ENVIRONMENT COURT OF NEW ZEALAND
WELLINGTON REGISTRY

I MUA I TE KOOTI TAIAO O AOTEAROA
TE WHANGANUI-A-TARA

ENV-2023-WLG-000005

Under	the Resource Management Act 1991
In the matter of	the direct referral of applications for resource consent and notices of requirement under sections 87G and 198E of the Act for the Ōtaki to North of Levin Project
By	Waka Kotahi NZ Transport Agency

STATEMENT OF EVIDENCE OF KEITH DAVID HAMILL ON BEHALF OF WAKA KOTAHI NZ TRANSPORT AGENCY

WATER QUALITY

Dated: 4 July 2023

BUDDLE FINDLAY

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INTRODUCTION

1. My full name is **Keith David Hamill.**

2. I am an Environmental Scientist and Director at River Lake Limited. My technical specialty is in water quality and aquatic ecology.

3. I prepared[1] Technical Assessment H: Water Quality (**Technical Assessment H**) as part of Volume IV of the Assessment of Environmental Effects (**AEE**), which accompanied the application for resource consents and notices of requirement for designations (**NoRs**) lodged with Manawatū-Whanganui Regional Council (**Horizons**), Greater Wellington Regional Council (**GWRC**), Horowhenua District Council (**HDC**) and Kāpiti Coast District Council (**KCDC**) in November 2022 in respect of the Ōtaki to north of Levin highway Project (**Ō2NL Project** or **Project**).

4. My qualifications and experience are set out in paragraphs 13 and 14 of Technical Assessment H. My evidence is supplementary to Technical Assessment H.

5. In preparing Technical Assessment H and my evidence:

   (a) I have provided advice on water quality matters related to the Project to Waka Kotahi since April 2021; and

   (b) I have presented at stakeholder meetings on the Project's stormwater effects.

6. Since the consent applications and NoRs were lodged I have updated the water quality summary tables to include recent monitoring data. These are provided in this evidence**.**

7. I assisted with the response to a number of questions in the section 92 further information requests from the Councils related to Technical Assessment H.

Code of conduct

8. I confirm that I have read the Code of Conduct for expert witnesses contained in section 9 of the Environment Court Practice Note 2023. This evidence has been prepared in compliance with that Code. In particular,

[1] I prepared Technical Assessment H in collaboration with Kristy Harrison, Principal Environmental Scientist, and Julia O'Brien, Environmental Scientist, Stantec.

unless I state otherwise, this evidence is within my area of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

Purpose and scope of the evidence

9. Technical Assessment H assesses the effects of the Project on surface water quality, and recommends measures to avoid, minimise and mitigate these effects, to inform the assessment of effects for the Project.

10. My evidence does not repeat in detail the matters discussed in Technical Assessment H. Rather, in this evidence I:

    (a) present the key findings of Technical Assessment H in an executive summary, updated to factor in the additional work carried out since lodgement;

    (b) provide a more detailed description of the additional work carried out, information obtained, and discussions held since lodgement, and the implications for my assessment;

    (c) comment on issues raised in submissions received in respect of the Project; and

    (d) comment on the section 87F/198D reports prepared by Horizons, GWRC, HDC and KCDC (**council reports**).

EXECUTIVE SUMMARY

11. The Ō2NL Project will cross five surface water catchments; these are:

    (a) tributaries to the Waitohu Stream;

    (b) Waikawa Stream (including its tributaries of the Manakau Stream and Waiauti Stream);

    (c) Kuku Stream;

    (d) Ohau River; and

    (e) Koputaroa Stream.

12. The Ō2NL Project also crosses the groundwater catchment of Punahau / Lake Horowhenua.

13. The current water quality in these catchments is variable, and largely dependent upon upstream land use, ranging from generally high (in the Ohau River and Waikawa Stream) to poor (in the Koputaroa Stream and tributaries of the Waitohu Stream).

14. Technical Assessment H identifies the potential effects of the Ō2NL Project on surface water quality during construction and operation; namely:

    (a) potential construction impacts including sediment discharges, use of hazardous chemicals (including cement), and vegetation clearance; and

    (b) stormwater discharges from long-term operation of the road.

15. Assessing the effect of sedimentation during construction was informed by using sediment yield models (found in the Erosion and Sediment Control Report attached to Design and Construction Report (**DCR**), Appendix Four to Volume II) to estimate the increase in catchment sediment load due to Project earthworks. Assessing the effects of long-term stormwater discharges was informed by the Contaminant Load Model (**CLM**).

16. The bulk earthworks during construction could increase sediment runoff to streams, resulting in higher suspended sediment loads and lower water clarity. This will be more apparent during high flow events where the risk of overland flow is greater.

17. However, the effects on downstream water quality can be minimised by applying industry best practice erosion and sediment control (**ESC**) as described in the Erosion and Sediment Control Report[2] and the evidence of **Mr Gregor McLean**. With the proposed controls in place, the magnitude of effects from construction sediment ranges from "Low" to "High". The catchments with a higher risk of sediment increase were those with the largest earthwork footprint relative to catchment size; these were: catchment B (Waitohu), catchments C and D (Waitohu, with Forest Lakes downstream), Catchment G (tributary to Manakau) and Catchment I (Mangahuia). The overall level of effect varies depending on the sensitivity of aquatic life in the receiving stream and is discussed in Technical Report K: Freshwater Ecology and the evidence of **Dr Alex James**.

[2] See Appendix Four to Volume II of the AEE.

18. Cement and uncured concrete pose a risk to water quality through elevated pH, therefore runoff from uncured concrete should be minimised. Overall, the risk of concrete causing adverse water quality effects on streams will be low, provided that concrete wash water is captured, and discharged to land or treated prior to discharge, to reduce pH to within a range of 6.0 to 9.0 (see Schedule 8 to the proposed conditions).

19. A range of hazardous substances will be used during construction, including but not limited to; cement, bitumen, diesel, oil, paint and adhesives. A Hazardous Substances Procedure (**HSP**) will be developed as part of an Erosion and Sediment Control Plan (**ESCP**), as required under Schedule 8 to the proposed conditions. The HSP is intended to manage hazardous substances on-site and avoid potential adverse effects on the environment and on the health and safety of people, including by identifying key roles and responsibilities, through record keeping, storage and refuelling procedures, and through approaches to concrete works. It will describe the processes to be implemented to minimise potential risks to water quality and aquatic life – including correct storage, handling, bunding and spill procedures (see Schedule 8 to the proposed conditions).

20. Woodchip from vegetation clearance can potentially leach organic material and tannins to waterways. However, for this Project, the effect of vegetation clearance (excluding associated earthworks) on surface water quality is expected to be negligible, due to the small areas of woody vegetation to be cleared and their distance from waterways. The Ecology Management Plan (**EMP**) required under Schedule 7 to the proposed conditions will include measures to avoid the leaching of wood chip residue to waterways, including ensuring that wood chip and mulch from cleared vegetation are not stored by waterways or overland flow paths.

