the NIWA suspended-sediment yield estimator tool and the ratio between the models was used to calculate the sediment delivery ratio, which was then applied to the USLE calculation, providing an estimate of sediment yield in each catchment.

41 Sediment rating curves to calculate event sediment yield from peak flow, were developed using the calculated average annual sediment yield and 50 years of simulated daily peak flow data, developed using the SMWBM[3] calculation of daily average flow and the flow gauge records on the Porirua, Pauatahanui and Horokiri streams. The sediment rating curve was applied to 20 years of simulated daily flow data, and a long term harbour model simulation was undertaken, this modelling indicated that the sediment accumulation predicted by the model was consistent with sediment accumulation measured in the harbour. The harbour modelling is discussed in **Mr Roberts'** evidence.

42 The rating curves were also validated with observed data (turbidity, total suspended sediment and flow).

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[3] Soil moisture water balance model.

43 The sediment yield model was then adjusted to reflect the construction staging scenario and the proposed mitigation design.[4]

Using design to manage construction effects

44 For the assessment of effects in the streams, the construction staging scenario assumed the peak year for construction in each stream. For the harbour, the construction staging scenario assumed 37.5ha of open earthworks in the Pauatahanui Inlet watershed and 17.5ha open in Onepoto Arm watershed.

45 The erosion control measures were assumed to remove 75% of sediment on an average annual basis.

46 The chemically treated ponds were assumed to remove 70% of sediment in the 2 year and 10 year ARI events and to remove 40% of sediment in the 50 year ARI event.

47 The design of devices and the basis for the performance assumptions are described in **Mr Gough's** evidence.

Stream sediment transport modelling results

48 The predicted quantity of sediment input into the streams during various rainfall events was modelled, so as to locate and quantify sediment built up in streams during events. For the harbour modelling, all sediment was assumed to reach the coast; this reflects the long term transport of sediment through the streams and into the Porirua Harbour and coastal area. [5]

49 In order to assess the effect of the Project construction in isolation, the ability to transport material from the channel bed was removed from the model as a variable. Bed load is often estimated as 5-15% of the total sediment load.[6] As the bed transport function of the model was not enabled, the modelling results describe relative change in fine sediment deposition, rather than absolute sediment transport and deposition.

50 The modelling accounted for the 1/3 of the 2 year (90th percentile storm), 2 year, 10 year and the 50 year ARI storms. These storms were chosen because they reflect a range of events from small events that are almost certain to occur during the construction programme through to a large event that could occur but is unlikely.

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4 See Figure 15.46 in Technical Report 15.

5 Sediment transport was modelled in HEC-RAS 4.1.0. The hydraulic models contain geometry and flow information and were calibrated with rainfall and flow records. The hydraulic models were coupled to a 1D sediment transport model.

6 US Army Corps of Engineers (USACE) 1990: Environmental engineering for flood control Channels. EM 1110-2-1205. Washington, D.C.

51 The increases in TSS in the 1/3 of the 2 year and 10 year ARI events range from an increase of 2% in the Pauatahanui and the Porirua catchments to an increase of 79% in the Collins catchment. The percentage increase is related to the proportion of the catchment that will be in construction, and to the background TSS levels which currently exist. In the 50 year ARI the percentage increase is larger due to an assumed lower performance of erosion and sediment control devices. The increase ranges from 4% in the Porirua catchment to 158% in the Collins catchment.

52 The hydraulic modelling of the streams indicated that there was an increase in the deposition of sediment in the streams in all modelled events. Whilst the modelling indicated that sediment deposition did increase in percentage terms, in terms of depth of sediment only small increases in the relative depth of sediment deposition are expected as a result of the Project.

53 In most scenarios the average change in bed deposition was less than 1mm. An estimated maximum of 8mm increase was identified in a 50 year ARI event in the Whareroa stream catchment. The outcomes of this modelling were provided to **Dr Keesing,** in order for him to consider the impacts on freshwater ecology.

Porirua Harbour modelling results

54 In order to understand how sediment moves around Porirua Harbour, a coupled hydrodynamic, wave and sediment transport model was developed[7]. This model is described in the evidence of **Mr Roberts**.

55 The hydrodynamic, wave and sediment transport models constructed as part of this study demonstrate acceptable calibration with the available data.

Event based modelling

56 To understand the spectrum of potential effects, event based modelling was undertaken for a range of storm events and wind conditions. The results of this modelling have primarily been used for the assessment of ecological effects.

57 Initial testing with the Harbour model indicated that sediment deposition within the Harbour during heavy rain was greatly influenced by the magnitude and location of the rainfall and by the prevailing wind conditions during the event. Therefore, the event based modelling was used to simulate the rainfall events coinciding

[7] To represent the Harbour and undertake the event based and long term modelling assessments using the DHI MIKE 21 HD (hydrodynamic), MIKE 21 SW (Spectral Wave) and MIKE 21 ST (Sediment Transport) of Porirua harbour. All models were built using Flexible Mesh (FM) and version 2009, service pack five.

with calm conditions as well as a 90th percentile northerly and southerly wind.

58 Simulations were carried out for a 15 day spring/neap tide cycle to include a full tidal range in the scenarios. The wind conditions were kept constant throughout the modelling period.[8]

59 Should a 2 year ARI rainfall event occur during the peak construction, the model indicates this could contribute up to an additional 200 tonnes of sediment to the Harbour (which is a 5% increase on the predicted total load during a 2 year ARI event in the 'without construction' scenario). The model results indicate that there will be little impact on sediment deposition patterns in a 2 year ARI rainfall event. Should this event occur during peak construction there are likely to be isolated pockets of increased sedimentation, typically less than 5mm deep, in locations already heavily impacted and largely in the sub tidal areas of the Harbour. The quantified increases in suspended sediment in a 2 year ARI rainfall event are unlikely to be visually detectable for an extended period of time.

