Te Ahu a Turanga: Manawatū Tararua Highway Project
Palmerston North Project Office
Level 1, 32 Amesbury Street
Palmerston North, 4410

29 April 2020

Horizons Regional Council
11-15 Victoria Avenue
Private Bag 11025
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Attention: Mark St. Clair & Jasmine Mitchell

Dear Mark and Jasmine

**Response to request for additional information pursuant to section 92 of the Resource Management Act 1991**

This letter provides a response to the request for further information pursuant to section 92 of the Resource Management Act 1991 (RMA) received on 3 April 2020 (**Attachment 1**) in regard to the Application (APP-2017201552.00), for resource consents required to authorise the Te Ahu a Turanga: Manawatū Tararua Highway ('the Project').

The responses are provided (shown in black font) on each of the items outlined (shown in blue font) in the aforementioned request for further information.

**The following questions relate to Technical Assessment H – Freshwater Ecology, Technical Assessment C – Water Quality, Appendix E Proposed Conditions and the Ecology Management Plan**

1. *In the sedimentation section of Technical Assessment H – Freshwater Ecology, especially around effects on aquatic ecology, the scale and magnitude of effects varies between the catchments. This is understandable given the different values that the different sub-catchments have. The overall conclusion for sedimentation effects appears to make an overall assessment that the effects from the entire Project are acceptable. This is despite an acknowledgement that the potential effects will be high even with the implementation of mitigation measures and during construction in Catchments 4, 5 and 7.*
   *Could the Applicant please advise as to what additional sediment and erosion control measures [are proposed], if any, that could/should be undertaken in these catchments (at a minimum Catchments 4, 5 and 7) with higher values to ensure that the values are not compromised in these catchments? If no additional measures are proposed, what will be the subsequent effects on those catchments?*

***Could the Applicant please advise as to what additional sediment and erosion control measures [are proposed], if any, that could/should be undertaken in these catchments (at a minimum Catchments 4, 5 and 7) with higher values to ensure that the values are not compromised in these catchments?***

The suite of controls for catchments 4, 5 and 7 are described by Mr Stewart in Technical Assessment A - Erosion and Sediment Control. The suite of controls proposed reflects best practice using the most efficient sediment reduction techniques and devices available. Best practice in this case entails as much worked area as possible discharging to chemically treated sediment retention ponds and open areas being progressively stabilised to limit the worked area that is exposed at any one time. Monitoring (including through the use of handheld turbidity meters) and maintenance of all of the controls is proposed to help ensure performance. This approach has been replicated across all catchments (including those less sensitive than those referred to in the question).

Additional safeguards within sensitive catchments are allowed for in the Erosion and Sediment Control Plan (Volume VI of the application documents) in the form of making provision for the installation of two additional permanent turbidity loggers in sediment retention ponds for the duration of works. The locations of these are proposed to be determined in discussion with Horizons, noting that ponds within catchments 4, 5, and 7 are possible/likely locations. These will supplement two continuous turbidity monitors that are already in place in catchment 7 and catchment 2 (gathering baseline data) which can remain for the duration of works if required. The data from these monitors will provide further information regarding the turbidity within catchments under all flow conditions and will assist with maintenance and refinement of controls on-site.

Additional measures could in theory be employed to reduce sediment concentrations in discharges from the Project, such as ‘tighter’ restrictions around exposed areas, but these tend to increase construction timeframes and therefore increase the duration of adverse sedimentation effects occurring and/or the likelihood of a large storm event occurring during construction. The approach proposed represents an optimisation of the various considerations relevant to devising a system of erosion and sediment controls.

The overall approach to in-stream ‘routine’ and ‘event-based’ monitoring is described section 10.7.4.3 and 10.7.4.4 in the Ecology Management Plan (Volume VI of the application documents) includes monitoring of biotic and abiotic parameters as indicators of potential change. The Aquatic Ecological Monitoring and Responses Flowchart (**Attachment 2**) summarises the overall approach to monitoring and effects management (if required).

***If no additional measures are proposed, what will be the subsequent effects on those catchments?***

In responding to this question, Ms Quinn has identified errors in Table H.12 of Freshwater Ecology - Technical Assessment H. Table H.12 and advises that it should be corrected as follows: Catchment 3 should have an overall effect of moderate (rather than low), and Catchment 6 should have an overall effect of high (rather than moderate).

An assessment the effects on catchments (allowing for mitigation) is provided in Table H.12 (Technical Assessment H, page 63 – 66). A summary version of this Table including the above described corrections is provided below:

| **Catchment** | **Step 1: Ecological Value** | **Step 2: Magnitude of effect (after mitigation)** | **Step 4: Overall effect during construction** |
|---|---|---|---|
| Manawatū River | High | Low | Low |
| Catchment 1 | Low | Low | Low |
| Catchment 2 | Moderate | Low | Low |
| Catchment 3 | Moderate | Moderate | ~~Low~~ Moderate |
| Catchment 4 | Moderate | Moderate | Moderate |
| Catchment 5 | High | Moderate | High |
| Catchment 6 | High | Moderate | ~~Low~~ <u>High</u> |
| Catchment 7 | High | Moderate | High |
| Catchment 8 | Low | Low | Low |
| Catchment 9 | High | Low | Low |

Ms Quinn confirms that the magnitude of effect (low or moderate) described in Table H. 12 (reproduced in summary form above) has been determined based on the erosion and sediment controls proposed, the scale of the works in the catchment and the duration of works as described in Technical Assessment

A - Erosion and Sediment Control. By way of background, the magnitude of potential adverse effects in any given catchment is paired with the ecological value to derive an overall level of effect (in accordance with EIANZ Ecological Impact Assessment Guidelines, refer to page 16 of Technical Assessment H). The magnitude of effect has been determined to be low to moderate in all catchments, meaning that the baseline condition may be discernibly or partially changed, during construction (paragraph 212 of Technical Assessment C). When coupled with the 'high' ecological values of catchments 5, 6 and 7, the overall level of effect is 'high'. These effects are assessed as temporary as they are short-term (consistent with the Ecological Impact Assessment Guidelines 2018).

Ms Quinn notes that this assessment of effect does not take into account the quantitative benefits of the progressive stabilisation proposed (included in the Erosion and Sediment Control Management Plan (Volume VII)), as this approach is not reflected in the sediment yield estimates provided by Mr Campbell (pages 29 to 36 of Technical Assessment A) due to limitations inherent in the Universal Soil Loss Equation (USLE). As such, the sediment yield estimates on which Water Quality - Technical Assessment C and Freshwater Ecology - Technical Assessment H have relied are conservative (worst case) assumptions.

2. *It is understood from the assessments included in the application that the Applicant relies on the effects from sedimentation being 'short' term and that the streams will revert to the pre-construction state after the Project has ceased, with post construction monitoring to confirm this is the case. However, the Applicant has not addressed the following matters:*

    2.1 *What happens if the monitoring shows that the streams have not returned to their pre-construction state?*

    2.2 *When comparing the post-construction with the pre-construction state what level is considered to be 'close enough' to the pre-construction state?*

An answer is provided to question 2.2 ahead of 2.1 for flow reasons. Ahead of answering the specific questions it is necessary to provide context.

The proposed routine monitoring described in sections 10.7.4.3 and 10.7.4.4 of the EMP will be used to identify potential adverse effects during and from earthworks activities, rather than only becoming apparent following construction. This will enable actions (if required) to be implemented to remediate issues identified at devices or within the environment in a proactive way. The attached Aquatic Ecological Monitoring and Responses Flowchart (**Attachment 2**) summarises the overall approach proposed in section 10.7.4 of the EMP and includes trigger values and proposed actions (where relevant).

Post-construction monitoring will be confirmed immediately following completion of construction of any particular stage and is proposed to be submitted to Horizons Regional Council for approval (see section 10.7.4.5 of the Ecology Management Plan). This approach is proposed as construction will stop in some sub-catchments before others.

The EMP explains that post-construction monitoring will likely follow the routine monitoring programme outlined in section 10.7.4.3 and 10.7.4.4 in the Ecology Management Plan but refined to particular sites / effects observed during construction and with potentially reduced frequency. Frequency will capture the parameters of concern (if any).

Te Awa o Manawatū Cultural Monitoring Tool and Framework proposed to be developed and implemented (as identified in condition TW3) will continue beyond the construction period. This tool and framework will include monitoring of streams, including along the Manawatū River (up and down river of the Project).

*2.2 When comparing the post-construction with the pre-construction state what level is considered to be 'close enough' to the pre-construction state?*

A year of quarterly post-construction monitoring is proposed. Section 10.7.4.4 in the Ecology Management Plan will be updated to provide the following bottom lines:

- 20% or greater decrease in mean QMCI relative to the lowest score from baseline monitoring that persists for 2 or more quarterly monitoring occasions; or
- Decline in median percent (%) EPT taxa richness of 20% or more compared to baseline monitoring scores that persists for 2 or more quarterly monitoring occasions.

Should there be a need to modify these bottom lines, alternate triggers/bottom lines may be proposed subject to review and approval of Horizons Regional Council prior to commencement of monitoring.

Should these bottom lines be exceeded, an assessment of freshwater ecological effects should be undertaken to ascertain if there are adverse effects beyond what was anticipated by the Freshwater Ecology - Technical Assessment H. This will be undertaken with consideration of results obtained in paired-catchment control sites, natural variability and in relation to seasonal/rain related patterns. This is further described in the response to Q2.1 below.

*2.1 What happens if the monitoring shows that the streams have not returned to their pre-construction state?*

Should the post-construction triggers or bottom lines described in response to question 2.2 above be exceeded then an assessment of the cause of the effect will be undertaken and remedial and or mitigation measures identified. Following a year of monitoring the following scenarios are envisaged:

| Monitoring results (summary) | Further action after a year of monitoring |
|---|---|
| Triggers and bottom lines are consistently achieved within the one-year post-construction monitoring | No additional action required<br><br>Monitoring may be stopped after half a year should results clearly indicate environment has returned to a pre-construction state. |
| Bottom lines not met within one-year post-construction monitoring period. | Project ecologist to assess to determine whether additional monitoring (up to one year) and or action is required based on the anticipated magnitude of effect and monitoring results.<br><br>Assessment to include any possible cause of change and analysis beyond bottom line measures (may include for example, statistical cluster analysis to identify community change or other variables observed/monitored post-construction).<br><br>Project ecologist to assess to determine if further mitigation or offset measures are warranted if the effects are additional to those already anticipated and are likely to persist. |

3. *The Freshwater Monitoring Plan includes a range of monitoring (baseline, event triggered etc.). It would however be useful if the Applicant included the monitoring information into a table which shows frequency, parameters, and sites for the different monitoring regimes. The current word format makes it difficult to track what and where monitoring is going to happen.*

   *Could the Applicant please provide this information as a table or via another appropriate means to demonstrate what is to occur and when?*

Please refer to the Aquatic Ecological Monitoring and Responses Flowchart (**Attachment 2**). This attachment brings together approaches provided in Technical Assessment A and H and the Ecology Management Plan (provided in Volume VII). The flow chart introduces lower (15%) triggers than the (20%) triggers proposed in sections 10.7.4.3 and section 10.7.4.4 of the EMP. The lower triggers provide an interim step trigger intended to ensure specific action is begun/taken should monitoring indicate that the 20% triggers are close to being or could be reached (see response to Question 7). The Ecology Management Plan is proposed to be amended to include the 15% and 20% triggers.

As noted above, monitoring by iwi partners is to be detailed in the Tangata Whenua Values Monitoring and Management Plan provided for in proposed condition TW3 (Appendix E of Volume I).

4. *There appears to be an inconsistency between proposed condition EC15 a) i. and EC15 a) ii. Condition a) ii. is technically more correct in its alignment with good practice for stream restoration. However, proposed condition a) i. states a maximum width of 20 metres, meaning that a 1 metre width would meet this condition but the environmental outcome would not be achieved.*

   *Could the Applicant please clarify whether this is a typo in the conditions referred above, or expand on how this approach aligns with/meets best practice and fits within the restoration requirements for these streams?*

There is no typo in Condition EC15(a). Proposed Condition EC15 establishes the standards for the offsetting of residual effects on freshwater ecology values that deliver the freshwater ecological outcomes specified in the EMP and that underpin the conclusions in the Freshwater Ecology - Technical Assessment H. Clause a(i) relates to new stream channel and clause a(ii) relates to stream restoration.

A maximum width of 20 metres of riparian planting is needed to achieve outcomes in respect of new stream channel. Within that maximum of 20 metres, the width of riparian planting that will be delivered responds to physical restrictions (including proximity to the road) that prevent riparian margin of 20 metres being planted along some of the stream diversions. The riparian width of margins (for each bank) is provided in Table 10-1 at pages 107 and 108 of the EMP. Table 10-1 confirms that no margin is less than 5 metres in width on either bank. The aquatic ecological benefits of the riparian margin widths in Table 10-1 have been captured in the modelling of estimated ecological gain (used in the stream ecological valuations and environmental compensation ratios), where narrower margins have a lesser ecological benefit.

While Condition GA1 ensures that new stream channels are consistent with Table 10-1, the Transport Agency proposes the following amendment to Condition EC15 to provide greater clarity:

*"Residual adverse effects on freshwater ecology must be offset through the provision of the following:*

*i.* *9,520m$^2$ of new stream channel constructed and planted to a maximum width of twenty (20) metres <u>and no less than five (5) metres;</u>*

*ii.* *riparian planting of 10,137m$^2$ of existing streambed area over an average width of twenty (20) metres on either bank."*

Condition EC15(c) provides for a post-construction recalculation of the offset measures provided in accordance with Condition EC15(a) and provides for further planting (i.e. sets a trigger for additional offsetting requirements) should the new riparian planting of stream channels be calculated as insufficient.