21. Stormwater discharges from the operation of the highway can have multiple levels of effects on waterways by affecting stream hydrology and morphology, water quality and the water temperature regime. The effect of operational stormwater from the Ō2NL Project on stream hydrology or water temperature is "low" in all sub-catchments, however three small tributaries directly receiving stormwater in catchments P, M and I (shown in Figure 1 below) may have a “moderate” risk. The risk at the sub-catchment level is "low" due to the relatively small change in impervious surface, but in these small receiving tributaries the Project causes the imperviousness to increase above a nominal threshold of 10% - indicative of potential effects

on the hydrological regime and temperature in the upper reaches. Potential "moderate" effects are mitigated and reduced by the use of stormwater detention basins, wetlands, and offset planting proposed in these catchments.

22. The Ō2NL Project will result in a **net reduction in road related contaminants** (including total suspended solids, zinc, copper and total petroleum hydrocarbons) entering waterways of all the major catchments (i.e. Waitohu, Manakau, Waikawa, Ohau, Koputaroa) crossed by the route. This is because traffic will be shifted from the current State Highway 1 (**SH1**) and State Highway 57 (**SH57**), which have no formal stormwater treatment, to the new highway which will have extensive stormwater treatment. Some sub-catchments will have a localised increase in contaminant load (generally those with a small length of SH1 draining to their catchment relative to a larger length of the new road). However, the risk of adverse ecological effects is still low because the concentration of contaminants in the stormwater discharges after treatment are expected to be within guideline values either at the point of discharge or after mixing.

23. Catchments receiving treated stormwater discharges from the Ō2NL Project are shown in yellow in Figure 1. Catchments with no discharges from the Ō2NL Project are shown in blue. The uncoloured area north of Ohau and east of Levin (between catchments M and O) has near complete infiltration to groundwater. The Project alignment is shown in purple.

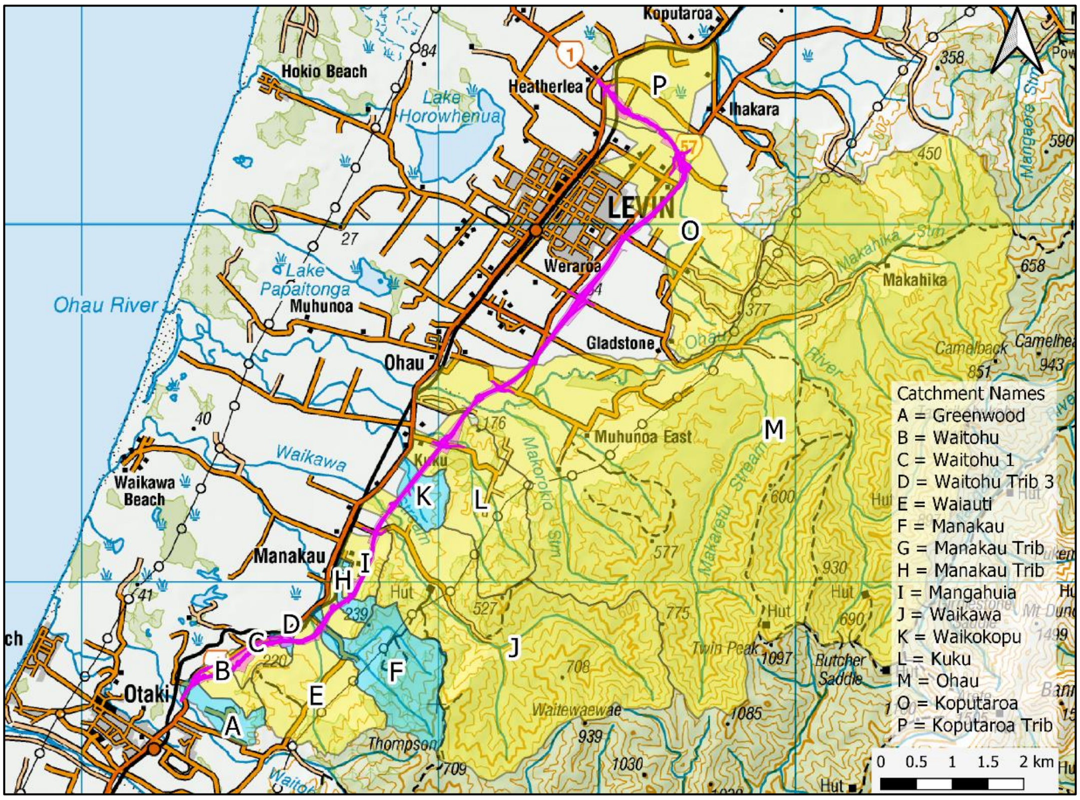

Figure 1: Locations of stream catchments in the Ō2NL Project area where the CLM was applied.

WORK SINCE LODGEMENT

24. Since the application was lodged, I have been involved in further work related to water quality as set out below.

25. Water quality monitoring has continued on a monthly basis at 12 sites to strengthen the baseline data record. This includes sites upstream of the proposed new road and downstream of the existing SH1. I have updated Table H.12 from Technical Report H to reflect data up to and including January 2023, and that is included below. Although the numbers have changed with the larger dataset, the interpretation and conclusions derived from the dataset remain unchanged, including the broad spatial pattern of higher concentrations of nutrients and sediment at sites lower in the catchment.

26. Turbidity logging has continued at four locations in the Manakau Stream, Waikawa Stream, Ohau River and Koputaroa Stream. Figure H.3 and Figure H.4 from Technical Report H have been updated below to include more recent data. The conclusions derived from the data in Technical Report H remain unchanged, as the more recent data confirms previous observations. There is high variability in turbidity associated with flood events that can increase turbidity 100 to 1000 times above baseflow levels.

Table H.12 update: Median water quality monitoring results for streams crossed by the Ō2NL Project, July 2021 to January 2023. Highlighted cells do not achieve the ANZG Default Guideline Values (DGVs). nd = not detected.

Id	Site	Temp. oC	%DO	Clarity m	EC mS/m	pH	TURB NTU	TSS mg/L	*E.coli* cfu/100mL	TN mg/L	NH4-N mg/L	NNN mg/L	TP mg/L	DRP mg/L
1A	1A Koputaroa at McDonalds Rd	14.5	81.6	0.62	138	7.2	7.7	4.5	1203	0.88	0.02	0.55	0.043	0.012
1B	1B Koputaroa at Travistock Rd	14.5	72.8	0.62	181	7.3	5.2	3.5	1120	2.8	0.017	2.40	0.039	0.015
2A	2A Ohau at Quarry	14.8	96.3	0.90	68.8	7.2	1.51	0	53	0.355	0	0.26	0.007	0.005
2B	2B Ohau at SH1 Bridge	10.3	99.9	4.85	72.9	7.3	1.02	0	34.2	0.415	0.004	0.34	0.015	0.01
3A	3A Kuku at Kuku East Rd	11.1	95.0	0.69	112	7.3	2.65	0	727	0.44	0.013	0.19	0.027	0.011
3B	3B Kuku at SH 1	14.2	92.1	0.71	119	7.3	3.4	3	727	0.425	0.012	0.16	0.028	0.012
4A	4A Waikawa at North Manakau Rd	9.8	99.6	4.10	79.5	7.4	0.58	0	58	0.14	0.005	0.08	0.017	0.015
4B	4B Waikawa at SH 1	13.7	99.0	2.63	76.9	7.2	0.68	0	151.5	0.14	0	0.08	0.011	0.007
5A	5A Manakau at Mountain View Rd	14.9	97.8	0.63	100	7.2	3.1	3	219	0.18	0	0.07	0.019	0.007
5B	5B Manakau at SH1 Bridge	10.5	100.4	1.40	128	7.4	3.95	3	649.6	0.46	0.011	0.18	0.038	0.015
5C	5C Waiauti at South Manukau Rd	15.6	93.9	0.57	127	7.3	5.45	7	866	0.45	0.021	0.21	0.044	0.016
5D	5D Mangahuia Stm	17.6	79.4	0.71	187	6.9	24	8	1120	4.1	0	2.60	0.096	0.046
6A	6A Waitohu Trib at SH1 (Puruaku)	13.8	60.5	0.64	285	6.9	2.55	4	38.5	6.7	0	6.50	0.051	0.035
6B	6B Waitohu Trib. 2	12.4	81.3		154	6.9	18.2	14	365	2.4	0.124	1.59	0.091	0.023