60 Should a 10 year ARI rainfall event occur during the peak construction period it is predicted that between 271 and 645 tonnes of additional sediment will enter the Harbour. Between 4% and 9% more sediment is predicted to enter the Harbour in a 10 year ARI event, as compared to the 'without construction' scenario. The model results determined that the effects of this additional sediment are dependent on where it enters the Harbour and the coincident wind conditions. The model was used to test a range of rainfall and likely wind conditions. In most of the scenarios the analysis of the 10 year ARI events indicated that much of the additional sediment would be deposited in the deeper central basins of the Harbour in areas already experiencing high levels of deposition. However two of the modelled events had a greater impact on areas which **Dr De Luca** has identified as more ecologically vulnerable intertidal zones.

61 These two events were:

61.1 High sediment loads entering the Harbour from the Duck and Pauatahanui catchments during a northerly wind event; or

61.2 High sediment loads entering the Harbour from the Kenepuru catchment during a southerly wind event.

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[8] The constant wind conditions were a simplification for modelling purposes, and not considered to represent a realistic wind scenario. The majority of the sediment drops out of suspension after 24 hours, and therefore the wind conditions after the first 24 hours are not a significant factor.

62 The likelihood of the 2 year and 10 year event occurring during the whole construction programme and during the peak construction period is discussed in Section 12.5.2 of Technical Report 15 and in **Dr Sim's** evidence.

Long term modelling

63 A long term simulation using a simplified Porirua Harbour model was undertaken to understand the cumulative effects of the construction of the Project on sediment deposition in the Harbour. The scenario assumed a 6 year construction programme.

64 The long term model results provide an indication of the cumulative effects of deposition in the Harbour from the full construction period. Results were extracted after running the model for 10 years and 20 years. In the long term simulation, an additional 3000 tonnes of sediment is estimated to enter the Harbour as a result of all the construction activities. This represents around 2% of the total terrestrial sediment load entering the Harbour over a 10 year period. The long term model results indicated that little terrestrial sediment deposited in the Harbour was subsequently washed out to sea, and that much of the sediment would migrate over time into the deeper central basins. The results indicated that 20 years after the start of construction of the Project there would be almost no detectable increase in sedimentation rates in the Onepoto Arm of the Harbour and only an average increase of between 0.1 and 0.2mm/yr in the Pauatahanui Inlet.

65 The long term impact on sediment deposition of the proposed mitigation planting discussed in **Mr Fuller's** and **Dr Keesing's** evidence was assessed. Once this planting has established such that it has the characteristics of native bush (which I am advised by **Mr Fuller** will take between 15 and 20 years), it will, after a further period of approximately 14 years, compensate for the increased sediment load that is anticipated as a result of the road construction. The mitigation planting was not accounted for in the long term simulation discussed above.

Streams and coastal construction effects assessment

66 The potential effects of construction stormwater discharges on streams have been assessed against the criteria in section 5.4.2 (as required under Rule 5) of the Regional Freshwater Plan.

67 Small amounts of oil, grease and floatable materials could be released into streams from construction machinery. Oil and grease were not noted at any site in the water quality characterisation sampling (described in paragraph 38.4 above). In my opinion, this potential effect is best managed through the proposed Construction Environmental Management Plan (*CEMP*). Proposed condition G.12 includes measures to manage the site, including the disposal and storage of onsite rubbish, fuel storage, maintenance of vehicles and

the location of vehicle access and storage. Provided this plan is implemented, I think these potential effects can be managed to an acceptable level.

68 While the TSS is expected to increase, the contaminant concentration is not expected to alter; therefore I would expect no change or a small change in scums, foams, odour, stock drinking water quality, biological growths and bathing water quality.

69 During heavy rainfall events the visual clarity and colour, even without the additional sediment associated with the Project construction, is likely to exceed ANZECC guideline values for recreational water quality and aesthetics in all streams and the coast. While the predicted changes attributable to the Project may be conspicuous, the effect of the increased TSS on visual clarity and colour is not expected to have a lasting effect in the streams or in coastal waters.

70 Storage of water in sediment ponds can result in an increase in the stored water temperature. However, I do not expect the temperature in the receiving streams to increase by more than 3 degrees celsius. I do not expect the natural temperature of the water to exceed 25 degrees celsius as a result of construction stormwater discharges.

71 The chemical treatment of sediment treatment ponds (to reduce TSS) can result in an increase in pH and increases in the discharge of Aluminium. In my opinion this potential effect is best managed through the proposed conditions. Condition E.15 identifies monitoring requirements including for pH and condition E.19 requires the development of a chemical treatment plan including details of monitoring, optimum dosage and a spill contingency plan.

72 During construction, additional sediment deposition is predicted to occur in all streams; the additional deposition is predicted to accumulate to very shallow depths and will not affect the stream channel capacity to convey flows.[9] The ecological assessment of the predicted increase in sediment loads during the Project's construction is discussed in **Dr Keesing's** evidence.