5. *There appear to be slightly conflicting opinions on the use of TSS between the Applicant's expert reports in Technical Assessment H – Freshwater Ecology, Technical Assessment C – Water Quality, and Technical Assessment A – Erosion and Sediment Control in terms of sedimentation and monitoring requirements. This is especially with regard to TSS vs NTU or visual clarity. Mr Stewart raises some technical challenges with the use of TSS, especially from an operational/response management point of view. The assessment completed by Mr Hamill uses TSS as the measure to assess effects. Mr Hamill has however calculated TSS using a relationship with turbidity based on the Manawatū River at the Teachers College flow site. In terms of end of pipe or in-river standards, would it therefore not be possible to calculate the turbidity level that would be associated with the TSS from either the Manawatū at Teachers College or Manawatū at Gorge monitoring locations? Such an approach would allow for ease of management (with instantaneous results) and allow for operational changes to occur. This relationship could also be tested with the baseline data/information that has been collected over the site.*

   *Could the Applicant please provide comment as to the above matter?*

There is consistency between the technical reports for Freshwater Ecology -Technical Assessment H, Erosion and Sediment Control - Technical Assessment A and Water Quality - Technical Assessment C with regard to total suspended solids (TSS) and the monitoring of sediment. Rather, there is a difference in the focus of these assessments and the application proposes to use different measures of sediment/sedimentation in different ways depending on the purpose of the monitoring or reporting.

The variables TSS, turbidity and water clarity can often be used as proxies for each other – but within limits. If one wants to convert between turbidity and TSS, then ideally a relationship is determined for any particular catchment. The Technical Assessment C - Water Quality, used a long dataset from the Manawatū River to establish relationships between TSS, turbidity and black disc clarity valid for turbidity values less than 1200 NTU (paragraph 28 of Technical Assessment C). The relationship between TSS and turbidity gets weaker at higher concentrations – possibly because of the mobilisation of different types of sediment with different scattering properties at higher flows (Figure 1).

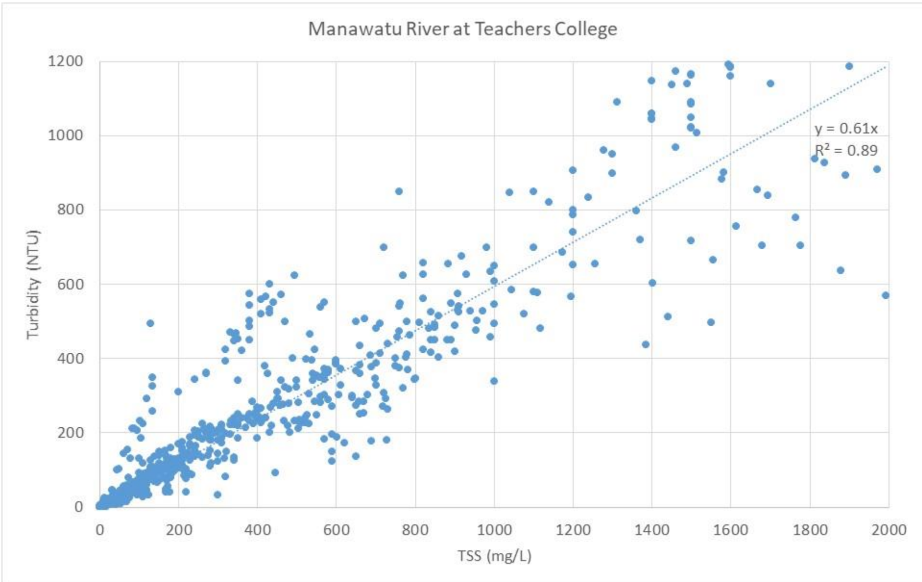


**Figure 1: Relationship between TSS and Turbidity in the Manawatū River at Teachers College Site.**

Turbidity and water clarity are preferred for monitoring performance of ESC devices because they can be measured in the field, in contrast to TSS which requires laboratory analysis. Turbidity also has an advantage because it can be measured on a near continuous basis using loggers. The Technical Assessment C - Water Quality focused more on TSS than turbidity because the models being used (i.e. CLM and USLE) estimated sediment load, which corresponds to TSS. Technical Assessment C also used relationships between TSS, turbidity and water clarity derived from Manawatū River data to convert the model results between variables so as to allow comparisons with guidelines (e.g. One Plan 30% change in clarity).

Some caution is needed if using relationships between TSS and turbidity or clarity derived from the Manawatū River to apply as an end-of-pipe standard from erosion and sediment control devices. Figure 2 demonstrates that individual measurements show considerable scatter around the general relationship between turbidity and clarity. Consequently, the uncertainty of estimating a 'true' value will be higher when applying equations to a single spot measurement that might be used for comparison with a water quality standard, as compared to applying it to a mean or median of multiple measurements. The application proposes that turbidity and clarity are measured from sediment control devices and the results used to assess treatment effectiveness and to trigger management responses.

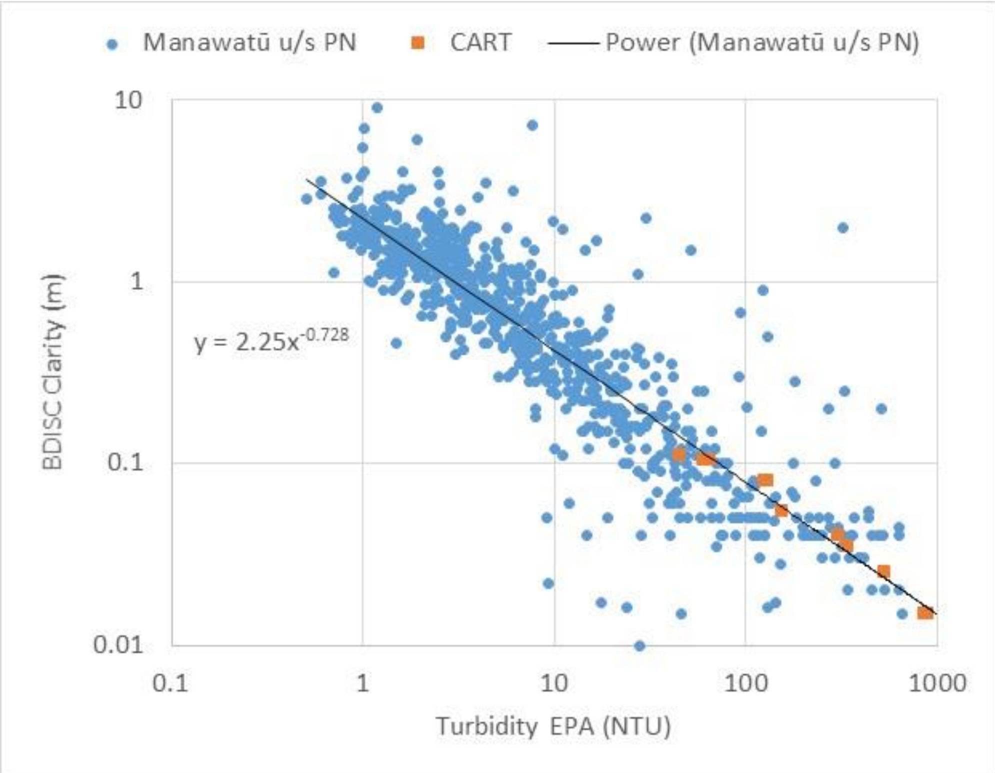


**Figure 2: Relationship between turbidity and black disc clarity in the Manawatū River at Teachers College site, and in 1 hour CART bench tests (Appendix 1.A of Erosion and Sediment Control Plan).**

There is no direct relationship between TSS (or turbidity or clarity) and sedimentation, especially for intermittent discharges during rain events. This is because sedimentation is affected by a lot of instream morphology and hydraulic factors. It is sedimentation (the sediment the settles on the stream bed) that most strongly impacts on fish and invertebrates. The AEMP (section 10.7 in the EMP) has 'Event Based' monitoring and 'Routine' monitoring of deposited sediment and aquatic macroinvertebrates, including metrics and triggers to help assess effects. Deposited sediment and aquatic macroinvertebrates are monitored instream and the results used to assess ecological effects and identify if any remediation is needed (see answers to questions 1 and 2 above and 7, 13 and 14 below).

6. *The application currently does not propose any standards for in-river or at the end of treatment devices. However, when calculating effects as a result of sedimentation on the streams/rivers, a value (standard/trigger) has been used for the water coming out of these treatment devices. Therefore:*

   6.1 *Could the Applicant please provide commentary on whether these values should be used as thresholds to ensure the devices treat the sediment water to a suitable standard and ensure effects are managed?*

   6.2 *In terms of establishing what these standards could/should be, could the Applicant please provide the end of pipe standards that have been used in the Technical Assessment C – Water Quality and Technical Assessment H – Freshwater Ecology, noting that the relationship between TSS/turb in 5 above would be the basis of being able to create this relationship and a standard/trigger in turbidity.*

A response to 6.2 is provided before 6.1 for better logical flow.

*6.2. What are the end of pipe standards that have been used in Technical Assessment C – Water Quality.*

It is understood that this question relates to the assumed sediment discharge values from earthworks sites that have been used to inform the Water Quality - Technical Assessment C. It is confirmed that the sediment discharge values are taken directly from Technical Assessment A and they have not been adjusted to account for the quantitative benefits of the progressive stabilisation proposed (included in the Erosion and Sediment Control Management Plan (Volume VII)).

The Water Quality - Technical Assessment C compared expected water quality changes from sediment discharges with the One Plan clarity target of <30% change (Table C.10) and interpreted this in the context of current water quality (clarity, turbidity, TSS) from baseline monitoring during wet and dry events (Table C.5) and from the Manawatū River (Table C.3).

By way of background, it is noted that the Water Quality - Technical Assessment C has not directly used the ANZG (2018) or 2019 consultation NPS-FM thresholds to assess potential effects of sediment. This is because the effects assessment undertaken has been of what could occur during rain events (when devices will be discharging), i.e. at the point of undertaking construction activity. Annual median concentrations (appropriate for comparing with ANZG (2018)) could be calculated but these will be much lower, do not focus on effects when they are occurring, and in any event cannot be reliably estimated with the data available.

*6.1. Could the Applicant please provide commentary on whether these [in-river or end of treatment devices] values should be used as thresholds to ensure the devices treat the sediment water to a suitable standard and ensure effects are managed?*

Table C.7 from Technical Assessment Report C shows that currently (without the Project) affected catchments do not / are unlikely to meet One Plan clarity and deposited sedimentation targets (aside from catchment 7 in respect of sediment deposition).

Developing a practical water quality standard for TSS that relates to effects on aquatic life is challenging because of the very high natural variability in TSS and lack of upstream controls. Table C.3 and C.5 of Technical Assessment C shows the variability of clarity, TSS and turbidity results of monitoring in Catchments 2 to 7 and in the Manawatū River. Outputs from continuous monitoring loggers in Catchments 2 and 7 are provided below in Figure 3 to further illustrate this variability. The figures show that turbidity is often high (e.g. >100 NTU) and often spikes in turbidity (green lines) are independent of measured flow or rain events (black lines – labelled discharge).

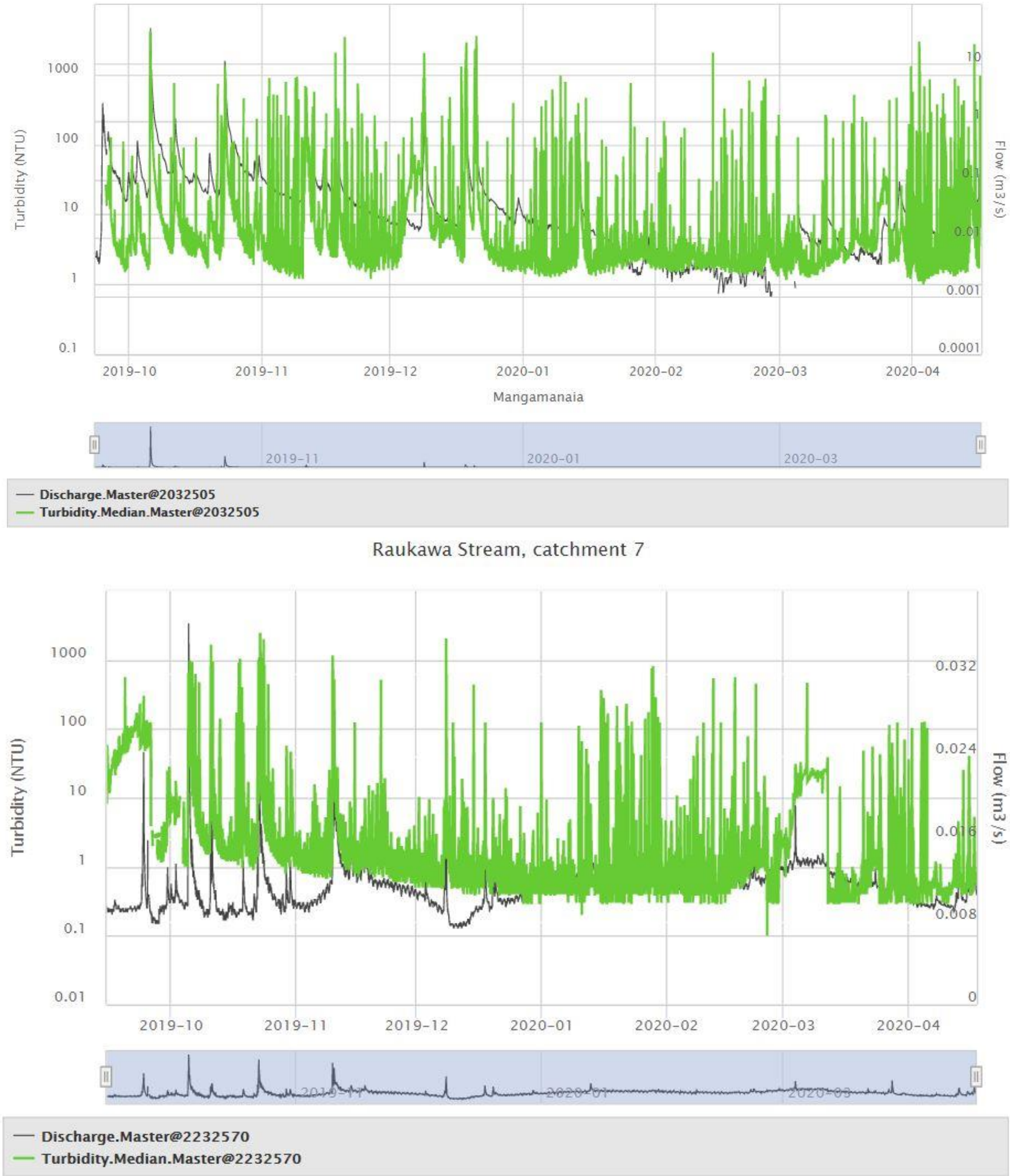


**Figure 3: Turbidity in Top Graph - Catchment 2 (Mangamanaia Stream) and Bottom Graph - Catchment 7 (Raukawa Stream)**

Note: The apparent increasing flow in **Catchment 7** (Raukawa Stream) between November 2019 and February 2020 is an artifact of willow roots increasing water levels; the flow data is yet to be corrected but is shown to identify flood events.