Id	Site	Hardness g/m3	DOC mg/L	Diss. Cr mg/L	Total Cr mg/L	Diss. Cu mg/L	Total Cu mg/L	Diss. Pb mg/L	Total Pb mg/L	Diss. Zn mg/L	Total Zn mg/L	TPH max mg/L	PAH mg/L
1A	1A Koputaroa at McDonalds Rd	26	4.1	<0.0005	<0.0005	0.001	0.001	<0.0001	<0.0001	0.002	0.002	<0.7	nd
1B	1B Koputaroa at Travistock Rd	50.5	3.7	<0.0005	<0.0005	0.001	0.001	<0.0001	<0.0001	0.001	0.002	<0.7	nd
2A	2A Ohau at Quarry	15.1	1.3	<0.0005	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0001	<0.0001	<0.7	nd
2B	2B Ohau at SH1 Bridge	16	1.1	<0.0005	<0.0005	<0.0005	0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.5	nd
3A	3A Kuku at Kuku East Rd	21.5	4.2	<0.0005	<0.0005	0.001	0.001	<0.0001	<0.0001	0.001	0.001	<0.7	nd
3B	3B Kuku at SH 1	23	3.9	<0.0005	<0.0005	0.001	0.001	<0.0001	<0.0001	<0.0001	0.001	<0.7	nd
4A	4A Waikawa at North Manakau Rd	18	1.35	<0.0005	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0001	0.001	<0.5	nd
4B	4B Waikawa at SH 1	16.65	1.3	<0.0005	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0001	<0.0001	<0.7	nd
5A	5A Manakau at Mountain View Rd	19.4	3.3	<0.0005	<0.0005	0.001	0.001	<0.0001	<0.0001	<0.0001	0.001	<0.7	nd
5B	5B Manakau at SH1 Bridge	25.5	3.45	<0.0005	0.001	0.001	0.001	<0.0001	<0.0001	<0.0001	0.001	<0.5	nd
5C	5C Waiauti at South Manukau Rd	25.5	4.55	<0.0005	<0.0005	0.001	0.001	<0.0001	<0.0001	<0.0001	0.001	<0.7	nd
5D	5D Mangahuia Stm	34	8.8	0.001	0.001	0.001	0.001	<0.0001	<0.0001	0.002	0.002	<0.7	nd
6A	6A Waitohu Trib at SH1 (Puruaku)	78	2.5	0.004	0.005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0001	0.002	<0.7	nd
6B	6B Waitohu Trib. 2	54		0.001	0.001	0.001	0.001	<0.0001	0.001	0.002	0.005	<0.7	nd

NB Site 1B Koputaroa at Travistock Rd had the July 2021 sampled collected at SH57. Site 2A Ohau at Quarry had the July 2021 sample collected at Mahunoa East Road.

Site 6B Waitohu Trib. 2 were sampled only once (29 July 2021).

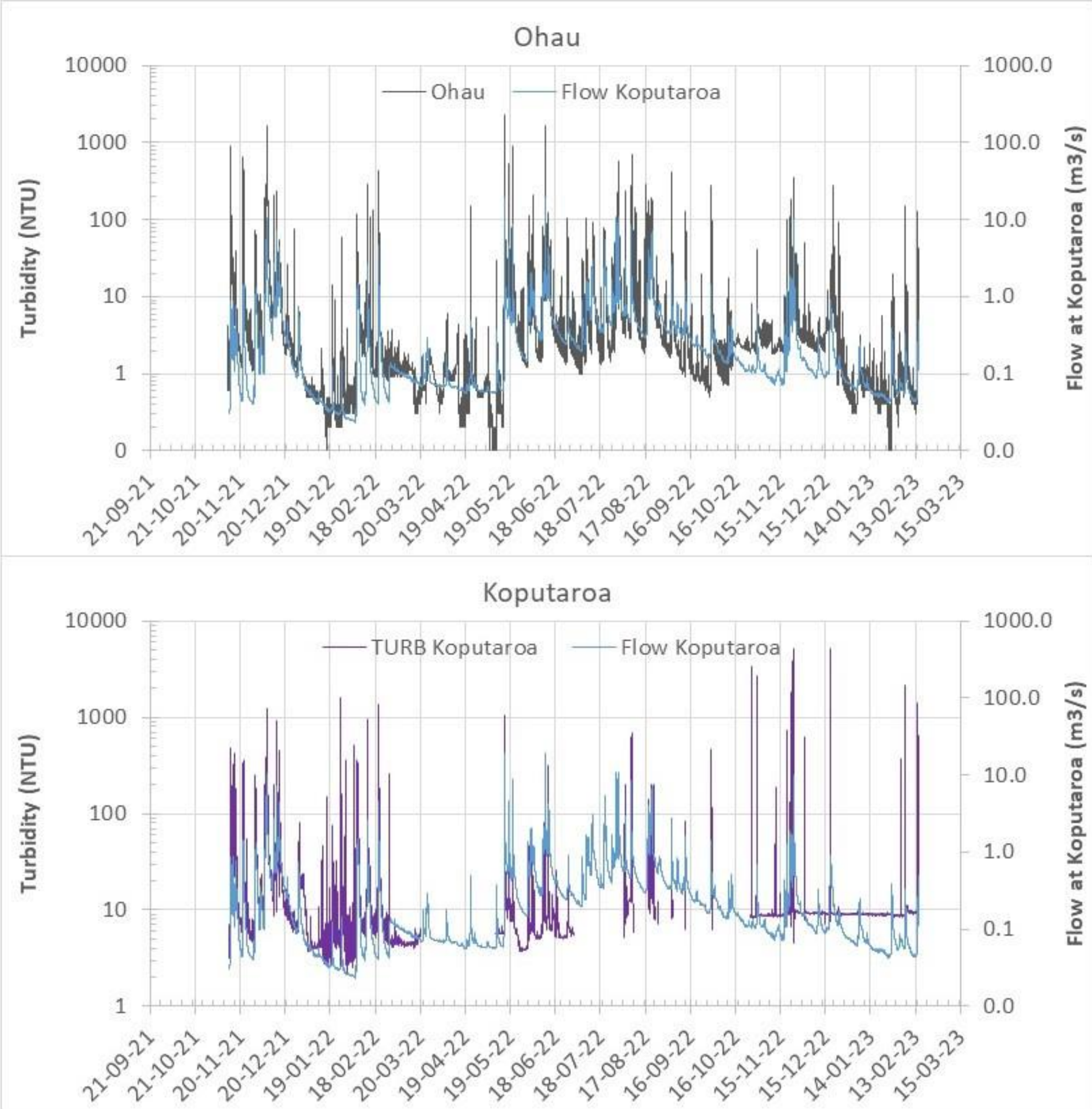

Figure H.3 update: Turbidity in the Ohau River and Koputaroa Stream (30-minute median of 5-minute readings). Flow in Koputaroa is shown for context.