73 During construction, additional sediment is expected to be conveyed by the streams into the coastal receiving environment. As noted above, the the modelling results indicated that, 20 years after the start of construction of the Project, there would be almost no detectable increase in average annual sedimentation rates (as compared to the "without construction scenario") in the Onepoto Arm of the Harbour over that period, and only an annual average

[9] Table 15.33 Maximum Sediment Deposited, Technical Report 15.

increase of between 0.1 and 0.2mm/yr in the Pauatahanui Inlet during that timeframe. In the longer term, mitigation planting proposed may reduce the sediment yield such that the increase associated with the road is compensated for, by a long term reduction in sediment load. The majority of sediment is transported in rainfall events. In large rainfall events, with coincident northerly or southerly winds, sediment may be deposited in the ecologically vulnerable intertidal zones. **Dr De Luca's** evidence discusses the ecological effects of the predicted increase in sediment deposition in the coastal area during the Project's construction.

OPERATIONAL EFFECTS ON WATER QUALITY

74 This section of my evidence discusses the impact of stormwater discharges during the operation of the Project on the contaminant load in streams, in the Porirua Harbour and along the Kapiti Coast.

Operational stormwater discharge results

75 For each catchment, the proportion of the catchment which will be converted to road was calculated. This was then weighted with median concentrations from motorway studies for TSS, total and dissolved zinc and total and dissolved copper. The proportion of the catchment that will not be converted to road was weighted with the median concentrations of each parameter, collected during the 2010 water quality characterisation sampling.

76 This method was used to estimate impacts in each stream catchment, at the most upstream discharge point, immediately downstream of the road and near the stream mouths.

77 The results of this analysis indicated that predicted small increases in concentrations are not expected to exceed ecological ANZECC guideline values for any of the catchments that do not already exceed ecological guideline values.

78 In addition to the catchment and motorway data method, the Auckland Regional Council's Contaminant Load Model (*CLM*) was used to assess the relative change in stormwater quality. The CLM incorporates the change in traffic associated with the Project and allows for the assessment of cumulative effects from other planned changes in land use.

79 A CLM was computed for each of the 23 watercourses that drain to the Porirua Harbour, and the Wainui/Te Puka and Whareroa catchments.

80 For some catchments, there is expected to be an overall improvement in water quality at the mouth of the stream due to the diversion of traffic off existing roads that have no stormwater treatment.

81 The stream catchments that the CLM predicted to have sediment quality poorer than the ANZECC ISQG[10] trigger levels for ecosystems in the '2031 without the Project' are: the Porirua, Kenepuru and Collins stream catchments for zinc, and the Porirua stream catchment for copper.

82 The contaminant load for the Porirua Stream catchment and the Collins Stream catchment is predicted to reduce in the scenario '2031 with the Project'. The contaminant load of zinc in the Kenepuru Stream catchment is expected to increase by 2%. For all other streams, the sediment quality is predicted to be better than the ISQG-low ecological trigger values. There is no change predicted in the rate or location of sediment deposition in streams in the operational phase of the Project.

83 The increase in imperviousness associated with the Project is approximately 1 - 2% per catchment. I consider that will have only a slight effect on stream flows. This is because the percentage amount of impervious area is small, and because wetlands are proposed for some catchments (Horokiri, Ration, Pauatahanui and Wainui) and will be designed to include extended detention. Native planting is also proposed which will in part compensate for increases in imperviousness in some catchments. Erosion protection measures will be used to protect streams from erosion at point source discharge locations. Erosion protection is discussed in **Mr Gough's** evidence.

84 In the Onepoto Arm of the Porirua Harbour and the Kapiti Coast, levels of TSS, metals and total petroleum hydrocarbons (TPH) in stormwater discharged are predicted to decrease. This is because the Project will displace traffic off existing roads that do not provide stormwater treatment.

85 Levels of TSS, metals and TPH in stormwater discharged to the Pauatahanui Inlet are predicted to slightly increase as a result of the Project. This is because the Project will result in a change in the distribution of traffic with more traffic directed into the watershed of the Pauatahanui Inlet.

Assessment against Regional Freshwater Plan Standards

86 The potential effects of operational stormwater discharges have been assessed against the permitted activity standards (under Rule 2) of the Regional Freshwater Plan.

87 For many catchments, a decrease in TPH is expected. For those where an increase is expected, in my opinion the proposed

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[10] Interim Sediment Quality Guidelines, Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000.

treatment devices will treat stormwater sufficiently so as to prevent the production of conspicuous oil and grease or notable increases in the emission of objectionable odour in streams and the marine environment.

88 All treatment devices are proposed to include gross pollutant traps. Therefore, it is expected that there will be a less than minor increase in floatable or suspended material in streams or the marine environment.

89 For all catchments, a small reduction in TSS is expected. For some streams, a reduction in contaminants is also expected. In these watercourses, a small positive effect in visual clarity and colour may be expected. In streams where an increase in contaminants is expected, in my opinion the proposed treatment devices will treat stormwater sufficiently so as to prevent any notable change in visual clarity or colour in streams and the marine environment.

90 In all streams, the levels of metals are lower than stock drinking water guidelines and the proposed treatment devices will treat stormwater sufficiently so as to prevent increases that would exceed these guidelines. In the Wainui/Te Puka stream, the only stream managed for fishery purposes, the metals are currently below the ANZECC guideline levels covering fish for human consumption. The proposed treatment devices will treat stormwater sufficiently so as to prevent increases that would exceed the fish for human consumption ANZECC guideline. Metals are predicted to slightly decrease in the Onepoto Arm and the Kapiti Coast. In the Pauatahanui Inlet, the small increase in metals is well below the trigger levels for bathing quality, and therefore I would expect no change in bathing quality standards.

91 While stormwater treatment in wetlands can increase the temperature of stormwater, I do not expect any discharges to result in a change in temperature greater than 3 degrees in streams or the marine environment. I do not expect the natural temperature of the water in the streams or the marine environment waters to exceed 25 degrees as a result of operational stormwater discharges.