The One Plan target of less than 30% change in clarity is not proposed to be used because the standard is unlikely to be met on a 'without Project' basis and because the relationship of intermittent discharges to ecological effects is very uncertain. Ms Quinn in Technical Assessment H (paragraph 195) notes that native species present in the streams affected are tolerant of elevated suspended sedimentation and turbidity levels.

Relevant guidelines from ANZG (2018) and attributes from proposed amendments to the NPS-FM apply to annual median values and so are overly conservative when applied to an intermittent discharge during a rain event.

Deposited sediment has a strong relationship to instream effects. However, the One Plan target of <20% deposited sediment is problematic as a threshold because (as outlined above) baseline monitoring found all sites had at least one sample occasion with deposited sediment coverage being greater than 20% and most sites had median deposited sediment cover much higher than 20% (see Water Quality – Technical Assessment C, Table C7 and C5). To address this issue, and as outlined in response to questions 1 and 2), section 10.7.4 of the Ecology Management Plan proposes instream monitoring and then management of deposited sediment. Ms Quinn and Mr Hamill (the Transport Agency's ecological and water quality experts respectively) advise that it is more appropriate to have effects-based monitoring (as described in response to question 1 and 2) rather than seek to calculate a discharge standard based on poor relationships.

7. *There is no reference in the application to standards in terms of limiting effects in-instream (i.e.* QMCI *and %EPT taxa richness), with the proposal based around trigger levels. Trigger levels are important as they raise awareness of potential issues that may arise and therefore result in management changes before there is an issue. However, there is a point at which effects should be limited by a standard to ensure that these effects are not allowed to occur.*

   *Could the Applicant please provide what they consider to be appropriate trigger(s) and subsequent standard levels for both in-stream parameters and also discharge from treatment devices?*

**<u>In Stream Triggers</u>**

Section 10.7.4.3 and 10.7.4.4.3 in the Ecology Management Plan provides in stream triggers deposited sediment and instream biota (see **Attachment 2**). As identified in answer to question 3 it is now proposed to update these triggers to include a stepped process with a lower trigger (of 15%) providing an interim step trigger intended to ensure specific action is begun / taken should monitoring indicate that the 20% bottom lines are close to being or could be reached.

The triggers proposed are as follows:

**Event-based monitoring of deposited sediment**

- An increase in the median visual sediment coverage of 15% or more, relative to the highest baseline visual estimates for that site, for two or more consecutive quarterly monitoring occasions; or
- An increase in the median re-suspendable sediment of 15% or more, relative to the highest baseline visual estimates for that site, for two or more consecutive quarterly monitoring occasions.

**Routine quarterly monitoring**

- 15% or greater decrease in mean QMCI relative to the lowest score from baseline monitoring that persists for two or more quarterly monitoring occasions; or
- Decline in median percent (%) EPT taxa richness of 15% or more compared to baseline monitoring scores that persists for two or more quarterly monitoring occasions.

If the above triggers are reached, then the 'feedback to action' process from instream monitoring is described on the same flowchart (**Attachment 2**).

The Ecology Management Plan (Volume VII of the application documentation) will be updated to reflect the above discussed changes.

**Discharge Targets**

The proposed targets for discharges from treatment devices are as follows (pages 22 – 28 of Technical Assessment A: Erosion and Sediment Control):

- pH will be checked to see if is in the range 5.5 – 8.5;
- Turbidity monitoring to achieve a 90% or better reduction in suspended sediment (a 90% or greater efficiency);
- Clarity of discharges of 100mm or greater; and
- Specific Trigger Event Monitoring: Pre-rain inspections if a rain event of 15mm in one hour and 25mm in 24 hours is forecast, and manual turbidity monitoring of discharges before and after an event recorded and compared with the 90% or greater efficiency target (refer to paragraphs 97 – 102 of Technical Assessment A - Erosion and Sediment Control for detail).
- Should the above targets not be met then these are reported on via a Trigger Event Report (as required the ESCMP). The Trigger Event Report will recommend actions as appropriate. For further clarification, these targets have been made explicit in Section 1.4.3 (Clarity monitoring) and Section 1.4.4 (pH Monitoring) of an updated version (**Attachment 3**) of the Erosion and Sediment Control Monitoring Plan (Appendix 2 of the Erosion Sediment Control Plan, Volume VII).

8. *Technical Assessment C – Water Quality refers to EOS Ecology 2018. Te Ahu a Turanga; Manawatū Tararua Highway – Baseline freshwater monitoring plan. EOS Ecology Report No. NZT02-18064-04 prepared by A. James for New Zealand Transport Agency, and Technical Assessment H – Freshwater Ecology refers to Te Ahu a Turanga; Manawatū Tararua Highway – Baseline Freshwater Monitoring Results. Report prepared by EOS Ecology. November 2019. Report number NZT02-18064-03.*

   *Could the Applicant please provide a copy of those report(s)?*

These reports can be found in **Attachments 4 and 5**, as well as at the links below:

- EOS Ecology 2018. Te Ahu a Turanga; Manawatū Tararua Highway – Baseline freshwater monitoring plan. EOS Ecology Report No. NZT02-18064-04 prepared by A. James for New Zealand Transport Agency
- https://www.dropbox.com/s/ykhjrhxj0lzcza8/Te_Ahu_a_Turanga-Baseline_fw_mon_plan_%282018-10-11%29.pdf?dl=0
- Technical Assessment H - Freshwater Ecology refers to Te Ahu a Turanga; Manawatū Tararua Highway – Baseline Freshwater Monitoring Results. Report prepared by EOS Ecology. November 2019. Report number NZT02-18064-03.
- https://www.dropbox.com/s/2c78mpw350qjx3j/TAaT_Baseline_fw_mon_%20report_%282019-11-04%29.pdf?dl=0

9. *It is noted that old Gorge Road had a stock effluent disposal facility at the eastern Woodville end, but there is no disposal facility proposed at the western Ashhurst end. Noting the gradient of the road, there is the potential for significant leakage (spillage) from stock trucks using the road, which will result in effluent spilling onto the roads and being transferred to the stormwater treatment devices. It is understood that these devices are not specifically designed to treat raw effluent.*

   *Could the Applicant please advise if it is proposed to provide stock effluent disposal facilities at one or both sides of the proposed road and what consent if any are required for such facilities? If it is not proposed to install such facilities, could the Applicant please provide details on how the stormwater treatment devices will be effective (both short and long term) to treat the concentrated contaminants from stock effluent potentially present in the stormwater prior to the discharge to water?*

There are no effluent disposal facilities proposed as part of this Project. Possible new facilities are part of a wider Transport Agency business case process that is to be completed in mid- to late- 2020.

The management of the spillage of stock effluent onto roads is achieved by compliance with the Industry Code of Practice for the Minimisation of Stock Effluent Spillage from Trucks on Roads (April 2003). Livestock carriers are required to manage routes and include measures and devices to ensure that no effluent spills occur. The risk of a spill occurring is thus the same for all roads in New Zealand.

In terms of managing any potential effects of a stock effluent spill, any contamination will be very small because:

- Stormwater from rural roads typically has little microbiological contamination (e.g. *E. coli* bacteria) due to low loading and bacteria die-off between rain events (paragraph 117 of Water Quality - Technical Assessment C).
- All stormwater runoff from the new road will be treated by either a wetland, wetland swale or swales, and often with additional pre-treatment from catch pits or grassed channels. Most (91%) of the road stormwater will be treated by either a wetland or a wetland swale. While stormwater treatment wetlands are generally not primarily designed to treat bacterial loads, they are nevertheless very effective at reducing bacterial loads and can achieve final concentrations typically found in natural waters (Kadlec and Wallace 2009)[1]. Hathaway et al. (2011)[2] reports faecal coliform removal rates from constructed stormwater wetlands ranging from 56% to 98% with better removal rates when influent concentrations were higher during storm events. Removal mechanisms include sorption to sediment, sedimentation, predation and solar deactivation.

Further, when compared to the current devices on roads in the Region and existing land uses, the Project will result in less risk of contaminants (e.g. microbial bacteria) from stock effluent because:

- The current route over Saddle Road has no stormwater treatment devices while all sections of the proposed new state highway Project will have stormwater treatment; and
- The existing land use being replaced by the road is predominantly farmland that has an existing bacterial load to the streams that will reduce as a result of the road and exclusion of stock from catchments.

[1] Kadlec, R. H. & Wallace, S. D. 2009. Treatment Wetlands, 2nd edition. CRC Press, Boca Raton, FL
[2] Hathaway JM, Hunt WF, Graves AK, Bass KL, Caldwell A (2011). Exploring fecal indicator bacteria in a constructed stormwater wetland. Water Science and Technology 63.11: 2707-2712.

10. *It is not clear whether there will be operational stormwater (which will contain contaminants – possibly stock effluent, hydrocarbons, etc) discharged to any at 'risk' or 'rare' or 'threatened' habitats (Rules 13-8 and 13-9).*
    *Could the Applicant please clarify the location of the operational stormwater discharge points/areas relative to any 'at risk habitat', 'rare habitat' or 'threatened habitat'?*

The location of Wetland 03 and its discharge locations in relation to Schedule F 'threatened' habitat is shown in Figure 4 below. A discharge permit is sought pursuant Rule 13-9 of the One Plan and section 15 of the RMA as a non-complying activity for discharges of stormwater (once operational from Wetland 03) to a rare habitat or threatened habitat.

This is the only the stormwater treatment device located within a Schedule F habitat.

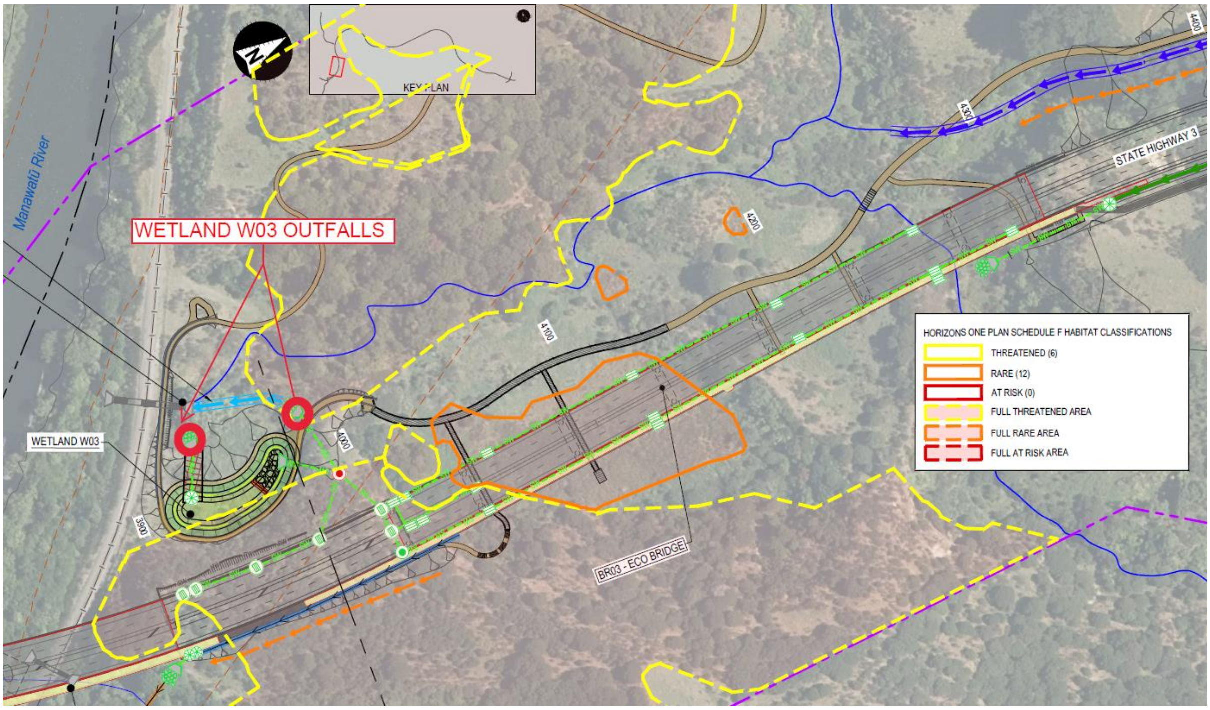


**Figure 4: Wetland W03 discharge points**

**The following questions relate to Volume 1 Application for Resource Consent, Technical Assessment A – Erosion and Sediment Control and Volume III - Drawings**

11. *Section 3.5 of the AEE details that "Cut slopes steeper than 1V:3H will not be planted as topsoil will not stay on the slope…" Whereas section 6.4.3 of the AEE implies rapid stabilisation over the entire exposed area and Paragraph 72 of Technical Assessment A – Erosion and Sediment Control, refers to progressive and rapid stabilisation.*

    *If these areas are not being topsoiled and planted, could the Applicant please clarify how cut slopes greater than 1V:3H are going to be stabilised?*

The slope angle referred to in Section 3.5 of the AEE is a typographical error and should read:

"Cut slopes steeper than 1.7V:1H will not be planted as topsoil will not stay on the slope…"

These slopes refer to the very steep batter cuts through the four significant Project cut areas, (refer to drawings in **Volume III**). These large benched cut slopes across the Project will be cut onto either sandstone, mudstone or conglomerates. The final and permanent design retains these cut slopes as rock faces. These completed rock faces are considered stabilised. All other cut slopes and disturbed soils will be progressively stabilised on a continuous and ongoing basis across the Project.