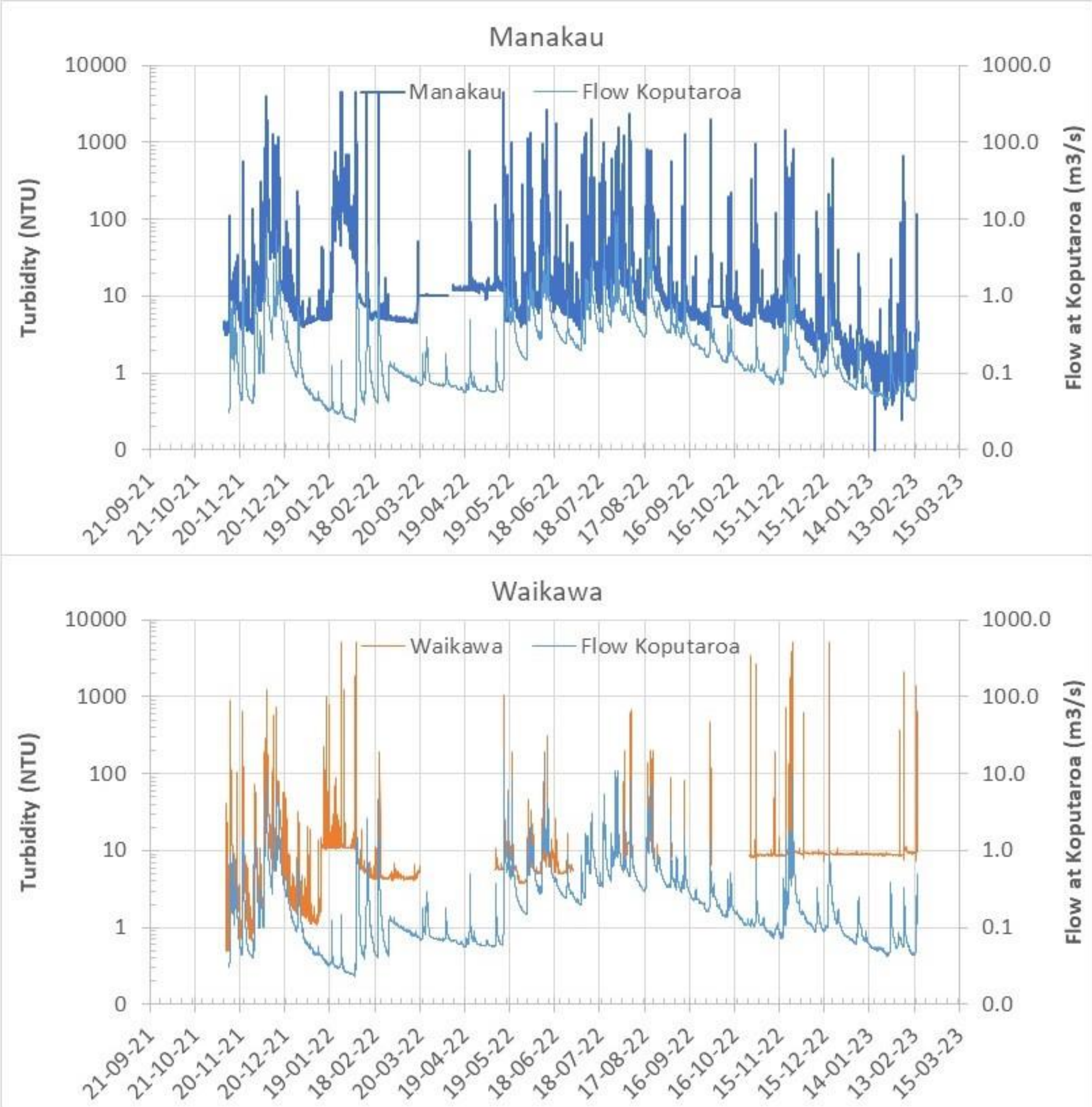

Figure H.4 update: Turbidity logger in Manakau Stream and the Waikawa Stream (30-minute median of 5-minute readings). Flow in Koputaroa is shown for context.

Response to section 92 requests for further information

27. I have assisted with the response to further information requests from the Councils related to Technical Assessment H. I provided technical advice in respect of Waka Kotahi's response to question 28 (relating to water clarity triggers), question 46 (relating to water hardness), question 47 (relating to turbidity graphs), question 50 (relating to stormwater treatment assumptions used in the CLM), and question 67 (relating to the relationship between clarity, turbidity and suspended solids).

COMMENTS ON SUBMISSIONS

John Bent, Palmerston North

28. The submission made by John Bent requested further consideration of the adverse effects arising from increased runoff from sealed, semi-sealed and other unsealed surfaces. In particular the submission raises questions about litter / floating contaminants from roads entering surface water and the adverse effects from the breakdown of plastics and contaminants that are petrochemical in origin. The submission seeks the installation of structures to capture and prevent off-site discharge of litter, supported by an operational management plan for maintenance.

29. The change in runoff from sealed and unsealed surfaces has been accounted for in the stormwater treatment design and the CLM. The Project will treat stormwater from the road using multiple treatment devices in a treatment train. As described in Technical Report H, the Project will result in a net reduction in the major road related contaminants, including a net reduction in total petroleum hydrocarbons (**TPH**). There are three sub-catchments (B, L and P) where the model indicated a small increase in TPH, but the effect on these sub-catchments would be negligible.[3]

30. As to the management of litter, highways are inevitably potential sources of litter and other forms of gross pollution to stormwater.[4] It is difficult to estimate the expected volumes for the Project, however, for reference, an estimated load of 0.4 m^3 ha^{-1} yr^{-1} of gross pollutants can be generated in suburban catchments, of which about 30% is anthropogenic (human-generated) litter (Auckland Council 2011). Litter volumes from the Project are likely to be lower than in a suburban setting but still present. Roadside litter management can be a significant component of highway operations (Andres and Andres 1994).

31. The proposed swales and wetland treatment devices will detain a proportion of the litter that will be removed during regular maintenance – this will provide a better outcome than the current situation, where stormwater from the current SH1 is predominantly untreated. However, I understand that the stormwater treatment devices as currently proposed for the Project have no specific screens to capture floating litter such as plastic bottles.

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[3] Technical Report H, at paragraphs [11], [158], [160] and [164].
[4] Gross pollutants are those >5 mm in diameter.