92 I do not expect any operational stormwater discharges to result in a change in scums and foams, pH, dissolved oxygen, biological growths, or sediment deposition.

93 The ecological assessment of the predicted increase in contaminant loads during the Project's operation, on streams is discussed in **Dr Keesing's** evidence and on marine ecology in **Dr De Luca's** evidence.

METHODS TO MANAGE EFFECTS DURING CONSTRUCTION (INCLUDING CONDITIONS)

94 The assessment of water quality effects during construction included assumptions around construction staging, the quantity of sediment discharged in stormwater, and the quantity of other contaminants discharged in stormwater.

Site Management

95 During construction, litter and oil could be discharged from the construction site. In my opinion, this potential effect is best managed through the proposed CEMP. Proposed condition G.12 includes measures to manage the site, including the disposal and storage of onsite rubbish, fuel storage, maintenance of vehicles and location of vehicle access and storage. The CEMP condition sets a framework that is consistent with my assumptions for the assessment of water quality effects.

Unplanned discharges

96 Condition G.19 sets out a process for notifying the manager of the consents department of the Regional Council if any contaminants (including sediment) or material are released and enter any watercourse. This requires the consent holder to establish control measures, liaise with the manager on remediation and rehabilitation, to carry our remedial action and record incidents and steps taken to remedy adverse ecological effects. This condition sets a process for managing potential effects of unplanned discharges, which is consistent with my assumptions for the assessment of water quality effects.

Construction staging

97 The CEMP is described in condition G.12. This condition requires a staging programme to be reviewed and certified, which includes details on a methodology to identify how earthworks will be staged during the relevant part of the Project to manage the effects of the Project on the Pauatahanui Inlet. I support a staged approach as my analysis has indicated that staging the Project is a key factor in avoiding potential effects associated with substantial increases in sediment loads.

98 In addition, conditions E.1 and E.2 set open earthworks limits in the Pauatahanui Inlet and Onepoto Arm watersheds. These limits for earthworks reflect the open earthworks assumptions in the modelling undertaken for the assessment of effects on water quality. The specified limits will manage the road construction in a manner that accounts for the cumulative effects of open earthworks. It also provides limits on open earthworks in those catchments that were identified as the most sensitive, thus limiting potential effects. Further reducing sediment loads would require reducing the open earthworks areas in catchments such as the Duck and Kenepuru.

This is not proposed because it would result in a longer construction programme.

Performance management

99 **Mr Gough** recommends that the wording of conditions is changed to address the design and performance of sediment control devices, so it is consistent with the assumptions in my assessment of water quality effects. I support this wording change, because it better reflects the assumptions made in the assessment of water quality effects.

100 Performance monitoring will be specified within each Erosion and Sediment Control Plan. Monitoring is outlined in conditions E.15 and E.16. The intent of the monitoring will be to confirm that effects that are occurring meet agreed performance criteria. The parameters also include monitoring for levels of pH and aluminium (Al3+) to ensure the chemical treatment of sediment retention ponds is not outside of agreed performance criteria. Conditions E.18 and E.19 set out a process for chemical treatment and the development of chemical treatment plans, which include monitoring, maintenance and providing details of optimum dosage. **Mr Gough** has recommended changes to these conditions; I support his recommendations, because chemical treatment has the potential to reduce pH of the discharge, which could impact on downstream water quality. My assessment has assumed that chemical treatment is designed and maintained in a manner which avoids this potential risk. The recommended modifications suggested by **Mr Gough** set a framework for the development of chemical treatment that is designed and operated in a manner that is consistent with the assumptions in my assessment of water quality effects.

RESPONSE TO KEY ISSUES REPORT

Greater Wellington Regional Council

101 In Section 4.7.2 of the Key Issues Report the Greater Wellington Regional Council notes that Rule 7 of the Regional Freshwater Plan provides for the minor abstraction of fresh water as a permitted activity subject to conditions. It is therefore possible that drinking water takes occur in the catchments affected by TGP. During the Project's operation I would not anticipate any effect on existing water takes. During construction, additional sediment may impact on the quality of permitted drinking water takes. However, it is unlikely that people will be abstracting drinking water during storms, and therefore I consider the main potential risk being to water intake equipment.

102 Section 5.7 of the Report discusses the removal of plantation forestry (RC1). The earthworks associated with this forestry removal would be subject to the open earthworks condition E.2,

which limits the peak area of non-stabilised earthworks in the Onepoto catchment to 17.25 ha.

RESPONSE TO SUBMISSIONS

Submitter 43 – Department of Conservation

103 The Department of Conservation (*DOC*) submission raises a number of points regarding the modelling of sediment yield and retention. I have also read the memorandum of counsel on behalf of the Director-General of Conservation in relation to a request for peer review of sediment generation modelling, dated 11 November 2011 (together with appended reports by Dr Les Basher and Brian Handyside).

104 The modelling methodology for sediment generation and delivery was developed by a team at SKM. I coordinated the technical work, under the guidance of Dr Phillip Jordan, who is the global practice leader for modelling catchment processes at SKM. The development of the soil moisture water balance model was undertaken by John Hansford, who at time was employed as a Senior Hydrologist at SKM. The unit hydrograph modelling is discussed in **Mr Martell's** evidence.