12. *The application refers to Site Specific Erosion and Sediment Control Plans (SSESCP), with examples provided as part of the application. While there have been plans provided as part of the drawing set, the full SSESCPs are missing from the application.*

    *Could the Applicant please provide the SSESCPs?*

The three complete example SSESCPs are included **Attachment 6.**

13. *The application contains details around the use of GD05 compliant controls and contains reports on how these are going to be constructed and managed. This includes the provision of example Site Specific Erosion and Sediment Control Plans. The application also contains detail on how sediment controls are going to be monitored for performance based on a 90% sediment treatment efficiency measured through turbidity. However, there appears to be no clear link between what ultimately comes off the site (sediment control device discharge point) and the resulting effects on the receiving environment. This is especially pertinent in sub catchments 4, 5, and 7 where the potential effects even through best practice sediment controls are stated in Technical Assessment H – Freshwater Ecology as being moderate to high.*

    *Could the Applicant please provide further information on the link between what is discharged from the sediment controls and the receiving environment, how this is measured, and what is considered an acceptable discharge from the site to the receiving environment?*

Please refer to answers to questions 1, 2, 6, 7 and 14 which contain the information sought by question 13. The following text provides further context.

As outlined in response to question 6, there is no quantified link between sediment yield and in-stream effects. Estimates of sediment yield have been undertaken, based on measured performance of the sediment retention ponds proposed and experience in the typical correlation between Universal Soil Loss Equations (USLE) and actual sediment yields, which has demonstrated that the USLE typically over-estimates for given rainfall events.

This information has been used to predict the likely effects on the various streams into which runoff will discharge from the sediment retention ponds during the construction phase of the Project. Technical Assessment C - Water Quality estimated potential changes in median TSS to each catchment as a result of the discharges during rain events. The results were converted to changes in water clarity for the purpose of comparing with One Plan targets.

The effect of TSS discharges on aquatic life is largely determined by sedimentation (see paragraph 101 of Technical Assessment C). Freshwater Ecology - Technical Assessment H, found that the magnitude of effects was low to moderate and in most sub-catchments the overall effects of short-term sedimentation on aquatic ecology are likely to be low. In sub-catchments with high ecological values, the overall effects are higher, albeit the magnitude remains low to moderate as the potential effects are on a temporary basis and subject to rainfall variability and the conservativeness of the assumptions inherent in the sediment yield predictions.

Further, the estimated sediment yields are considered conservative for the reasons explained in the application documents. The Freshwater Ecology - Technical Assessment H has assessed the potential sediment effects based on these conservative numbers and taking into account their temporary nature.

The ESC measures are to be designed, installed, operated and maintained in accordance with GD05. The comprehensive and proactive ESC monitoring program has been proposed to help ensure that the ESC (GD05) standard is achieved at all times. Consequently, the assumptions of the sediment yield prediction and the conclusions of the Freshwater Ecology - Technical Assessment H can be relied on for the duration of the Project. The ESC monitoring programme will be complemented by the ecological monitoring (shown in the Aquatic Ecological Monitoring and Responses Flow Chart (**Attachment 2**)) to provide feedback and, if necessary, adjustment to the management of the site.

Sediment control device treatment efficiencies and assessments are based on averages. Sediment retention efficiencies vary significantly throughout a storm, and between storms of various intensities and durations. The efficiencies reported through research are actually averages across multiple storms rather than individual storms. Moreover, in large storms the average efficiencies will progressively drop as inflow rate continues to exceed outflow rate and flows start to spill into the primary spillway (the manhole riser) and then again over the secondary (100yr) spillway. The sediment yield predictions upon which the ecological assessment is based take account of this variability. Temporary fluctuations in sediment loads within streams will not necessarily indicate an adverse effect of significance.

Finding a meaningful and reliable link between sediment discharges and instream ecological effects is challenging (see discussion above to questions 5 and 6). Accordingly, Ms Quinn, Mr Hamill and Mr Campbell (experts advising the applicant) have recommended a performance-based approach to ESC with end-of-pipe monitoring to monitor and improve performance, if it is necessary to do so. In addition, there is routine and event-based monitoring of potential effects instream and the results will be used to assess ecological effects and identify if any remediation is needed (see response to Questions 1, 2, 3, 6 and 7.).

14. *There is some discussion on monitoring of erosion and sediment controls. However, there is no detailed discussion on contingency measures should monitoring determine that the systems in place are not functioning to a satisfactory level and what the trigger in terms of a sediment discharge might be in order to determine what a satisfactory level is.*

    *Could the Applicant please clarify what the sediment discharge trigger points are and what additional measures will be considered should monitoring show sediment control performance is not meeting expectations?*

Please refer to the answer to question 7 which provides information on trigger points and targets.

Details of proposed measures that will be considered should monitoring show that sediment control performances do not meet the triggers is provided in the attached Aquatic Ecological Monitoring and Responses Flow Chart (**Attachment 2**), as follows:

- Erosion and Sediment Control
- ‘Business as usual’ site monitoring and maintenance to ensure that the earthworks sites are managed in accordance with GD05 at all times;
- Rainfall triggers (15mm/hr and 25mm/24hrs) will instigate additional site monitoring and measurement (turbidity, pH). This will provide greater certainty of the ESC performance during those higher intensity or larger events and allow a consideration of any additional monitoring and responses that may be required (notwithstanding that GD05 compliance is anticipated to achieve an appropriate level of sediment management throughout the Project);
- Turbidity monitoring (continuous at 2 locations) will identify when pond performance drops below 90% efficiency as a trigger for additional site checks and downstream observations and ‘Trigger Event Reporting’ to Horizons. 90% efficiency has been nominated as a practical average value that allows for some variability between storms and prompts an additional review of all site controls and performance; and
- Device failures and slips/slumps will also trigger downstream ecological investigations and remediation as required.

**<u>Freshwater Ecology</u>**

As detailed in Attachment 2, a report will be prepared by the Project ecologist describing recommendations for any additional monitoring or mitigation that is required. This will consider:

- Remedial and / or mitigation measures based on an assessment of the cause of any effect;
- Recommendations for any additional monitoring or mitigation if considered appropriate by the Project ecologist;

- Quarterly freshwater ecology reporting including assessment of effect and review of trigger levels; and
- Annual reporting to include all activities undertaken in accordance with the Aquatic Ecology Monitoring Plan and a review of the construction phase monitoring programme.

In the event that effects are identified (additional to those already anticipated within a sub-catchment) but the contributing area of the Project is in full compliance with GD05 and the approved SSESCP, then liaison with Horizons would be undertaken to discuss response options. Response options would look for opportunities to further enhance erosion and sediment control devices such as adjusting cut off drains, increasing the number of pond and control devices, adjusting chemical treatment in devices and adjusting construction methodologies.  However, these could have unintended consequences such as, for example, extending the works programme and thus the chance of encountering a large rainfall event while work is underway.

**The following questions relate to Technical Assessment F – Terrestrial Ecology and Technical Assessment G – Terrestrial Offset and Compensation**

*15. There appear to be a number of inconsistencies between the AEE Tables 4-6 and the tabulated values for habitats, magnitude of effects, and/or level of residual effects in Technical Assessment F – Terrestrial Ecology. By way of example;*

*15.1 Table 2 reports the value of Old Growth tree land as 'moderate' whereas Table 8 says “High”.*
*15.2 Table 2 reports value of Advance secondary broadleaf as 'very high', whereas Table 8 says “High”.*
*15.3 Table 2 reports value of secondary broadleaf with old growth signatures as 'Very High', whereas Table 8 says "High".*
*15.4 Table 2 reports value of the raupo wetland as "High", whereas table 8 says "Very High".*
*15.5 Table 2 reports value of “moderate value wetlands” as "High", whereas Table 8 says 'Moderate'.*

*Could the Applicant please explain these apparent inconsistencies and indicate the values to be utilised for the ecosystem value, the magnitude of effects, and the residual effect to be addressed through the Project?*

Inconsistencies within Terrestrial Ecology - Technical Assessment F (Table 2, 6 and 8) have been corrected in **Attachment 7**. The changes specifically relate to the following:

- 15.1: Table 8 incorrectly states the value as ‘High’ when it should be ‘Moderate’, as per Table 2
- 15.2: Table 8 incorrectly states the value as ‘High’ when it should be ‘Very High’, as per Table 2
- 15.3: Table 8 incorrectly states the value as ‘High’ when it should be ‘Very High’, as per Table 2
- 15.4: Table 8 incorrectly states the values as ‘Very High’ when it should be ‘High’, as per Table 2
- 15.5: Table 2 incorrectly states the value as ‘High’ when it should be ‘Moderate’ as the Ecological Context sub-criterion incorrectly states its value as ‘High’ when it should be ‘Moderate’.

Importantly, none of these inconsistencies have a material effect on the assessment in Technical Assessment F as the level of effects assessed and corresponding effects management requirements remain unchanged.

Additionally, Table 6-4 of the AEE was based upon Table 8 of Terrestrial Ecology - Technical Assessment F. However, the inconsistencies do not impact the outcome of the assessment of effects on terrestrial ecology, and as such, conclusions drawn within the AEE remain the same.

16. *Could the Applicant and the Project Ecologists please provide comment as to the level of confidence that the hydrological integrity of the raupo-dominated seepage wetlands will remain intact?*

Any effects on the hydrology of the raupō-dominated wetlands by the Project are considered to be less than minor. Please refer to the response in full in **Attachment 8**.

17. *In relation to water abstraction, could the Applicant please provide clarification as to which map in the Ecology series shows the indigenous habitats affected by the enabling works consents?*

The application for resource consent for the water abstraction (ie the enabling works package referred to in question 17) has not yet being lodged, and the details of that proposal have not yet been finalised.

The potential scope of vegetation removal or disturbance is allowed for in the Potential Construction Footprint shown on Sheets 1 through to 7 of the Terrestrial Ecosystem Plans (TAT-3-DG-4131 to 4137).

18. *In order to demonstrate the ability/confidence for the offset/compensation to be undertaken, could the Applicant please provide a copy of a draft landowner agreement for the offset/compensation habitat restoration sites?*

Under the proposed conditions included within Appendix E, Volume I of the application, the Transport Agency must undertake the offset/compensation measures set out in conditions EC12[3] and EC15. If the Transport Agency does not comply with those requirements, it will be unable lawfully to carry out the works authorised by the consents. To that extent, therefore, Horizons can have confidence that the Transport Agency, in undertaking the consented activities, will comply with the legally enforceable obligations set out in the conditions.

Condition EC18 sets out a process intended to provide further assurance of the Transport Agency's ability to comply with those obligations. The condition requires the Transport Agency to provide Horizons with written confirmation that it has entered into legal agreements and/or holds other authorisations necessary to allow entry onto land to carry out, continue and maintain all offset and compensation measures required by Conditions EC12 and EC15. This type of condition has been endorsed in another recent roading proposal, namely the Mount Messenger Bypass Project.

Proposed condition EC18 is also similar to designation condition 24(b), agreed by the relevant parties to the designation appeals and confirmed by the Environment Court, which provides that *"The Requiring Authority must confirm to the Responsible Officer(s) prior to the commencement of construction that it has secured the legal agreements and/or other authorisations necessary to carry out, continue and maintain, as required, all the measures provided for in the Ecological Management Plan"*.

The Proposed Ecological Offset/Compensation Plans included within Volume III of the application (drawing numbers TAT-3-DG-E-4150 to 4147, 4161, and 4162) show the location of various elements of the intended package of offset/compensation measures.

In terms of the habitat restoration sites, the Crown intends to acquire a number of the relevant properties under the Public Works Act, including the western end of the Project where a significant area of habitat restoration is intended to take place. In respect of other properties, such as Ratahiwi Farm where a significant amount of riparian planting is to be undertaken, the Transport Agency intends to enter into agreements with the landowners to allow entry onto land to carry out, continue, and maintain all offset and compensation measures required.

In order to comply with condition EC18, the Transport Agency will (in due course) advise Horizons in writing of the relevant land parcels that have been acquired, and that agreements have been entered into in respect of the restoration planting locations on land that will continue to be owned by third parties.

The proposed condition does not require the Transport Agency to provide copies of those agreements to Horizons. Rather, if the Transport Agency were to breach a consent condition, Horizons would be

[3] Offset/compensation habitat restoration sites excludes pest control compensation measures which are subject to a separate and different forms of licences/agreements with land owners.

able to initiate enforcement action. In order to mitigate this compliance risk, it is in the Transport Agency's interests to ensure that any relevant third party landowners are legally obliged to uphold the Transport Agency's obligations in respect of the restoration planting areas.

It is also relevant to note that:

- while the resource consents sought from Horizons will have a finite term, a resource consent condition can impose an obligation on the consent holder that endures beyond the expiry of the consent (see for example *Bay of Plenty Regional Council v Waaka* A080/09); and
- condition 19(b) of the designations, which will have enduring effect, provides that "Planting required by condition 24, or the conditions of any regional resource consents granted for the Project, must be legally protected in perpetuity".

Against that background, the Transport Agency does not have a draft landowner agreement to provide to Horizons in response to its request. Many of the proposed habitat restoration sites will not require such an agreement, as the Crown is seeking to acquire the fee simple title to the properties. Agreements regarding sites to remain in private ownership have not yet been prepared, as discussions with the landowners are progressing.

The Transport Agency has entered into similar agreements in relation to numerous recent Projects, including the Mount Messenger Bypass, Peka Peka to North Ōtaki Expressway, and Mackays to Peka Peka Expressway. The key elements of such agreements, adapted as necessary to meet the relevant requirements, include:

- rights for the Transport Agency to enter the land to:
    - undertake, monitor, and maintain planting;
    - erect fences to exclude stock; and
    - undertake pest control;
- an obligation on the landowner not to interfere with the Transport Agency's works, including the plantings and fencing;
- the agreement being in perpetuity (i.e. 999 years) so that the non-interference obligation endures; and
- registration of the relevant instrument on the computer freehold register of the land so that it binds future owners.