32. There is the potential to modify the current stormwater treatment design as part of the detailed design phase to allow for the capture of gross pollutants, including plastics and other floating litter. This could be in the form of screens installed at either the forebays or prior to discharge, with the clearing of these screens incorporated into the regular maintenance schedule.

33. In conclusion, the installation and maintenance of screens at the forebay or at the discharge point of each stormwater treatment wetland is a potential design modification to further minimise impacts. This initiative will be investigated as part of the detailed design phase.

COMMENTS ON THE COUNCIL REPORTS

34. I have made comments in the sections below on key issues relating to water quality that have been raised by experts to inform the Section 87F report and the Section 198 D report.

Section 87F Report, Appendix 3: Water Quality and Aquatic Ecology by Logan Brown

Effects of sediment during construction

35. Mr Brown notes in paragraph 45 of his report that "*Assessments need to be undertaken at both the catchment and proposed works area scale to consider the full effects of the Ō2NL Project within the context of the catchment*", including an assessment for the "*immediate receiving environment*". I can confirm that this has been done. Assessments of water quality effects were undertaken, for all practical purposes, for the immediate receiving environment. Sub-catchment boundaries used in the water quality assessment were generally defined at the current SH1, with an additional sub-catchment created where a significant stream entered between the new road and current SH1 (i.e., Waiauti Stream, catchment E). Because the new road is located close to the current SH1, this results in sub-catchment areas being only a little larger than if defined at the stormwater outlet, while greatly simplifying analysis, reporting and monitoring of the effects of the Project.

36. Some of the proposed operational stormwater treatment wetlands will discharge to small tributaries as discussed in Technical Assessment H.[5] There is potential for elevated risk of hydrology and temperature effects in catchments with greater than 10 percent as impermeable area, i.e.,

[5] At paragraphs [156], [157] and [163], for example.

discharges from treatment devices WP 1 (catchment P), WP 2 (catchment P), WP10 (catchment M) and WP14 (catchment I). However, even in these catchments, any effect of water temperature will still be "low" given to the nature of the receiving water. I also note that the assessment is conservative because for small rain-events, the first flush will go to infiltration or be detained within the water quality volume of the treatment wetland.

37. The locations of erosion and sediment control treatment devices used during the construction phase are not yet known[6] and there are likely to be multiple devices per sub-catchment. In my view, the sub-catchment boundaries are a reasonable and appropriate scale to assess effects of construction sediment.

38. Table 1 of Appendix 3 of the Section 87F report repeats data from Table H.15 from Technical Assessment H and from Table 4.3b the DCR. The column titled *"% increase in catchment sediment load*" in Table 1 of Mr Brown's appendix to the Section 87F report has different values from those in Table H.16 of Technical Assessment H. This is because of a calculation error in Table 4.3b of the DCR. I have discussed this issue with Mr Brown and we are in agreement to apply the calculation method used in Table H.16. This has been used in updated calculations presented in **Appendix A** of this report.

Sediment in estuaries

39. Mr Brown notes (paragraph 51 of his report) that consideration should be given to the effects of sediment on the four estuaries receiving water from rivers crossed by the Project – Ohau, Waikawa, Manawatū and Waitohu.

40. Estuaries are important and sometimes sensitive receiving environments, however, for this Project the estuaries are likely to be less sensitive than the rivers and (in the case of Waitohu catchment) the downstream wetland systems. This is because the Project, during bulk earthworks of the construction phase, contributes only a small fraction[7] of the total sediment load to Manawatū estuary (0.002%), Ohau estuary (0.19%), Waikawa estuary (1.3%) and Waitohu estuary (1.9%). In the case of the Waitohu estuary, much of the sediment load estimated from the Project during construction will not actually reach the estuary, but instead be trapped and

[6] The location of ESC devices will be identified in the Site-Specific Erosion and Sediment Control Management Plans (SSESCMP).
[7] Calculated using the same method as used in Table H.16 of Technical Assessment H.

retained by *Glyceria* within the drains entering the O-Te-Pua wetland and within the wetland system itself.

41. Furthermore, over the long-term, the Project will result in a net decrease in sediment loads due to less sediment loss during the operational phase compared to the current land use. For Waitohu estuary, Waikawa estuary, Ohau estuary and Manawatū estuary, I calculated that the Project will achieve a net reduction in sediment load in 14.3 years, 8.8 years, 5.7 years and 8.0 years respectively. These are indicative numbers to provide context (the calculations are described in **Appendix A**). The timeframe is shorter in catchments with a smaller earthwork's footprint relative to the final road, and in catchments that will have more land retired.

Sediment Standards for sediment treatment devices

42. Mr Brown has proposed (paragraphs 16(e) and (f) of his report) that standards for discharges from sediment treatment devices reflect the sensitivity of the receiving environment, on the basis that even with the proposed ESC measures in place to limit instream effects as a result of sediment discharges, the Project will still result in more sediment entering the catchments than the status quo. As discussed in the response to the section 92 request, the 100mm trigger is set for the management of ESC treatment devices. I understand, from discussions with **Mr Gregor McLean**, that setting stricter clarity triggers at the outlet of erosion and sediment control devices is unlikely to be consistently achievable. Instead, I suggest that construction risks are managed using a robust aquatic monitoring and response framework that has clear responses if triggers are exceeded. A draft Aquatic Monitoring and Response Framework has been prepared to describe the triggers, targets and responses for each type of monitoring (**Appendix B**).

43. In Technical Assessment H, I estimated the magnitude of effects from earthworks during construction. This ranges from 'Low' to 'High' depending on the relative increase in catchment sediment load due to the earthworks, and the relative effect on water clarity. However, the overall effects on streams will depend also on their hydrology, substrate, and the sensitivity of the aquatic life in the streams. The streams with the highest relative sediment load, i.e., catchments B, C, D (Waitohu), G (Manakau Trib) and I (Mangahuia) have aquatic communities already reflective of sediment inputs. In contrast, large rivers with the smallest relative increase in sediment from

earthworks have macroinvertebrate communities more dominated by sensitive taxa (see Technical Assessment K: Freshwater Ecology). In my view, the Aquatic Monitoring and Response Framework provides an effective way to manage risks of sedimentation from earthwork in streams with different risks and sensitives.

Sediment to O-Te-Pua Wetland

44. Mr Brown raised specific concerns about potential effects of sediment from construction on the Paruauku Swamp / O-Te-Pua Wetland (paragraph 77 of his appendix to the section 87F Report), which is downstream of the Project catchments C and D. The catchment sediment load to O-Te-Pua Wetland is estimated to increase by 22% during the period of bulk earthwork activity (**Appendix A**). Much of this sediment will contribute to long-term sedimentation when trapped by *Glyceria* within the drains, wetland vegetation or deposited within the wetland lagoon.