105 The estimation of sediment yield for the Transmission Gully Project has relied on four models:

105.1 The USLE to estimate soil loss under the existing and both the "with construction" and "without construction" scenarios;

105.2 Suspended sediment yield estimator (*SSYE*) to estimate sediment yield and calculate a sediment delivery ratio for the USLE;

105.3 The soil moisture water balance model to calculate daily average and daily peak flows; and

105.4 The unit hydrograph models to calculate storm peak flows and volumes.

106 For the purposes of assessing the effects of the Project on water quality, the primary interest is the sediment that is delivered to the receiving environment. In the text, 'Handbook of Erosion Modelling' it is stated: "*When dealing with practical problems, it is important to decide how much information is needed on the processes by which sediment gets detached, transported and deposited. If it is sufficient to know only the quantity of material eroded over time, there is no*

need to assess the different processes and a lumped model is likely to suffice."[11]

107 The NIWA tool suspended sediment yield estimator (SSYE) is a lumped empirical model that provides sediment yield for all catchments in New Zealand and has been calibrated against a large NZ dataset, it has been reported as predicting 96% of variance for measured North Island yields with a variance of 1.8. However the model cannot be used to assess change in landuse directly. [12]

108 The USLE is an empirical method for estimating sediment loss, and can model the change in soil loss resulting from a change in land use. It is a widely used and accepted method of estimating sediment loss, which has been shown to perform well compared with process-based models: *Studies*[13] *have shown that overall, average annual and even annual values of soil erosion rates as measured on erosion plots are not better predicted by using a dynamic, process-based model rather than a statistical approach*"[14].

109 A limitation of the USLE is that it only predicts erosion from sheet and rill erosion, not gully erosion, mass movement or stream bank erosion. The USLE only models sediment loss on a plot scale, and the application of a sediment delivery ratio (*SDR*) is required to estimate the sediment yield at the receiving environment. A comparison between the estimates of sediment loss made by the USLE and the sediment yield from the SSYE was made and a strong relationship between the two models was found (see **Figure 3** below). The ratio of 0.17 between the models was applied as the SDR for the USLE in all catchments. It is recognised that using the ratio of the two models to calculate a catchment wide SDR is a pragmatic solution, to a complex problem.

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11 Morgan R.P.C. and Nearing M.A *Handbook of Erosion Modelling*. Pg 19

12 Hicks DM, Shankar U, McKerchar AI, Basher L, Jessen M, Lynn I, Page M 2011. Suspended sediment yields from New Zealand Rivers. Journal of Hydrology (NZ) 50: 81-142.

13 Tiwari Ak, Risse LM, Nearing MA, 2000: Evaluation of WEPP and its comparison with USLE and RUSLE, from the Transactions of the American Society of Agricultural Engineers. 43, pg 1129 -1135

14 Morgan R.P.C. and Nearing M.A *Handbook of Erosion Modelling*.pg 124

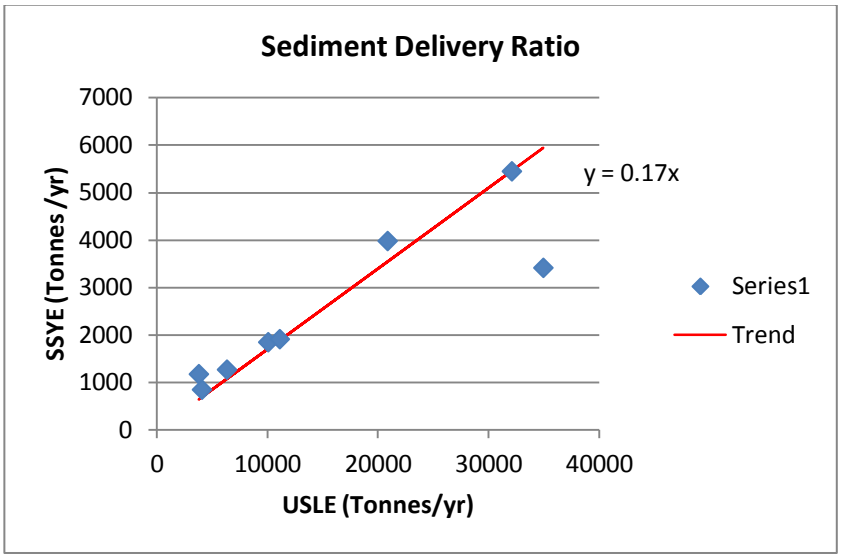

Figure 3: Comparison of sediment loss with sediment yield

110 Using a standard SDR effectively attributes all of the sediment that is calculated by the SSYE to surface erosion processes, when in reality a proportion of this sediment would be generated by other processes such as gully erosion, mass movement and stream bank erosion. For the baseline scenario, this SDR simplification is acceptable, because the interest is in sediment yield from all sources, to provide the context for the additional sediment that will be generated from the road construction.

111 For the construction scenario, the fixed SDR of 0.17 established from the baseline scenario may underestimate the proportion of sediment generated from the construction areas that is delivered to the receiving environments because there may be stronger connection between the construction areas and the receiving environment. However, when the calculated estimates of sediment yield from the construction areas (see **Table 1** below) are compared to literature values for rates of erosion measured from construction sites[15][16], the values are similar. Therefore, this simplification is considered suitable at this scale.