  In respect of restoration planting on land to be acquired by the Crown for the Project, if the Transport Agency were to dispose of that land it would ensure that it retained access rights and imposed similar 'non-interference' obligations on any purchaser.

**The following questions relate to Technical Assessment E – Air Quality**

19. *Technical Assessment E – Air Quality states that it has "built on" the air quality management plans required by the Designation Conditions.*

    *Could the Applicant please clarify what is meant by this statement i.e. are the plans intended to form a baseline and if so, could the Applicant provide the Te Āpiti Wind Farm Management Plan, National Grid Management Plan, and Ballantrae Research Station and Fertiliser Trial Management Plan?*

The Air Quality - Technical Assessment E advised the following: "When I come to consider mitigation for the Project, I have sought to build on the mitigation proposed to date through the Designation Conditions."

The management plans required by the conditions of the designation have not been prepared at this time. The intent of the statement was that when considering mitigation, it would build on the mitigation proposed through the designation conditions, not the plans required by the designation which are not yet in existence.

The requirement for the various management plans required by the designation conditions has not been used to form a baseline, other than to the extent that they help inform aspects of the receiving environment that may be sensitive to dust impacts that were highlighted during the designation process.

20. *In Technical Assessment E – Air Quality, the air quality assessment for the Woodville section identifies R4 and R5 as experiencing moderate to high levels of nuisance dust based on proximity and frequency of strong winds where the receptors are down wind.*

    *Could the Applicant give consideration to including R7 as a receptor for potentially moderate to high nuisance due to proximity and the frequency that it is downwind of the north westerly? If not, please explain why?*

Receptor R7 is located to the west of the proposed Woodville Roundabout. While the expected wind exposure for this location is relatively low (which led to it initially not being classified as being of a high risk), on reflection and given its close proximity (40 m), it would be appropriate to classify it as having a higher risk of exposure and mitigation responses and monitoring consistent with Receptors R4 and R5.

21. *There are recommendations in Technical Assessment E – Air Quality that do not appear to have been addressed in the ESCP Dust Management Procedure (DMP). For example, the sensitive receptors identified for the Woodville Section (Table 1) of the DMP differ between those identified in Technical Assessment E – Air Quality, as do the mitigation measures for site entranceways.*

    *Could the Applicant please advise if it is intended to update the DMP to ensure that it includes the air quality assessment recommendations?*

There are no deviations from the procedures suggested in the Air Quality - Technical Assessment E, other than the appropriate inclusion of procedures for minimising the tracking of material onto public roads around site access points. Consequently, the DMP provides additional details to the Air Quality - Technical Assessment E.

However, it is noted that there is an incorrect reference to two wind turbines within the DMP; therefore, an updated version is provided in **Attachment 9**.

## The following questions relate to Technical Assessment I – Natural Character

22. *The assessment states that its rating of effects has not considered mitigation measures. However, in some instances it appears that mitigation measures have influenced the assessed level of effects of the Project. For instance, in the table for Catchment 7 (page 110) it is stated that "On balance, given the extent of stock exclusion compared to the current situation, the Project could lead to the improvement of overall water quality and hence increase the rating of this parameter to moderate high". It would appear in this example that the mitigation measure of stock exclusion has been considered in the assessment. Similarly, the table for Catchment 8 (page 117) says the following: "May see small improvement in the riparian margins as diversions are planted." In this case, the mitigation measure of riparian planting appears to have been incorporated as part of the assessment. While the table for Crossing Point 7B (page 145) states that "Crossing involves near-complete loss of existing channel in the sub-catchment and replacement with permanent diversion. Provided this results in complete removal of stock from the catchment with revegetation/retirement of former pasture in the sub-catchment then an increase in rating may result." In this instance it appears that the mitigation measures of stock exclusion and revegetation have been assessed as changing the existing natural character of water quality from low to moderate-low.*

    *Could the Applicant please confirm:*

*22.1 What mitigation measures have and have not been considered as part of the assessment of effects on natural character, and which ratings include or exclude mitigation?*

*22.2 If a difference in approach has been taken as between mitigation and non-mitigation of effects in any given instance, which ratings should be changed for the purpose of ensuring a consistent rating approach?*

The post-development state was assessed in terms of what is proposed to be delivered on the whole at the completion of this Project. This includes:

- the proposed measures in the Design and Construct Report (including proposed stormwater treatment; culvert design, including provision of fish passage where practicable; and diversion of streams);
- implementation of the CEMP and ESCP; and
    - fencing of the new highway, which will also result in excluding stock from certain waterways.

In addition, the members of the team assessing water quality, exotic aquatic flora and fauna; indigenous taxa assemblages, ecosystem functioning and terrestrial ecology (Mr Hamill, Dr James, Ms Quinn and Mr Markham) took into account the contribution of riparian planting of constructed stream channels in assigning their attribute ratings. Other members of the team (Dr McConchie, Mr Hughes and Mr Evans) did not, however, they have confirmed that if they had, this is unlikely to have affected their individual attribute ratings. While there is some discrepancy in the approach in this respect, each individual member of the team applied a consistent approach in assigning their individual attribute ratings.

Further detail is provided below.

**Fencing/stock exclusion**

The new highway will be fenced as part of the Project to prevent stock access as is standard Transport Agency practice; this is an operational and safety requirement of all roading projects. Fences are similar to culverts and bridges in that they are elements required to facilitate the construction and operation of a road.

Where fencing is required for the operation of the road and this will result in excluding stock from waterways, which will result in potential beneficial outcomes, this is explicitly stated in the assessment tables in Appendices I.3 and I.4. This is explained further below:

- In catchments 3, 4, 5, 6 and 7 (Appendix 1.3), the statements in the tables in relation to water quality post-development note the removal of stock or the reduction of stock density in the upper catchments.
- For water quality in catchments 3 ,4, 5 and 6, the post-development ratings do not change.
- Catchment 7 is a special case as the road will effectively remove stock access for the remainder of the main channel that is not already protected by a QEII open space covenant and in relation to water quality, the post-development rating improves from moderate to moderate high, noting that, *"On balance, given the extent of stock exclusion compared to the current situation, the Project could lead to the improvement of overall water quality and hence increase the rating of this parameter to moderate high."*
- In relation to crossing point 7B, under water quality, reference is made to the removal of stock from this area post-development and it is stated that, *"Crossing involves near-complete loss of existing channel in the sub-catchment and replacement with permanent diversion. Provided this results in complete removal of stock from the catchment with revegetation/retirement of former pasture in the sub-catchment then an increase in rating may result."* The water quality rating therefore changes from low to moderate low post -development.

**Riparian planting**

As noted above, only certain members of the natural character team took riparian planting of constructed stream channels into account in assigning post-development ratings. Some examples of where this has occurred are set out below:

- In catchment 1, the commentary for the terrestrial ecology attribute post-development notes that, "May see some improvement in the riparian margins as diversions are planted. Minor improvement only, given modification of landscape, proximity to road, anthropogenic planting of 'easy maintenance' species rather than diverse representative of natural ecosystems." The attribute rating for terrestrial ecology therefore changes from very low to low post-development.
- In relation to crossing point 5B, the commentary for the terrestrial ecology attribute post-development states, "Diversion on top of spoil will have some riparian planting but restricted by location in windfarm and engineered materials." Therefore, the terrestrial rating changes from moderate to low post-development.
- For crossing point 7B, the commentary for the terrestrial ecology attribute post-development notes, "Diversion on/adjacent to embankment will provide opportunity for planting to improve riparian margins from pre-development but not reflective of natural conditions." There is, however, no change to the rating (i.e. it remains low post-development).

23. *The assessment of natural character for the various streams affected by the Project appears to be considered at a catchment scale. The report provides the total catchment area and the length of stream under the Project footprint for each catchment. However, the report does not provide the total stream length in each catchment. This makes it difficult to ascertain the percentage or ratio of stream affected in comparison to its total length.*

Stream lengths have been calculated on the basis of either field assessments (which have been used to ground-truth the extent of Project works impacting on streams) or GIS/Lidar modelling, which has been used to estimate intermittent and permanent stream lengths beyond the areas impacted.

In the table below, the stream length impacted is from Freshwater Ecology - Technical Assessment H and represents the length of stream that is culverted, infilled or diverted (noting that this does not take into account the contribution of stream diversions). These walked stream lengths were considered by the natural character team when assigning their individual and overall natural character ratings.

As it was not feasible or necessary to walk all streams in the wider catchments, the length of all potential overland flow paths with a contributing area of 30,000m$^2$ or more within each stream catchment was calculated to ascertain the total length of the affected streams. This catchment area was determined as being sufficient to generate flow to form intermittent streams and was informed by the field assessments. These total stream lengths are based only on contributing catchment area and do not consider the influence that vegetation, soil type or topography can have on flow generation.

For catchment 4, the Lidar coverage did not extend over the entire catchment and therefore did not allow the overland flow paths to be processed. Therefore, for a small portion of the top of catchment 4, a manual assessment of stream length based on aerial photographs was carried out.

| Stream Catchment | Stream length with contributing catchment > 3ha. (m) | Stream length impacted by works (m) | % of total stream length impacted |
|---|---|---|---|
| 1 | 12850 | 923 | 7% |
| 2 | 190190 | 2808 | 1% |
| 3 | 5060 | 724 | 14% |
| 4 | 18545* | 3167 | 17%* |
| 5 | 5745 | 3311 | 58% |
| 6 | 4715 | 127 | 3% |
| 7 | 5000 | 1195 | 24% |
| 8 | 6340 | 1052 | 17% |
| 9 | 10395 | 59 | 1% |

24. *The AEE states "That Assessment concluded that the Project may lead to a significant diminishment of natural character of particular streams at the location where the Project's construction footprint crossed the stream, but that the reduction in natural character would diminish when considered at an overall stream scale" (page 137). This appears to be inconsistent with the natural character assessment which states that the assessment was undertaken at a catchment scale (rather than an overall stream scale).*

    *24.1 Could the Applicant please clarify whether the AEE should say "catchment scale" rather than "overall stream scale"?*

    *24.2 If this is the case, could the Applicant please clarify how the effect of 'context', which diminishes as one moves beyond the river/stream corridor, has been considered in a catchment scale or stream scale?*

In response to question 24.1, yes, the AEE should have stated "catchment scale" rather than "overall stream scale."

Context simply provides a framework in which to consider things, whether it be landscape, rivers, streams, lakes, wetlands or other things. The focus of the natural character assessment for this Project is, however, on rivers and streams and their margins.

To clarify further, paragraph 57(c) in Technical Assessment I should read as follows (i.e. the word *only* has been deleted – shown in strikethrough)

> *"Context (as shown above in **Figure I.1**) is relevant when assessing the experiential attribute of natural character. However, it was considered that "context" is a much broader concept that contributes to the overall setting of the rivers, streams and wetlands. Given the focus of a natural character assessment is to understand the condition of rivers, wetlands and their margins, the extent to which "context" influences overall natural character ratings diminishes as one moves beyond the river/stream corridor. Accordingly, experiential ratings have ~~only~~ considered the natural attributes and qualities of the active bed and margins of the waterbodies, as well as the immediate area beyond the margins (refer **Table I.2**)."*

25. *The natural character assessment states that only Catchment 9 has an overall high existing natural character rating, with high representing the highest rating of existing natural character in the report. Catchment 6 is rated as having a moderate-high existing natural character. In the Notice of Requirement (NOR) process the natural character assessment for East QEII Crossing had an overall rating of high. This area corresponds with Catchment 6 in the natural character assessment undertaken for regional consenting purposes. Catchment 7 is rated as having a moderate-high existing natural character. In the NOR natural character assessment the QEII West Stream and lower stream/wetland had an overall rating of high. Both of these areas correspond with Catchment 7. If a catchment is not considered as having an existing natural character rating of high or above,*

*then it is not assessed as to whether effects of the Project will be significant (as per wording in Objective 6-2(b)(ii) of the One Plan).*

*Could the Applicant please clarify/explain:*

*25.1 Why Catchment 6 and 7 (which include QEII East, QEII West and lower stream/wetland (raupō wetland)) are considered to have an existing natural character rating of moderate-high, while QEII East, QEII West and lower stream/wetland were identified as having high existing natural character ratings in the NOR natural character assessment prepared by NZTA and its experts?*

*25.2 Why is there a decrease in existing natural character ratings between this current assessment and the ratings provided as part of the NOR natural character assessment?*

As noted in the Technical Assessment I, an almost completely new team to that which completed the natural character assessment for the NoR phase was involved in the assessment for the regional consents. In addition, other specialist inputs have been included in the current natural character assessment team (i.e. Dr Jack McConchie and David Hughes who covered stream morphology and flow regime).

When the current team was assembled, each member reviewed the natural character assessment that was completed for the NoR phase, together with the evidence that was presented at the NoR hearing and the other associated material (e.g. outcome from witness conferencing and the Commissioners' decision). The team also reviewed the assessment methodology and the matrix used in the NoR assessment. From this review, the team decided to make several refinements and amendments. These are noted in paragraphs 57 and 58 of Technical Assessment I. It is worth noting that there is no nationally recognised methodology for assessing natural character of rivers, streams, lakes and wetlands. In the few examples where assessments have been carried out, refinements have been made each time based on increased levels of understanding and knowledge.

One aspect that is widely accepted is that natural character assessment, given the range of attributes to be considered, is not the domain of any one discipline; instead it requires inputs by and collaboration across several disciplines. This is approach adopted in both the NoR assessment and Technical Assessment I.

The current team carried out a totally new assessment based on their own field work, knowledge and experience. Since the completion of the work for the NoRs lodged in November 2018, and the subsequent appointment of the Alliance and the adoption of the Northern Alignment, the specialists involved in the natural character assessment have carried out extensive field investigations and analysis as part of their technical assessments and have contributed to developing the Northern Alignment design.