45. However, this short-term increase in sediment loads during bulk earthworks is balanced by a long-term reduction in sediment loads following construction. The reduction in long-term sediment loads is due to a change in land use (retirement of land from pastural farming) and, to a lesser extent, the treatment of stormwater from the new road. For the O-Te-Pua wetland, I estimated that the Project will attain a net reduction in sediment loads after about 16.3 years following construction (**Appendix A**).[8]

Monitoring

46. In Paragraph 74(b) of his report, Mr Brown proposes Condition RFE4(b) be amended to provide for a longer period of baseline monitoring before commencing works. Although a longer period of monitoring may better characterise natural variability at a site, monitoring upstream and downstream of sites better accounts for natural variability. Ideally, studies have a Before, After, Control, Impact (**BACI**) design, but upstream-downstream monitoring commonly provides reliable information for assessing effects even in the absence of baseline monitoring. The draft Aquatic Monitoring and Response Framework incorporates both triggers determined from baseline monitoring, and the use of upstream and downstream monitoring to allow for reliable comparisons. Accordingly, I do not consider

[8] This time assumes that bulk earthworks occur for two years with the overall construction phase, including enabling works, being longer.

the amendments to Condition RFE4(b) proposed by Mr Brown are necessary.

Monitoring of stormwater treatment devices

47. Mr Brown's report (paragraphs 111, section O) notes that the stormwater treatment devices rely on ongoing monitoring and maintenance to ensure that they operate as designed. I agree with Mr Brown that such ongoing monitoring and maintenance is important. This can be effectively and practically achieved by undertaking inspections alongside routine and corrective maintenance. There are common monitoring and maintenance procedures (e.g., Farrant et al. 2019) that can be undertaken for all stormwater devices, which is further discussed by **Mr Nick Keenan**.

48. Mr Brown's report proposes intensive monitoring of at least two treatment wetlands in sensitive catchments to characterise their performance.[9] In my view, monitoring the performance of the stormwater treatment wetlands is more suited to a longer-term research study than a consent condition. Using swales and wetlands to treat stormwater is mature technology, with established design criteria and extensive studies of their performance (e.g., Kadlec and Wallice 2009). Treatment performance varies with hydraulic loading, seasons, maturity of the wetland design and maintenance, so intensive, time-integrated monitoring of inflows and outflows is requited to accurately assess loads and performance. Assessing the effectiveness of the swales provides an additional challenge as they have non-point source inflows. Furthermore, confirming the performance of a particular stormwater treatment device as part of a consent condition has limited value compared to the operational monitoring and maintenance that will be undertaken.

49. If there are concerns about the effects of operational stormwater on receiving waters, then monitoring should be effects based and focus on contaminants of concern in sensitive waterways upstream and downstream of discharges. However, in my view this type of monitoring is not needed at present, because the Project is following good practice for stormwater treatment, the modelling has found the treatment will result in an overall net benefit in reducing contaminant loads, and even for sites / variables that do not have net benefits, the risk of adverse effects on water quality are low (see Technical Assessment H, Table H.26).

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[9] At paragraphs [114] – [115].

Section 198 D Report Appendix 5: Water quality by Justine Bennett

50. At paragraphs 48 to 52 of her appendix to the section 198D report, Ms Bennett comments on monitoring during the construction phase, focussing on parameters to be included in event-based monitoring (clarity and total suspended sediment), timing for event-based monitoring and baseline monitoring.

51. As discussed above, a draft Aquatic Monitoring and Response Framework has now been prepared to describe the triggers, targets and responses for each type of monitoring (this is included in **Appendix B**), which provides more clarity on monitoring and response actions during the construction phase. An important part of the monitoring framework is the use of aquatic macroinvertebrates and deposited sediment to assess effects. It also incorporates a comparison of upstream and downstream monitoring results to account for temporal variability (as previously discussed). Each of the major catchments has sites suitable for monitoring located upstream and downstream of the Project, so in my view, requiring an extended period of baseline monitoring of two to three years (as per paragraph 52 of Ms Bennett's report) is unnecessary.

52. Ms Bennett recommends monitoring of the performance of operational stormwater devices at paragraphs 57-61 of her report. As discussed above, confirming the performance of a particular stormwater treatment device as part of a consent condition has limited value compared to the operational monitoring and maintenance that will be undertaken. If there are concerns about the effects of operational stormwater on receiving waters, then monitoring should be effects based and focus on contaminants of concern in sensitive waterways upstream and downstream of the discharges. It is relevant to note that some of the benefits of the Project are due to a change in land use, and even if the operational stormwater had no treatment there is likely to be a substantial reduction in sediment loads simply due to the land not being in farmed pasture.

Keith David Hamill

4 July 2023

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APPENDIX A: NET SEDIMENT LOAD FROM EACH CATCHMENT AND THE TIME FOR THE PROJECT TO ACHIEVE ZERO NET SEDIMENT LOAD.

The table includes calculated sediment loads for periods before the Project, during bulk earthworks and after construction/during operation.

		Earthwork Footprint from USLE calculations			Stream catchment (NIWA Suspended Sediment Yield Estimator)						Sediment Load from final footprint before and after Project					
ID	Name	Earth work area (ha)	Increase in sediment load from Project footprint (fraction)	Project footprint as % of catchment	Stream Catchment area (ha)	Catchment sediment Load before (t/y) (Hicks et al 2011)	Footprint sediment Load before (t/y)	Footprint Sediment Load during earthworks (t/y)	Increase in catchment sediment load during earthworks (t/y)	% increase in catchment sediment load during earthworks	Final footprint (ha)	Footprint Sediment Load before Project (t/yr)	Sediment Load of SW device during operation (t/yr)	Sediment Load of planted during operation (t/yr)	Change Sediment Load (After - Before) (t/yr)	Years for zero net sediment load (Earthwork incr. / Operation decr.)
A	Greenwood	7.38	3.70	3.9%	187	76	1.9	7.0	5.1	6.7%	6.00	1.53	0.00	0.23	-1.3	7.8
B	Waitohu	20.30	5.92	14%	144	69	5.5	32.3	26.9	39.0%	19.30	5.19	0.24	0.54	-4.4	12.2
C	Waitohu 1	22.70	5.92	18%	127	79	4.2	24.9	20.7	26.2%	17.50	3.24	0.28	0.20	-2.8	15.0
D	Waitohu Trib 3	8.57	5.92	32%	27	9.4	1.7	10.1	8.4	89.3%	4.85	0.97	0.00	0.14	-0.8	20.5
E	Waiauti	11.75	5.92	1.5%	792	837	3.1	18.4	15.3	1.8%	22.62	5.99	0.20	0.70	-5.1	6.0
F	Manakau	2.73	5.92	0.4%	750	1,106	0.9	5.5	4.6	0.41%	6.26	2.12	0.00	0.32	-1.8	5.1
G	Manakau Trib	9.59	5.92	11.3%	85	45	3.3	19.4	16.1	36.0%	6.95	2.38	0.28	0.07	-2.0	16.0
H	Manakau Trib	3.85	3.70	4.5%	85	55	1.3	5.0	3.6	6.6%	3.61	1.26	0.00	0.19	-1.1	6.8
I	Mangahuia	28.87	4.67	14%	202	117	10.2	47.8	37.6	32.1%	27.44	9.74	0.55	0.91	-8.3	9.1
J	Waikawa	7.35	3.70	0.23%	3,211	8,153	2.5	9.2	6.7	0.08%	12.02	4.09	0.16	0.45	-3.5	3.9
K	Waikokopu	9.59	3.70	4.8%	198	163	3.3	12.3	9.0	5.5%	7.63	2.66	0.00	0.40	-2.3	8.0
L	Kuku	29.14	3.70	3.0%	960	1,088	9.4	34.6	25.3	2.3%	25.91	8.32	0.67	0.58	-7.1	7.1
M	Ohau	27.94	3.70	0.20%	13,687	32,426	8.9	33.1	24.1	0.07%	40.47	12.95	0.53	1.41	-11.0	4.4
O	Koputaroa	43.75	4.67	2.9%	1,489	1047	11.4	53.1	41.7	4.0%	38.39	9.98	0.89	0.61	-8.5	9.8
P	Koputaroa Trib	27.19	4.67	4.6%	595	81	3.0	14.0	11.0	13.5%	38.16	4.20	0.11	0.52	-3.6	6.1
A, B, C, D	Waitohu Estuary	58.95	5.90	1.3%	4,579	3,462	13	78.1	64.9	1.9%	47.65	10.71	0.55	1.06	-9.1	14.3
C, D	Paruauku Swamp	31.27	5.92	9%	356	134.6	5.9	35.0	29.1	21.6%	22.4	4.19	0.29	0.34	-3.6	16.3
E, F, G, H, I, J	Waikawa Estuary	64.14	5.60	0.83%	7,711	7,366	21	119.9	98.5	1.3%	78.89	26.34	1.20	2.75	-22.4	8.8
K, L, M	Ohau Estuary	66.67	3.70	0.36%	18,615	31,229	22	80.0	58.4	0.19%	74.01	24.01	1.22	2.38	-20.4	5.7
O, P	Manawatū Estuar	70.94	4.67	0.012%	589,800	2,419,374	14	67.0	52.7	0.002%	76.55	15.50	0.88	1.44	-13.2	8.0