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15 ARC 2006 ICMP funding eligibility guideline. *Contaminant Load Model. Earthworks 12 months, slopes <10 degrees: 25000 kg/ha/yr. Slopes 10 – 20 degrees: 150000 kg/ha/yr.*

16 ARC 2003: Predicting sediment loss under the proposed development in the Waiarohia catchment. *Ng and Buckeridge (2000) in a review of sediment yields from construction sites within the Auckland region. Interannual bare earth sediment losses range between 5,000kg/ha/yr (1981) and 36,000 kg/ha/yr(1966), whilst the predicted daily loss of sediment peaked at over 26,000 kg/ha/day in February 1966.*

Table 1. Sediment from Road construction areas in Ration and Horokiri catchments

Transmission Gully Peak Construction Scenario. **SDR 0.17 applies to both scenarios. No erosion or sediment control applied. P of 0.9 in construction scenario. C factor alters to reflect landuse change.**		
		Kg/Ha/Yr
Ration (24 Ha)	Baseline	800
	2017 Road. Approx 7 degrees	47500
Horokiri (21 Ha)	Baseline	2600
	2018 Road. Approx 19 degrees	114800

112 The first method of verifying the estimate of the average annual sediment load was to run a long term simulation of the Harbour model for 20 years (this is described in Section 12.6.1 of Technical Report 15). This modelling indicated that the rates of deposition predicted using the average annual sediment load were broadly consistent with sediment accumulation depths measured in the Harbour. This is further discussed in **Mr Roberts'** evidence.

113 The second method of verification was to compare observed data with the calculated sediment rating curve. When this data is plotted against the rating curve, good agreement was found (as illustrated in Figures 15.43 – 15.45 in Technical Report 15). In his report, Dr Basher states that the plot of TSS and flow for Horokiri, looks entirely reasonable (paragraph 27), but he is uncertain how the rating curve was developed and questions why the USLE method was used to derive the sediment rating curve rather than developing a curve from observed data.

114 The rating curve was developed by assuming that 50 years of simulated flow data would provide a sufficiently long record to calculate an average annual sediment load. Therefore, the rating curve selected was the curve that enabled the average annual sediment load to be distributed across the flow record such that the average annual sediment load was achieved after 50 years. This calculation assumed an exponent of 1.9 for all curves. The rating curve was then adjusted to reflect the percentage increase in average annual sediment load, calculated using the USLE (adjusted with the SDR) in the construction scenario. The advantage of this method over calculating a rating curve from the observed data is that this rating curve relates to the landuse in the catchment through the USLE, and therefore can be adjusted to reflect the predicted landuse change. The observed data was only collected for one year at the same time as the model was being developed, and therefore this data was considered more suitable for verification.

115 The report by Dr Basher (paragraph 26) acknowledges the peak flow to event sediment yield relationship is very good (illustrated in Figure 15.43 – 15.45 in Technical Report 15). He is unclear how turbidity data was converted to sediment yield and states that there is likely to be high uncertainty in the data points. The calculation of turbidity data to sediment yield was undertaken by converting turbidity to TSS, using the relationships described in Table 15.84 of Technical Report 15. Specific events were selected and event loads were calculated using the turbidity and flow gauge data for the event duration. The flow gauge record was adjusted to represent flow at the turbidity logger site. For grab sample data, the measured concentrations were taken to be average concentrations, and the loads were calculated from SMWBM flow and measured flow estimates. It is recognised that there is uncertainty around these estimations of event sediment loads, but they are suitable for verifying the sediment rating curve.

116 The submission from DOC[17] and report by Dr Basher[18] suggest that other models may have been more suitable for calculating sediment yield for this Project, (such as the GLEAMS model and WEPP model). The GLEAMS model has been used by NIWA for the estimation of sediment yield for the recent Waterview Connection Project. The GLEAMS model is a process-based model as regards the simulation of runoff and sediment, and relies on the factors of the USLE as part of the erosion component sub models. The WEPP model is a daily simulation model based on hydrology and erosion processes.

117 GLEAMS models sheet and rill erosion; it does not model mass movements or stream bank erosion. Therefore a baseline estimate of sediment yield generated using GLEAMS may underestimate sediment yield; exhibiting the same behaviour as the USLE approach that was used for the Project. Both GLEAMS and WEPP can model erosion processes within catchments. However for the Project the key concern is about the sediment yield at the receiving environment. Using GLEAMS and WEPP, it is possible to assess the effectiveness of erosion and sediment control devices at specific locations. However, the Transmission Gully Project's construction methodology, including the erosion and sediment control design, has not yet been developed in detail. Therefore, the approach used for the Project, where the performance of sediment control devices is applied to the sediment yield calculations, is more consistent with the current level of information available.

118 GLEAMS, allows for the calculation of daily sediment loads, and therefore seasonal variations and staging can be assessed. However, the construction methodology for the Transmission Gully

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17 Paragraph 9

18 Paragraphs 29 - 32

Project does not yet enable a staging programme linked to seasons to be applied. Therefore, the approach used (being to calculate an estimated peak construction year to generate an estimate of average annual sediment under the construction scenario) is more consistent with the current level of information available.

119 In summary, the approach adopted for the Project is pragmatic and suitable. When the model projections for the existing situation are compared with observed sediment accumulation in the Harbour and measured suspended sediment concentrations in streams, good agreement is found. This provides confidence in the long term and event based sediment yield predictions. For the construction scenario, the construction design is not sufficiently developed to enable the complex assessment available with process-based models such as GLEAMS or WEPP to be fully utilised. When the estimates of sediment yield from the construction areas are compared with literature values there is good agreement. This affords confidence that the adopted modelling approach provides a realistic estimate of sediment yield in the existing and the construction scenarios and is suitable for assessing the effects of the Project.

120 The DOC submission[19] states that the generation of sediment does not include any analysis of uncertainty, and there is little data to confirm the accuracy of the model's predictions. The verification process described above has been used to provide confidence, given the uncertainty associated with the estimation of sediment yield. Additional scenarios with higher and lower estimations of the average annual sediment load or different rating curve shapes, could be modelled. Any change would apply to both the 'with Project' and 'without the Project' scenarios, and therefore would be unlikely to significantly alter the relative change between scenarios.