This has involved, for example:

- More stream length and wetland area being identified than was estimated during the NoR phase.
- Visual inspection of all of the impacted stream length and riparian margins across the Project footprint.
- An additional 26 stream ecological valuations and associated macroinvertebrate samples.
- Verification and further surveys of terrestrial and wetland habitat across the Project alignment.
- Additional fish surveys at six sites.
- Carrying out a baseline water quality programme between December 2018 and September 2019 that collected baseline water quality (turbidity, TSS) and habitat (deposited fine sediment) data from 19 sites, and freshwater macroinvertebrate data from 17 sites, from catchments along the proposed route.
- Carrying out additional water quality sampling in October and November 2019 from 10 sites to collect baseline data on cadmium, chromium, copper, nitrogen, nitrite, nitrate, nickel, phosphorous, lead, zinc, pH, turbidity, TSS, and *Escherichia coli*.

- Carrying out water quality modelling based on a more detailed level of design that predicted the relative effects of the road on a catchment by catchment basis.
- Continuous turbidity and water level loggers installed in catchment 2 and in catchment 7.
- Improved understanding of the hydrology of the affected streams through the inclusion of an experienced hydrologist in the team and his assessment.

Consequently, while the team is very familiar with the NoR natural character assessment, the current assessment was approached afresh with each specialist assessing and rating 'their' particular attribute(s) and then collaborating through a series of workshops to share and debate their respective findings. The commentary and findings in the body of Technical Assessment I are supported by the detailed comments against each of the attributes in the tables in Appendices I.3 and I.4.

26. *The calibration method for the natural character assessment only provides examples of rivers and streams with existing natural character ratings of very high/outstanding, moderate and low/very low. There is a gap in the examples of high and moderate-high rivers and streams (shown in Figure 1.3).*

    *Could the Applicant provide examples of streams or rivers in the Horizons Region that would have a high and moderate/high natural character rating and include these in the calibration section of the report?*

The calibration diagram and commentary provide a base framework and guide. For most New Zealand rivers and streams, natural character will generally vary along the length of the waterway. For rivers originating in the mountains or hill country there is often a less significant level of modification and the levels of naturalness are generally greater near the river's source, but once the river traverses through gentler country and across the lowlands, the level of modification increases and the degree of naturalness decreases. This variability is noted in relation to the examples provided.

The aim of the diagram and the commentary was not to systematically provide an example for each rating on the seven-point rating scale but simply to provide some parameters by referring to several different rivers and streams within the region.

Further, it is not considered useful to add examples to the calibration section of Technical Assessment I now, after the event, of rivers that were not in fact used to calibrate the results of the assessment.

27. *In paragraph 24 (d) and 234 (d) (page 8 and 68) of the assessment it is concluded that "Post-development, there is a reduced level of overall natural character in catchments 2, 3, 4, 5 and 7; in catchments 1, 6, 8 and 9 there is no change." In paragraph 134 it is stated that "Given the scale of the works associated with construction and operation of the Project, the natural character of the waterbodies it interacts with will be affected in some way" (page 36). There appears to be inconsistency between these paragraphs.*

    *Could the Applicant please explain in detail why catchments 1, 6, 8 and 9 will experience no change in natural character despite the Project affecting the natural character of the waterbodies in these catchments in some way?*

The paragraphs referred to are the same in that paragraph 24(d) is in the Executive Summary and has drawn on paragraph 234(d) which is in the Summary Rating of Effects. For clarity, both paragraphs should read, "*Post-development, there is a reduced level of overall natural character in catchments 2, 3, 4, 5 and 7; in catchments 1, 6, 8 and 9 there is no change* ***in overall natural character****.*"

As can be seen in the tables in Appendices I.3 and I.4, the individual attribute ratings for catchments 1, 6 and 9 do change from existing to post-development, however, the overall level of natural character remains the same. The exception is catchment 8, which is already highly modified, and where the individual attribute ratings and the overall natural character rating is low in both the existing and post-development situations.

A summary of the changes to the individual attribute ratings for catchments 1, 6 and 9 is set out below:

- Catchment 1 - the Ecological Function attribute rating changes from low to very low and the Terrestrial Ecology attribute rating changes from very low to low.
- Catchment 6 - the Structures and Human Modifications attribute rating changes from moderate to moderate low and the Experiential attribute rating changes from high to moderate.

- Catchment 9 - the Structures and Human Modification attribute rating changes from moderate-high to moderate.

It is also worth noting from the table included in response to question 23, that the percentage of stream length impacted in catchments 1, 6 and 9 is relatively low (i.e. 7%, 3% and 1% respectively).

28. *Paragraph 237 (page 69) of the natural character assessment, identifies a number of modifications within the Project area (pasture, farm, a wind farm, Saddle Road, the railway line, and the former Gorge Road), however the report does not include a cumulative effects assessment of the Project across the different catchments, nor does it consider the cumulative effects with existing modifications in the Project area. Could the Applicant please provide a cumulative effects assessment which considers both these factors?*

A section on the cumulative effects of the Project on natural character is included in paragraphs 236 to 239 of Technical Assessment I. This explains that by assessing the effects of the Project on the existing level of natural character in the nine catchments (i.e. both existing and post-development levels of natural character), the assessment has inherently considered how the existing land use activities have modified the streams and their margins (i.e. this is the "existing" natural character rating), as well as the cumulative effect of the Project on natural character (i.e. this is the "post-development" natural character rating).

While an assessment of natural character has been carried out for each individual catchment, the summary tables include all of the catchments together so the results can be seen collectively and in relation to each other.

Paragraph 239 of Technical Assessment I also notes that only a small proportion of the overall Manawatū River catchment is affected by the Project.

It is considered therefore that the Project is consistent with the objectives and policy framework in the One Plan. In particular, the Project has avoided adverse effects, including cumulative effects, on the natural character of rivers and wetlands and their margins that would significantly diminish the attributes and qualities of areas with high natural character (Objective 6-2(b)(ii)). In this respect, Technical Assessment I provides a cumulative effects assessment for each catchment affected by the Project and concludes that any areas with high natural character will not experience a significant diminishment in natural character.

Further, the Project meets Policy 6-9 which provides that use or development is generally appropriate where, amongst other factors, it will not, by itself or in combination with effects of other activities, significantly disrupt natural processes or existing ecosystems.

See also the planning assessment of the natural character effects of the Project provided in the AEE.

29. *The AEE recognises that the Project alignment is within "Two regionally outstanding natural features and landscapes being the ridgeline of the Ruahine Range and the Manawatū Gorge (Schedule G)" (page 157). The AEE goes on to say that "the management of competing pressures for the subdivision, use and development of land that may affect ONF and landscapes is most appropriately dealt with at a territorial level and therefore not dealt with in this application" (page 187). The objectives, policies and methods contained within Chapter 6 (the RPS component) of the One Plan provide guidance and direction for the protection of the values identified for the areas within Schedule G, as well as any areas spatially defined within District Plans (note not all District Plans have given effect to the Regional Policy Statement at this time). In particular, Policy 6-6 requires avoidance of significant adverse cumulative effects (i.e. cumulative effects that are so adverse that they have the potential to significantly alter or damage the essential characteristics and values of the natural feature or landscape.). The assessment of effects has not considered Policy 6-6.*

    *Could the Applicant please provide an assessment of the Project (and its effects) against Objective 6-2 and Policy 6-6 of the One Plan? Also:*

    *29.1 The Landscape Management Plan (LMP) forms part of the Construction Environmental Management Plan (CEMP), which states that the LMP will be prepared in accordance with Condition 17. The CEMP provides a list of what the LMP should include but the completed LMP itself is missing. Could the Applicant please provide the LMP?*

*29.2 In the CEMP (page 66), under clause b)iii)B) and C) of the LMP, it refers to "landscape and visual amenity planting(s)". The Ecology Management Plan (12.2, page 128) refers to various types of planting (offsetting, compensation and revegetation). Could the Applicant please clarify if the landscape and visual amenity planting refers to all plantings that are to be undertaken as part of the Project (including offsetting, compensation and revegetation planting) or if this refers to a subgroup of planting in specific areas? If it refers to a subgroup, could the Applicant please define where these are to be located or alternatively what criteria/conditions will determine their location?*

**Landscape assessment**

A comprehensive assessment of the landscape and visual effects of the Project was undertaken for the NoR phase[4] and is referred to below as the "**NoR Landscape Assessment**". This assessment was refined to support the Transport Agency's request to the Environment Court to modify the relevant requirement (within Tararua District) to provide for the Northern Alignment[5] (referred to below as the "**Northern Alignment Assessment**"). The key findings from these two assessments are summarised below before providing an assessment against Objective 6-2 and Policy 6-6 of the One Plan.

*Assessment of the effects of the Project on the characteristics and values of Regional ONFLs*

The Project intercepts two regionally outstanding natural features and landscapes (ONFLs) listed in Schedule 5 of the One Plan, these being:

- the series of highest ridges and highest hilltops along the full extent of the Ruahine and Tararua Ranges; and
- the Manawatū Gorge down to the confluence with the Pohangina River.

The spatial extent of these ONFLs is not defined in the One Plan.

For the purposes of the NoR Landscape Assessment a plan was prepared to spatially define these ONFL areas based on the descriptions provided in Schedule G (**Drawing C-06**).[6] This plan was subsequently provided to each of the three relevant territorial authorities and Horizons for review and verification.

On Drawing C-06, the Ruahine Tararua Range ONFL is shown as a line joining the highest ridges and highest hilltops along the ranges as described in Schedule G (the whole of the Tararua and Ruahine Ranges and their slopes are not included). Schedule G also identifies a range of characteristics and values, including visual, natural and scenic characteristics of the skyline of the ranges to be considered.

A ridgeline and skyline are different things; a ridgeline is a physical entity (which can be defined and mapped), whereas a skyline is very dependent on the viewpoint, and is experienced as the interface of the land and sky. The skyline from a viewpoint close to a hill range is generally different to the skyline from a much greater distance viewed across the plains.

The Manawatū Gorge ONFL area is also shown on Drawing C-06 and aligns with the Manawatū Gorge Scenic Reserve extent, including the enclosing slopes above the Gorge from the Ballance Bridge at the eastern end of the Gorge down to the confluence with the Pohangina River situated beyond the western end of the Gorge.

[4] *Te Ahu Turanga, Notices of Requirement and Designations, Volume 3, Technical Assessment #4. Landscape, Natural Character and Visual Effects Assessment.*

[5] *Te Ahu a Turanga: Manawatū Tararua Highway Project – Addendum to Technical Assesment 5 (sic) – Landscape, Natural Character and Visual Effects,* 21 August 2019, attached as Exhibit H to the affirmation of Lonnie Dalzell dated 16 October 2019.
[6] Drawing C-06 in Volume 4 of the NoR document set (drawings and plans).

**Excerpt from Schedule G Horizons One Plan**

| Outstanding Natural Features or Landscapes | Characteristics / Values |
|---|---|
| (l) The series of highest ridges and highest hilltops along the full extent of the Ruahine and Tararua Ranges, including within the Forest Parks described in items (j) and (k) | (i) Visual, natural and scenic characteristics of the skyline of the Ruahine and Tararua Ranges, as defined by the series of highest ridges and highest hilltops along the full extent of the Ruahine and Tararua Ranges, including the skyline's aesthetic cohesion and continuity, its prominence throughout much of the Region and its backdrop vista in contrast to the Region's plains<br>(ii) Importance to tangata whenua and cultural values<br>(iii) Ecological values including values associated with remnant and regenerating indigenous vegetation<br>(iv) Historical values<br>(v) Recreational values |
| (m) Manawatu Gorge, from Ballance Bridge to the confluence of the Pohangina and Manawatu Rivers, including the adjacent scenic reserve | (i) Visual and scenic characteristics, particularly provided by its distinctive landscape<br>(ii) Geological feature, provided by being the only river in New Zealand to drain both east and west of the main divide<br>(iii) Ecological significance, provided by its regenerating indigenous vegetation and remnant native shrubland<br>(iv) Scientific value, particularly for its geology |

*Effects on the Ruahine and Tararua Ranges ONFL*

The Ruahine and Tararua Ranges ONFL traverses the series of hilltops and ridges that separates Catchments 3 and 4. In order to show this, the ridgeline from Drawing C-06 (referred to above) has been overlaid on the Catchment Map from Volume VII of the application (refer to **Figure 1** in **Attachment 10)**. This ridge is described in the NoR Landscape Assessment as *the Ruahine Ridge Crest* (paragraphs 76-79) as follows:

> *"76. At the crest of the Ruahine Range, a wide rolling area of grazed farmland separates the western hill slopes from the generally steeper eastern hill slopes. The Te Āpiti Wind Farm extends over this area with the eastern-most turbine located on the edge of the adjoining steep hill slopes. Te Āpiti is one of several wind farms that have been built along the Tararua – Ruahine Ranges. The Tararua Wind Farm is located on a plateau immediately south of the Gorge.*
>
> *77. The series of highest ridges and hilltops along the Ruahine (and Tararua) Ranges are recognised as a Regionally Outstanding Natural Feature; the Manawatū District Plan identifies the ridgeline of the Ruahine Range as an outstanding landscape and the Tararua District Plan identifies the "skyline of the Ruahine Ranges" in its schedule of natural features and landscapes.*
>
> *78. The Te Āpiti Wind Farm substation and operational area is located on the ridge crest, as are groups of farm buildings and yards; Cook Road is also located on the crest and runs south off Saddle Road towards the Project. There are small stands of remnant native forest present, several of which are protected by QEII Trust open space covenants.*
>
> *79. The rolling ridge crest also extends into the upper sections of the Manawatū Gorge Scenic Reserve, which then drops steeply into the river gorge below.*

For the NoR Landscape Assessment, the Ruahine Ridge Crest was considered as part of the *Te Āpiti Wind Farm and Ridge sector* (paragraphs 231 to 251). The NoR Landscape Assessment (**Table 4.14**) records the effects of the Project in this sector as:

- Biophysical effects: Moderate
- Landscape character effects: Moderate High

The visual effects assessment carried out as part of the NoR (also contained in the NoR Landscape Assessment) considered viewing audiences from the eastern and western sides of the Ruahine Range, from Saddle Road and from a track in the Manawatū Gorge Scenic Reserve on the south side of the Manawatū River. Several visual simulations were produced as part of this assessment.