Note:

Sediment Load Reduction Factor is the relative reduction in sediment yields if changing landuse from Pasture to Road (0.51), Pasture to Retired (0.862), and the LRF for Wetland Treatment of road stormwater (0.8), as used

Final footprint includes road, SW treatment devices, batters, mitigation planting, and natural character planting (excluding grass rehabilitation on fill).

Assume that the earthwork area = road + 20m either side

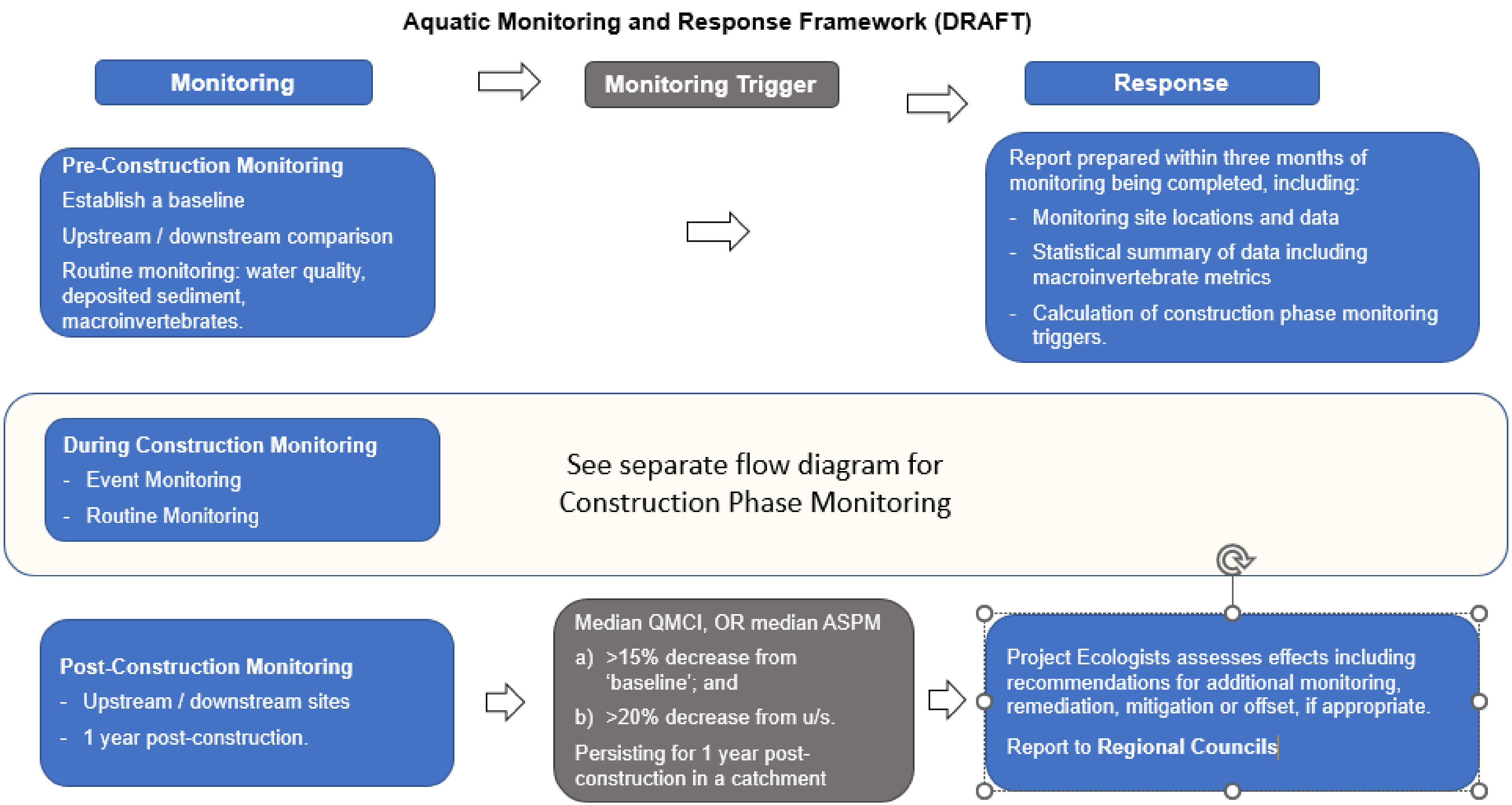
Specific yields for catchments and the Project footprint came from NIWA Suspended Sediment Yield Estimator (Hicks et al. 2011). The sediment load for catchments at the estuary were from on Hicks et al. (2019).

Time to achieve zero net loads assumes bulk earthworks in each catchment occurs for two years, with the total construction period (+ enabling works) being longer.