121 The other area of uncertainty relates to the sediment generated by the Project construction. This is most relevant in understanding the effects of the Project. The main factors that contribute to the generation of sediment in the construction scenario are the open areas of earthworks and the effectiveness of the erosion and sediment control measures. While it would be possible to model a range of different assumptions, it is my opinion that this uncertainty is best managed by the conditions. Conditions E.1 and E.2 set earthworks limits that are consistent with the assessment of effects. Conditions E.3 and E.15 and E.16 set performance and monitoring standards to manage the erosion and sediment control measures, in a manner that is consistent with the assumptions in the assessment of effects.

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[19] Paragraph 10

122 Dr Basher's report concludes that it is unclear how the USLE was applied to the specific works of TGP and the specific locations. Section 10.6.2 of Technical Report 15 describes how the baseline USLE was altered to reflect 2021 landuse and the Project. The factors that were altered were the C[20] factor, the P[21] factor and the SRE[22] factor. The C factor was altered to reflect 2021 land use in both the 'with the Project' and 'without the Project' scenarios. In the 'with the Project' scenario, it was also altered to describe bare earth for a 75m wide length along the proposed open earthworks area of the Project alignment. The SRE factor describes the effectiveness of the erosion control measures. For the 'with the Project' scenario, the erosion control measures were assumed to have a 75% treatment efficiency, and were applied to the whole of the alignment area described as bare earth. The P factor was adjusted from 1 to 0.9 to represent bare soil with a rough irregular surface. The assumptions for open earthworks are described in Section 3 of Technical Report 15. Figure 15.1 of that Report illustrates the locations of the coincident open earthworks areas in the Kenepuru, Duck and Horokiri catchments that were used as the peak construction scenario for the Harbour modelling.

123 DOC's submission[23] states that the magnitude or probability of adverse effects on the Pauatahanui Inlet and streams could be greater if the amount of sediment generated by the Project is greater than predicted. While this is true, there could also be lesser effects if the amount of sediment generated by the Project is less than predicted. The approach taken has been to select a scenario that represents a realistic estimation of the effects in the 2 year ARI and 10 year ARI rainfall events. In addition, conservative assumptions have been applied. Peak open earthworks have been assumed and so it follows that for the majority of the Project it is likely that the area of open earthworks, and therefore sediment yield, will be less than those assumed. It is assumed that the open earthworks are always in soils that have the characteristics of surface soils, while in reality there are significant sections of rock and cohesive sub-soils, which are less erosion prone. The 90th percentile northerly and southerly winds are also assumed to coincide with rainfall events.

124 DOC's submission[24] states that assessment of rainfall events and sediment yield should not be limited only to the 2 year peak construction period, but should be extended to include information

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20 Cover

21 Bare soil management

22 Sediment removal efficiency

23 Paragraphs 11 and 14

24 Paragraph 12

for the 6 year construction timeframe. The assessment does account for the whole period. Firstly, the event based scenarios where the 2 year and 10 year events are modelled coinciding with the peak construction period, are a conservative assessment of effects for the entire construction period, the likelihood of these events occurring over the entire construction period is discussed in Section 12.5.1 of Technical Report 15, and further discussed in **Dr Sim's** evidence. Secondly, the long term modelling accounts for the increased sedimentation over the entire construction period. This is discussed in Section 12.6 of Technical Report 15.

125 The DOC submission[25] states that it is unclear as to whether climate change predictions have been applied to the sediment yield predictions. Climate change scenarios were not applied to the calculation of the sediment yield. The construction period for the assessment of effects was assumed to be 2016 – 2021. While it is recognised that the IPCC climate change predictions provide a linear increase in temperature and associated climatic effects between the present time and future, the Ministry for the Environment Guidance[26] [27] provides projections for scenarios starting at 2040, by which time the road construction is likely to be complete. Modelling could be undertaken to assess the impact of climate change on sediment yield. However, this would apply to both the 'with the Project' and the 'without the Project' scenarios and therefore the relative change between the scenarios is unlikely to be significantly altered. If climate change was applied to the sediment yield calculations for the assessment of effects, projected sea level increases would also be applied, which would alter the intertidal areas being assessed for their ecological values. However, changes in rainfall intensity could result in changes to the sizing requirements for the sediment retention ponds, therefore I suggest the conditions are amended to require that relevant climate change guidance is applied to sediment pond design, at the time of construction.

126 The DOC Submission[28] also suggests that larger events than the 10 year ARI should be considered. I have undertaken calculations of the change in sediment in the 50 year ARI event, and these calculations have been provided for the assessment of the effects in the streams. After discussion with **Dr De Luca,** it was decided not to model the 50 year ARI in the Porirua Harbour. Her advice was that the background effects in the 'without the Project' scenario

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25 Paragraph 16

26 Ministry for the Environment 2008: Tools for estimating the effects of climate change on flood flow. A guidance manual for local government.

27 Ministry for the Environment 2008: Climate change effects and impact assessment. A guidance manual for local government.

28 Paragraph 16

were likely to be such that the 2 year and 10 year ARI scenarios were a higher priority for assessment.

127 The DOC submission[29] suggests that the sediment generation and management assessment be independently peer reviewed. The assessment of water quality effects has already been subject to peer reviews. NZTA engaged Dr Tim Fisher and Dr Alastair Senior from Tonkin and Taylor who undertook an independent peer review. In addition, an independent review was also undertaken for the RATAG group by Golders. These peer reviews have provided valuable comment that has been carefully considered and taken into account in the development of the assessment of effects, and none have raised concerns about the validity of the USLE equation and the predictions of sediment.