To assist with assessing the visual impacts of the Project on the ridgeline, three plans showing the zone of theoretical visibility from three representative viewpoints compared to the ridgeline (which is taken from from Drawing C-06, referred to above). These plans are provided as **Figures 2 – 4** of **Attachment 10.**

When viewed from the representative viewpoint on the eastern side of the Ruahine Ranges, west of Woodville at the junction of SH3 and Hope Road[7] the part of the Ruahine ridgeline that the Project intercepts is visible, and the level of visual effects were assessed as moderate (refer **Figure 4** in **Attachment 10**).

Two representative viewpoints from the western side of the Ruahine Ranges were prepared as part of the visual effects assessment to consider the effects of the Project on the ridgeline: one from the northern end of Ashhurst at the start of Saddle Road, and another from the SH3 bridge.[8] From these viewpoints, the ridgeline of the Ruahine Ranges (as shown in **Figures 2 and 3** in **Attachment 10**) is not visible but the skyline punctuated by the wind turbines certainly is.[9]

Approximately 5.9 km of the Ruahine Ridgeline underlies the Te Āpiti Wind Farm with 13 turbines and the existing turbine access road located on the ridge top itself; and three turbines are close to the ridge top. Saddle Road crosses the ridge immediately to the north of the Project. From the plains and lowlands on both the eastern and western sides of the Ruahine Range, turbines are visible, silhouetted on the skyline. Together, these existing modifications, the turbines in particular, impact on the skyline ONFL values as described in Schedule G. Interestingly, the turbines of the Te Āpiti Wind Farm on the Ruahine Range, together with the turbines of the other wind farms along the Tararua Range, have become part of the local identity of the region.

As noted above, the NoR Landscape Assessment was updated to support the Transport Agency's request to the Environment Court to modify the requirements to provide for the Northern Alignment[10] (referred to as the "**Northern Alignment Assessment**"). This Assessment concluded that the Northern Alignment change has benefits (over the previous alignment) in landscape and visual terms at the western section of the alignment, particularly in relation to the old growth forest and streams on the northern bank of the Manawatū River and to the two QEII open space covenants. Not only is the total area impacted reduced but fragmentation of the two covenanted areas is also avoided.

However, the Northern Alignment does increase the extent and height of the cuts moving further east beyond the open space covenants, which will result in an increase in adverse biophysical and natural character effects in this section of the alignment. However, given that the Project traverses the steep hill country of the Ruahine Range, which is already extensively modified, the cumulative effects on the Ruahine ONFL will be similar to the effects associated with the original NoRs.

The physical changes resulting from the current design of the Project (i.e. the Northern Alignment) in the vicinity of the Ruahine Ranges ONFL, will be the large cuts as part of the earthworks required for the proposed highway, spoil sites 15, 16 and 28 and construction access roads. From the location of the main viewing audiences of Ashhurst and Woodville, these earthworks will not alter the visual profile

[7] Paragraph 303 and Table 4.4 of the NoR Landscape Assessment.
[8] Paragraphs 293-299 and Table 4.4 of the NoR Landscape Assessment. An additional viewpoint on the western side was also considered in order to illustrate the bridge approach, however, this is not relevant to the ridgeline.
[9] An additional viewpoint was considered in the NoR phase, being the viewpoint from the proposed new bridge crossing.
[10] *Te Ahu a Turanga: Manawatū Tararua Highway Project – Addendum to Technical Assesment 5 (sic) – Landscape, Natural Character and Visual Effects,* 21 August 2019, attached as Exhibit H to the affirmation of Lonnie Dalzell dated 16 October 2019.

of the skyline because of their particular location and their relatively small scale in relation to the overall topography.

Other values and characteristics of the Ruahine Ranges ONFL as listed in Schedule G, relate to recreational, ecological and cultural values. The Project does not encroach on any high value ecological areas within this ONFL. The provision of pedestrian/cycle access along the proposed shared path will enable new access and experiences to the community through the ONFL.

Therefore, given the already modified nature of the Ruahine Ranges ONFL as defined in Schedule G, together with the limited adverse effects of the Project within the ONFL, there will not be significant adverse cumulative effects on the characteristics and values of the ONFL.

*Manawatu Gorge ONFL*

The Manawatū Gorge ONFL includes the Manawatū River and Gorge and the Manawatū Gorge Scenic Reserve as described but not mapped in Schedule G of the Horizons One Plan.

The proposed new bridge (BR02) is proposed to cross the Manawatū River at the western mouth of the Gorge and will cross the lower part of the Manawatū Gorge ONFL at its narrowest point. The 7 km long Manawatū Gorge runs east-west separating the Ruahine and Tararua Ranges and is unique in New Zealand for being the only river to flow through a hill range. The steep slopes either side of the Gorge are densely covered in indigenous forest at different stages of succession. While the Gorge landscape is considered largely unmodified with high conservation values, the road along the length of the Gorge on the southern side and railway line along the length of the Gorge on the northern side are dominant elements. Retaining structures to support the road and rail platforms, culverts, land slip management structures and road and rail activity have modified the Gorge to varying degrees along its entire length.

The NoR Landscape Assessment (paragraphs 178 -196) assessed the effects of a new bridge in the immediate vicinity of the proposed crossing point, rather than for the whole Gorge landscape. The assessment records the following:

- Biophysical effects: Moderate,
- Landscape character effects: High

The visual effects of the proposed bridge were assessed as high (paragraph 300).

The potential effects of the proposal relate to the physical modifications to the riverbanks to construct the bridge abutments, the bridge structure itself across the river as well as the proposed recreational area/carpark. As identified in the NoR Landscape Assessment, the effects of the Project will be confined to the lower part of the Gorge at the western mouth and the physical impacts will be low or negligible in most of the ONFL. Therefore, when considered in terms of the whole ONFL, the effects on the visual, scenic and ecological characteristics and values would be less than those at the immediate bridge crossing. In addition, removal of road traffic from SH3 has already reduced the effects associated with road activity along the length of the ONFL.

The ONFL is a popular recreational area and the carpark and facilities on the southern side of the river at the western end of the Gorge where the new bridge will cross, are well used year-round. The Project will develop and enhance the recreational facilities and opportunities on both sides of the river and also on the bridge itself with pedestrian and cycle access and a viewing platform.

Given the effects of the Project are limited to a small portion of the ONFL, at a location where there is already considerable modification, the Project will not have significant adverse cumulative effects on the characteristics and values of the ONFL.

**Assessment against relevant provisions of the One Plan**

Objective 6-2(a) in the RPS section of the One Plan requires the characteristics and values of the Region's ONFLs to be protected from inappropriate use and development.

Policy 6.6 states that the natural features and landscapes listed in Schedule G Table G.1 must be recognised as regionally outstanding. The ONFLs relevant to this Project have been previously identified and discussed above. Policy 6-6 provides that use and development directly affecting these areas must be managed in a manner which:

- avoids significant adverse cumulative effects on the characteristics and values of those ONFLs (Policy 6-6(a)); and
- avoids adverse effects as far as reasonably practicable and, where avoidance is not reasonably practicable, remedies or mitigates adverse effects on the characteristics and values of those ONFLs (Policy 6-6(b)).

This matter was traversed in some detail at the NoR phase, given that the management of competing pressures for the subdivision, use and development of land that may affect ONFLs is most appropriately dealt with at a territorial authority level (refer to Section 6.1.3 of the One Plan). However, in order to respond to the question, further analysis of the abovementioned policy framework is provided below.

The landscape assessment completed as part of the NoR phase and summarised above found that the Project traverses already highly modified landscape environments, including the predominant and extensive pastoral land use evident on the Ruahine Ranges and prominent existing physical infrastructure, including wind farm infrastructure and transport infrastructure (road and rail, bridging and farm access tracks). The assessment concluded there will be limited physical change in respect of the Ruahine Ranges ONFL (and immediate surrounds) and the scale is appropriate. The change and associated adverse effects associated with the Manawatū Gorge ONFL will be confined to the lower part of the Gorge (i.e. the western extent) only, with effects on the wider ONFL being deemed low or negligible. In both instances, other landscape values and characteristics are either not affected, while in the case of recreation values, are proposed to be enhanced.

When the above is considered against the policy framework:

- Given the limited nature of the adverse effects associated with the Project and the already highly modified nature of both the Ruahine Ranges ONFL and western extent of the Manawatū Gorge ONFL, the Project will not result in significant adverse cumulative effects on the characteristics and values of the ONFLs as a whole; and
- While the Project will result in some adverse effects associated with the highway traversing the two identified ONFLs, these adverse effects have been avoided as far as reasonably practicable and avoided, remedied or mitigated though a combination of the proposed resource consent design and the various requirements embedded in both the confirmed designation conditions and the proposed conditions of resource consent. These conditions cover matters including, but not limited to, the ongoing development of the Cultural and Environment Design Framework, further development of values relevant to tangata whenua (which will influence both design refinements and construction), native vegetation removal limitations (which have been significantly reduced through the proposed resource consent conditions), landscape planting requirements (discussed further below), bridge design requirements and general effects management during construction to manage potential shorter term effects on the landscape.

Other provisions in the One Plan will also be relevant when considering the effects of the Project, including Policy 3-3, which is considered at Section 8.5.2.3 of the AEE (page 180), and which provides a framework by which the adverse effects associated with the establishment of regionally important infrastructure are allowed or are appropriate where they can be avoided, remedied or mitigated, specifically where it is not reasonably practicable to avoid the adverse effects through the identified ONFLs. This supports the direction of Policy 6-6 discussed above.

Based on the above, the Project is consistent with the direction provided by Objective 6-2 and Policy 6-6 of the One Plan.

**Management plans**

*Question 29.1 – Process for developing and finalising the Landscape Management Plan*

The Landscape Management Plan required by Designation Condition 17 forms part of the Construction Environmental Management Plan required by Designation Condition 14. Preparation of the Landscape Management Plan required to comply with the designation conditions is underway as part of detailed design, but not complete.

The conditions that are proposed to be imposed on the resource consents do not require a landscape management plan and, as such, Resource Consent Condition CM4 does not require a landscape management plan to form part of the Construction Environmental Management Plan developed as part of regional resource consents. This is consistent with the Methods included in the One Plan (RPS) and the following statement included in 6.1.3 of the One Plan:

> *"Territorial Authorities have the responsibility of managing the effects of land use, through district plan provisions and land use resource consents. Consequently, the management of competing pressures for the subdivision, use and development of land that may affect outstanding natural features and landscapes is most appropriately dealt with at a territorial level."*

*Question 29.2 – Relationship between landscape and visual amenity planting and replacement, offset, and compensation planting*

The Applicant has been asked to clarify if the landscape and visual amenity planting referred to in the Landscape Management Plan includes all plantings that are to be undertaken as part of the Project, including any replacement, offset or compensation planting required by the Planting Establishment Management Plan and/or Ecology Management Plan.

The landscape and visual amenity planting to be provided is additional to the planting for ecological offset and compensation purposes. The specific location and type of landscape and visual amenity planting will be confirmed by the Landscape Management Plan as part of the detailed design process (currently underway) and when the replacement, offset and compensation planting required for ecological purposes has been confirmed, in order to ensure that these two kinds of planting are appropriately integrated.

Under the designation conditions, the Landscape Management Plan must demonstrate its compliance with certain matters in the Cultural and Environmental Design Framework and be submitted to the territorial authorities for certification and as part of the outline plan(s) for the Project. It is therefore intended that the detailed design of the landscape planting will be worked through with the iwi partners and others, guided by the principles in the Cultural and Environmental Design Framework, before being finalised in the Landscape Management Plan. In addition, Designation Condition 12 requires the establishment of a Community Liaison Group (which has been done), and one of the purposes of this Group is to enable the Transport Agency to share information and seek comment on detailed design, including planned landscaping, and the Landscape Management Plan.

Therefore, the details of the landscape and amenity planting will be finalised through the process outlined above. In the meantime, the intended area of landscape planting is shown (on a provisional basis) on the proposed ecological offset/compensation plans contained in Volume VII of the application.

**The following questions relate to Appendix E Proposed Conditions and consent duration**

30. *It is understood that some of the offset/compensation measures, such as revegetation and/or restoration will be permanent. However, it is noted that the duration of resource consents applied for are either 10 years or 35 years.*

    *Could the Applicant please clarify:*

30.1 *How the permanence as to offset/compensation measures (for both terrestrial and freshwater) will be achieved relative to the particular consents applied for, the duration of any such consents, and the conditions proposed?*

As noted in response to question 18 above, while the resource consents sought from Horizons will have a finite term, a resource consent condition can impose an obligation on the consent holder that endures beyond the expiry of the consent. As such, Horizons will be able to enforce conditions with enduring effect beyond the expiry of the consents.

Further, the territorial authorities will retain an ability to enforce condition 19(b) of the designations (which will not expire), which provides that *"Planting required by condition 24, or the conditions of any regional resource consents granted for the Project, must be legally protected in perpetuity"*.

The Transport Agency will continue to comply with all condition obligations that endure beyond the construction period, i.e. conditions that relate to ecological offsets, and will ensure that it can do so either by retaining the relevant land or entering into agreements with third party landowners as described above.

*30.2 How they intend to condition to affirm (through monitoring for example) that the offsets/compensations perform as they have been modelled, and what the response will be if the offsets/compensations do not achieve the modelled outcomes?*

These matters are set out in the Ecology Management Plan that was lodged with the application for resource consents and is intended to be confirmed through the consenting process. See in particular the Planting Establishment Management Plan and Residual Effects Management Plan, which in turn requires preparation of a Pest Management Plan. The proposed conditions require the Project to be undertaken in general accordance with the Ecology Management Plan (as do the confirmed designation conditions), and the suite of conditions proposed (including conditions EC12 and EC15) sets out various standards required to be achieved.