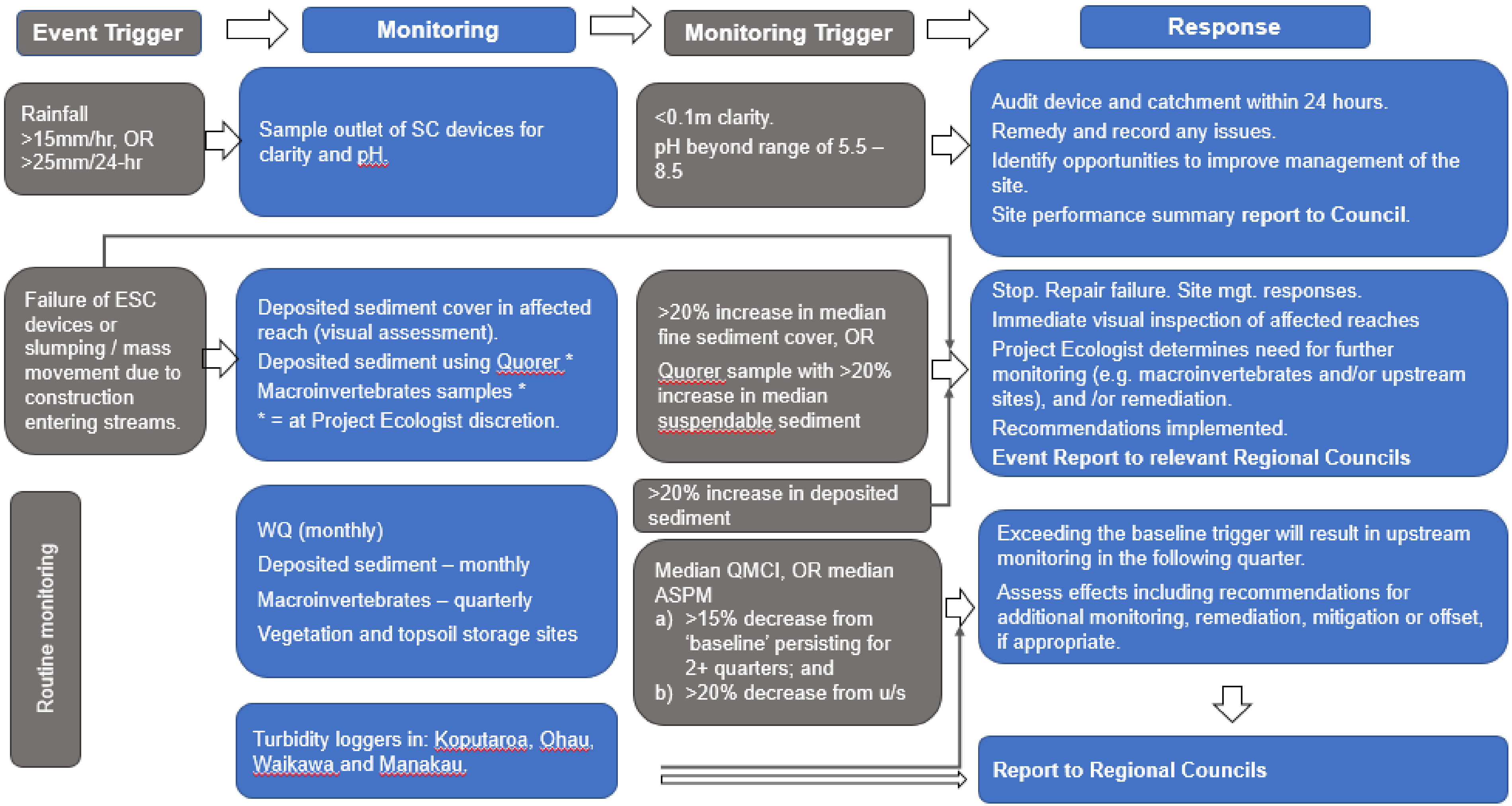
Method used for calculating the net sediment load due to the Project and the time to achieve zero net sediment load

- Earthworks during construction increase the sediment load to streams in the short-term, but over the long-term the Project results in less sediment loss compared to before the Project due to a change in landuse and treatment of road stormwater. The time for the Project to achieve a net reduction in sediment loads was calculated as the increase in sediment load during earthworks divided by the decrease in sediment load after construction is completed.
- The sediment load during construction was calculated using USLE estimates of the relative increase in sediment load during bulk earthworks, and multiplying this by the estimated sediment load of the earthwork footprint prior to the Project.
- The sediment load of the earthwork footprint prior to the Project was calculated as the sediment yield of the footprint area (from NIWA suspended sediment yield estimator (Hicks et al. 2011)) multiplied by the area of the earthwork footprint.
- The change in sediment load during the operational phase of the road was calculated as the sediment load of the final footprint after construction, less the sediment load of the final footprint prior to construction.
- The sediment load follow construction was the estimated sediment load of the final footprint prior to the works, multiplied by 1- the load reduction factors for changing landuse and for treating stormwater.
- Sediment Load Reduction Factor (LRF) was the relative reduction in sediment yields if changing landuse from Pasture to Road (0.51), Pasture to Retired (0.86), and the LRF for Wetland Treatment of road stormwater (0.8), as applied in the Contaminant Load Model.
- The calculations assumed that bulk earthworks would occur for two years for each catchment, with the overall construction phase (including enabling works) being longer.
- Note that the sediment specific yield in the footprint was less than for overall catchment due the footprint having a lower gradient. Also note that the assumed earthwork footprint is larger than the final footprint for the road during operation.
- Catchments that take less time to attain a net zero sediment loss are those that have a smaller earthworks footprint relative to the final road, and in catchments that will have more land retired (e.g. with landscaping, natural character or offset planting).

APPENDIX B: DRAFT AQUATIC MONITORING AND RESPONSE FRAMEWORK



Aquatic Monitoring and Response Framework: During Construction (DRAFT)



Aquatic Monitoring and Response Framework

Explanatory Notes:

- Event Trigger can also include failure of perimeter control, failure of a SRP or DEB, slumping or mass movement of erosion associated with construction works that enters a stream.
- The Event Report prepared by the Project Ecologist will determine the ecological effects associated with the discharge, any need for further action, and recommends any additional monitoring or remediation.
- Where Event Monitoring or Routine Monitoring shows that baseline triggers are not met, then the immediate action is to review on-site ESC practices. The Project Ecologist may recommend further monitoring, remediation, mitigation or offset if the overall ecological effects on streams are determined to be additional to those already anticipated in the AEE.
- During the construction phase there will be routine quarterly sampling at the downstream sites, but if a QMCI or ASPM baseline trigger is exceeded, then the following quarter will have replicate sampling at both upstream and downstream sites. The Project Ecologist will also have discretion to increase replicates and sampling of upstream /downstream sites if there is a trigger of >20 increase in fine sediment cover during either event based monitoring or routine monitoring.
- The trigger used for control sites shall be adjusted to reflect any differences observed between paired upstream / downstream sites during the baseline monitoring.
- Assessing the effects of construction work on streams shall consider the effects on the stream as a whole including spatial extent persistence, frequency and the extent to which the effects cascade through the ecosystem (e.g. effects on substrate, macrophytes, macroinvertebrates and fish). Effects shall be interpreted in the context of results from baseline monitoring, upstream control sites and relevant water quality monitoring. The comparison of paired upstream and downstream sites will generally be given more weight than direct comparisons with baseline monitoring as it better accounts for temporal variability.
- Post-Construction Monitoring will generally follow the routine monitoring programme, with control sites, for one year following completion of works in any particular catchment. The Project Ecologist will have discretion to refine the post-construction monitoring to focus on particular sites and/or variables so as to be relevant to any effects observed during construction. Additional monitoring, mitigation of offset shall only be recommended for effects exceeding trigger values that persist for more than one year following construction and additional to effects that are being offset or compensated through the Residual effects Management Plan.