Submitters 32, 35, 42 Pauatahanui Inlet Community Trust, Guardians of Pauatahanui Inlet, Paremata Residents Association

128 The submitters propose a number of possible mitigation options. It is suggested that NZTA contribute to plans contained in the Harbour Strategy aimed at reducing sediment entering the harbour from sources other than the Transmission Gully Project. The sediment yield model developed for the Project provides a suitable tool for assessing the relative change in sediment generation that could be expected from landuse change within the harbour catchment.

129 The submitters recommend that NZTA be required to continuously update stormwater treatment methods. The NZTA is not seeking resource consent for the operational stormwater discharges because they meet the permitted standard, and therefore this recommendation may be best implemented through NZTA's stormwater maintenance programme.

130 The submitters also recommend that stormwater treatment measures be installed to treat stormwater from other roads in the catchment. It would be possible to retrofit stormwater management devices to treat runoff from existing roads in many locations. This would reduce sediment loads delivered to the Harbour from these other sources, and it may be that devices could be installed such that the small increase in contaminants in the Pauatahanui Inlet associated with the Project could be compensated for, resulting in reduction in the overall contaminant loads to the whole of the Harbour. However, the stormwater management devices that are proposed to treat operational stormwater from the Project are predicted to be successful at reducing contaminant loads, and the water quality effects that are predicted as a result of the operational stormwater discharges do not necessitate the need for additional

[29] Paragraph 17.

mitigation. (My evidence excludes discussion of ecological effects which are discussed by **Dr Keesing** and **Dr De Luca).**

Submitter 46 Pukerua Bay Residents Association

131 The submitter states that the construction of the Transmission Gully Project must not contribute to environmental degradation and should ideally contribute to mitigating existing damage. The water quality effects of the Project (excluding the ecological effects, discussed by **Dr Keesing** and **Dr De Luca**), are largely avoided through the use of erosion and sediment control devices. In the long term the increase in sediment generated during construction will result in only a small increase in infilling of the Harbour, and in time the proposed mitigation planting will compensate for that small increase in infilling. When the road is operational the proposed stormwater management devices are expected to be effective at removing contaminants, and it is expected that the Onepoto arm of the Harbour will experience a slight improvement in water quality and the Pauatahanui inlet will experience a small increase in contaminant load.

Submitter 31 Sheriden and Osborne, 36 G&M Milner 51 Mr Jianfei Li, 52 Mrs J E Gray, 62 D&J Barnes, 63 SB Hill & J Sinclair Grace

132 The submitters raise a concern that construction sediment could build up in the stream at 27000 to Culvert PO6. The sediment in this catchment (Porir3HR, Table S.1, Appendix 15.S of Technical Report 15) during the peak construction period is predicted to increase by 17% in the 2 year and 10 year ARI and 33% in the 50 year ARI. The proposal at culvert PO6, discussed in **Mr Martell's** evidence, is to provide some attenuation for flows in the 10 year ARI event and larger events. This is likely to result in less sediment being discharged downstream of the culvert in these events. This is likely to provide a small benefit for the stream and harbour downstream of the culvert in these events, but is likely to result in local deposition of sediment behind the culvert. The Porirua Stream and Porirua Harbour sediment transport and deposition modelling did not account for sediment deposition in this location, and make the conservative assumption that all sediment from this catchment reaches the Porirua Stream and that all sediment from the Porirua Stream reaches the Harbour. **Dr Keesing** discusses the ecological effects of the proposed culvert and increase in sediment loads.

Submitter 15 Cannons Creek Residents and Ratepayers Association

133 The submitter is worried that that the chemical runoff from the new link road tar seal may affect pets and plant life. With the proposed stormwater treatment, the operational stormwater discharges are unlikely to cause adverse effects on plants or pets. The predicted concentrations in the 'With Project' scenario, for zinc and copper in all streams, are below the contact recreation and drinking water

standards for humans. Other contaminants that may cause risks to pets, such as nutrients and microbiological contaminants, are not expected to increase as a result of the operational stormwater discharged from the Project.

Submitter 60 Whitby Coastal Estates

134 The submitter proposed that a series of small choker dams be built on each tributary of the Duck creek upstream of the Project to restrict flood events to around 50% of flood flow, and suggests that if the silt and nutrients could be retained on the paddocks for a time this could perform a benefit. From a water quality perspective, I agree there may be benefits in capturing sediment in small dams in Duck Creek upstream of the Project. However, the work to achieve those benefits is not justified by the water quality effects of the Project. The hydraulic aspects of this proposal are addressed in **Mr Martell's** evidence. The ecological aspects of this proposal are discussed in **Dr Keesing's** evidence.

CONCLUSIONS

135 The modelling and analysis of the predicted construction stormwater discharges has indicated that the assumed construction staging and the proposed erosion and sediment control devices will be effective at reducing the potential effects of an increase in sediment associated with construction of the Project.

136 The modelling and analysis of the operational stormwater discharges has indicated the proposed permanent stormwater management devices are effective at reducing the potential effects of the change in distribution and increase in contaminants discharged in stormwater.

137 Assuming the consent conditions are confirmed as proposed (including amendments suggested in evidence), and that the proposed management plan framework is accepted, it is my opinion that the potential adverse water quality effects can be managed to an acceptable level.

138 The potential ecological effects of the construction and operational stormwater discharges are discussed by **Dr Keesing** and **Dr De Luca**.

Michelle Kathleen Malcolm
22 November 2011