## Additional matters

*31. As per the requirements of section 89A of the Act, Maritime New Zealand ("**MNZ**") have reviewed the application and note the key concern for MNZ is Bridge "BR02" to be built over the Manawatū River at the western end of the Manawatū Gorge. MNZ advise that the application does not provide any detail around the typical use of this stretch of the navigable river by the public (whether for recreational and / or commercial activities) and what controls, apart from condition BD3, are planned to ensure the safety of any river users whilst the bridge "BR02" is being constructed in this particular location.*

*Could the Applicant please provide detail around the typical use of this stretch of the navigable river by the public (whether for recreational and / or commercial activities) and what, if any, additional measures are planned to ensure the safety of any river users whilst the bridge "BR02" is being constructed in this particular location?*

The 'typical use of this stretch of the navigable river by the public (whether for recreational and / or commercial activities)' was considered as part of the NoR phase of the Project, and the material and findings from the NoR phase has since been validated. Relevant information is contained in:

- NoR Technical Assessment #3 - Social Impact Assessment, Amelia Linzey / Jo Healy, dated 2018;
- Tourism and Recreation Section 42A Report, Jeff Baker, dated 25 March 2019;
- Evidence of Amelia Linzey - Social Impact Assessment, dated 8 March 2019; and
- Joint Witness Statement – Transport and Social, dated 19 March 2019.
- The applicant has since discussed and validated that information with:
- Jeff Baker - Senior Planner, Palmerston North City Council on Friday 17 April 2020; and
- Jo Healy - Senior Planner, Beca on Wednesday 22 April 2020.

Based on the above analysis and validation process, the applicant can confirm the following:

- There is no scheduled club activity or commercial usage that currently relies on the stretch of the Manawatū River upstream or downstream of proposed BR02;
- A prospective jetboat operator may be interested in a commercial operation at the Woodville end of the Gorge (i.e. outside the Project area, and not in the area affected by the construction of BR02), however there is no current operation;

- Members of the community were concerned during the NoR phase that access be maintained to a river beach at the Ashhurst Domain; this is approximately 600 metres downstream of the proposed bridge location and therefore not affected by the construction of BR02;
- Members of the community were concerned with access to the river edge from the existing carpark; and
- In terms of informal recreational activities (e.g. kayaking, swimming, fishing), the potential has been noted by Mr Baker but these generally occur at other locations or along other stretches of the Manawatū River.

As such, the potential for recreational and commercial usage of the Manawatū River in the area that will be affected by the construction of BR02 is low.

Proposed condition BD3(b) provides that prior to the commencement of works in the active flowing channel of the Manawatū River, signs must be installed upstream and downstream of the bridge site to warn river users of the works and to advise of any specific navigation and/or safety restrictions required to maintain the safety of any river users. In addition, proposed condition BD3(a) requires that access to the river and its margins is restricted only where necessary to provide for the health and safety of the public; this is considered appropriate to ensure informal access to the river is maintained in the general vicinity of the bridge construction activity.

The applicant considers that this response is appropriate and proportionate to the current level of navigation occurring in this area (i.e. infrequent recreational use only), however, it intends to discuss this further with Horizons and Maritime NZ to determine whether any additional procedures/restrictions need to be put in place to ensure that safe navigation of the river can continue.

**Closing**

We trust that the above responses sufficiently address matters raised in your request for additional information. Please do not hesitate to contact Damien McGahan if you have any queries.

Your faithfully,

Damien McGahan

Enc: Attachment 1: Request for further information pursuant to section 92 of the RMA
Attachment 2: Aquatic Ecological Monitoring and Responses Flowchart
Attachment 3: Updated Erosion and Sediment Control Monitoring Plan
Attachment 4: EOS Ecology 2018. Te Ahu a Turanga; Manawatū Tararua Highway – Baseline freshwater monitoring plan. EOS Ecology Report No. NZT02-18064-04 prepared by A. James for New Zealand Transport Agency
Attachment 5:Te Ahu a Turanga; Manawatū Tararua Highway – Baseline Freshwater Monitoring Results. Report prepared by EOS Ecology. November 2019. Report number NZT02-18064-03.
Attachment 6: Site Specific Erosion Sediment Control Plans
Attachment 7: Amendments to address the inconsistencies within Technical Assessment F
Attachment 8: Raupo Wetland Memorandum
Attachment 9: Updated Dust Management Procedure
Attachment 10: Natural Character Drawings

3 April 2020

Waka Kotahi NZ Transport Agency
PO Box 1947
Palmerston North 4440
Via email: greg.lee2@nzta.govt.nz & Damien.mcgahan@aurecongroup.com

Attention: Greg Lee and Damien McGahan

Dear Greg and Damien,

**Additional Information Request for Application APP-2017201552.00**

Thank you for the resource consent application lodged for Te Ahu a Tūranga Manawatū-Tararua Highway (the "**Project**") on 11 March 2020. The application has been assessed and it has been determined that in order to fully assess the effects of the Project additional information is required.

The additional information is listed below and is requested under section 92(1) of the Resource Management Act 1991 (the "**Act**"):

**The following questions relate to Technical Assessment H – Freshwater Ecology, Technical Assessment C – Water Quality, Appendix E Proposed Conditions and the Ecology Management Plan**

1. In the sedimentation section of Technical Assessment H – Freshwater Ecology, especially around effects on aquatic ecology, the scale and magnitude of effects varies between the catchments. This is understandable given the different values that the different sub-catchments have. The overall conclusion for sedimentation effects appears to make an overall assessment that the effects from the entire Project are acceptable. This is despite an acknowledgement that the potential effects will be high even with the implementation of mitigation measures and during construction in Catchments 4, 5 and 7.

   Could the Applicant please advise as to what additional sediment and erosion control measures, if any, that could/should be undertaken in these catchments (at a minimum Catchments 4, 5 and 7) with higher values to ensure that the values are not comprised in these catchments? If no additional measures are proposed, what will be the subsequent effects on those catchments?

2. It is understood from the assessments included in the application that the Applicant relies on the effects from sedimentation being 'short' term and that the streams will revert to the pre-construction state after the project has ceased, with post construction monitoring to confirm this is the case. However, the Applicant has not addressed the following matters:

   2.1 What happens if the monitoring shows that the streams have not returned to their pre-construction state?

2.2 When comparing the post-construction with the pre-construction state what level is considered to be 'close enough' to the pre-construction state?

3. The Freshwater Monitoring Plan includes a range of monitoring (baseline, event triggered etc.). It would however be useful if the Applicant included the monitoring information into a table which shows frequency, parameters, and sites for the different monitoring regimes. The current word format makes it difficult to track what and where monitoring is going to happen.

   Could the Applicant please provide this information as a table or via another appropriate means to demonstrate what is to occur and when?

4. There appears to be an inconsistency between proposed condition EC15 a) i. and EC15 a) ii. Condition a) ii. is technically more correct in its alignment with good practice for stream restoration. However, proposed condition a) i. states a maximum width of 20 metres, meaning that a 1 metre width would meet this condition but the environmental outcome would not be achieved.

   Could the Applicant please clarify whether this is a typo in the conditions referred above, or expand on how this approach aligns with/meets best practice and fits within the restoration requirements for these streams?

5. There appear to be slightly conflicting opinions on the use of TSS between the Applicant's expert reports in Technical Assessment H – Freshwater Ecology, Technical Assessment C – Water Quality, and Technical Assessment A – Erosion and Sediment Control in terms of sedimentation and monitoring requirements. This is especially with regard to TSS vs NTU or visual clarity. Mr Stewart raises some technical challenges with the use of TSS, especially from an operational/response management point of view. The assessment completed by Mr Hamill uses TSS as the measure to assess effects. Mr Hamill has however calculated TSS using a relationship with turbidity based on the Manawatū River at the Teachers College flow site. In terms of end of pipe or in-river standards, would it therefore not be possible to calculate the turbidity level that would be associated with the TSS from either the Manawatū at Teachers College or Manawatū at Gorge monitoring locations? Such an approach would allow for ease of management (with instantaneous results) and allow for operational changes to occur. This relationship could also be tested with the baseline data/information that has been collected over the site.

   Could the Applicant please provide comment as to the above matter?

6. The application currently does not propose any standards for in-river or at the end of treatment devices. However, when calculating effects as a result of sedimentation on the steams/rivers, a value (standard/trigger) has been used for the water coming out of these treatment devices. Therefore:

   6.1 Could the Applicant please provide commentary on whether these values should be used as thresholds to ensure the devices treat the sediment water to a suitable standard and ensure effects are managed?

6.2 In terms of establishing what these standards could/should be, could the Applicant please provide the end of pipe standards that have been used in the Technical Assessment C – Water Quality and Technical Assessment H – Freshwater Ecology, noting that the relationship between TSS/turb in 5 above would be the basis of being able to create this relationship and a standard/trigger in turbidity.

7. There is no reference in the application to standards in terms of limiting effects in-instream (i.e. QMCI and %EPT taxa richness), with the proposal based around trigger levels. Trigger levels are important as they raise awareness of potential issues that may arise and therefore result in management changes before there is an issue. However, there is a point at which effects should be limited by a standard to ensure that these effects are not allowed to occur.

   Could the Applicant please provide what they consider to be appropriate trigger(s) and subsequent standard levels for both in-stream parameters and also discharge from treatment devices?

8. Technical Assessment C – Water Quality refers to *EOS Ecology 2018. Te Ahu a Turanga; Manawatū Tararua Highway – Baseline freshwater monitoring plan. EOS Ecology Report No. NZT02-18064-04* prepared by A. James for New Zealand Transport Agency, and Technical Assessment H – Freshwater Ecology refers to *Te Ahu a Turanga; Manawatū Tararua Highway – Baseline Freshwater Monitoring Results. Report prepared by EOS Ecology. November 2019. Report number NZT02-18064-03.*

   Could the Applicant please provide a copy of those report(s)?

9. It is noted that old Gorge Road had a stock effluent disposal facility at the eastern Woodville end, but there is no disposal facility proposed at the western Ashhurst end. Noting the gradient of the road, there is the potential for significant leakage (spillage) from stock trucks using the road, which will result in effluent spilling onto the roads and being transferred to the stormwater treatment devices. It is understood that these devices are not specifically designed to treat raw effluent.

   Could the Applicant please advise if it is proposed to provide stock effluent disposal facilities at one or both sides of the proposed road and what consent if any are required for such facilities? If it is not proposed to install such facilities, could the Applicant please provide details on how the stormwater treatment devices will be effective (both short and long term) to treat the concentrated contaminants from stock effluent potentially present in the stormwater prior to the discharge to water?

10. It is not clear whether there will be operational stormwater (which will contain contaminants – possibly stock effluent, hydrocarbons, etc) discharged to any at 'risk' or 'rare' or 'threatened' habitats (Rules 13-8 and 13-9).

   Could the Applicant please clarify the location of the operational stormwater discharge points/areas relative to any 'at risk habitat', 'rare habitat' or 'threatened habitat'?

**The following questions relate to Volume 1 Application for Resource Consent, Technical Assessment A – Erosion and Sediment Control and Volume III - Drawings**

11. Section 3.5 of the AEE details that "Cut slopes steeper than 1V:3H will not be planted as topsoil will not stay on the slope..." Whereas section 6.4.3 of the AEE implies rapid stabilisation over the entire exposed area and Paragraph 72 of Technical Assessment A – Erosion and Sediment Control, refers to progressive and rapid stabilisation.

    If these areas are not being topsoiled and planted, could the Applicant please clarify how cut slopes greater than 1V:3H are going to be stabilised?

12. The application refers to Site Specific Erosion and Sediment Control Plans (SSESCP), with examples provided as part of the application. While there have been plans provided as part of the drawing set, the full SSESCPs are missing from the application.

    Could the Applicant please provide the SSESCPs?

13. The application contains details around the use of GD05 compliant controls and contains reports on how these are going to be constructed and managed. This includes the provision of example Site Specific Erosion and Sediment Control Plans. The application also contains detail on how sediment controls are going to be monitored for performance based on a 90% sediment treatment efficiency measured through turbidity. However, there appears to be no clear link between what ultimately comes off the site (sediment control device discharge point) and the resulting effects on the receiving environment. This is especially pertinent in sub catchments 4, 5, and 7 where the potential effects even through best practice sediment controls are stated in Technical Assessment H – Freshwater Ecology as being moderate to high.

    Could the Applicant please provide further information on the link between what is discharged from the sediment controls and the receiving environment, how this is measured, and what is considered an acceptable discharge from the site to the receiving environment?

14. There is some discussion on monitoring of erosion and sediment controls. However, there is no detailed discussion on contingency measures should monitoring determine that the systems in place are not functioning to a satisfactory level and what the trigger in terms of a sediment discharge might be in order to determine what a satisfactory level is.

    Could the Applicant please clarify what the sediment discharge trigger points are and what additional measures will be considered should monitoring show sediment control performance is not meeting expectations?

**The following questions relate to Technical Assessment F – Terrestrial Ecology and Technical Assessment G – Terrestrial Offset and Compensation**

15. There appear to be a number of inconsistencies between the AEE Tables 4-6 and the tabulated values for habitats, magnitude of effects, and/or level of residual effects in Technical Assessment F – Terrestrial Ecology. By way of example;

    15.1 Table 2 reports the value of Old Growth tree land as 'moderate' whereas Table 8 says "High".
    15.2 Table 2 reports value of Advance secondary broadleaf as 'very high', whereas Table 8 says "High".
    15.3 Table 2 reports value of secondary broadleaf with old growth signatures as 'Very High', whereas Table 8 says "High".
    15.4 Table 2 reports value of the raupo wetland as "High", whereas table 8 says "Very High".
    15.5 Table 2 reports value of "moderate value wetlands" as "High", whereas Table 8 says 'Moderate'.

    Could the Applicant please explain these apparent inconsistencies and indicate the values to be utilised for the ecosystem value, the magnitude of effects, and the residual effect to be addressed through the Project?

16. Could the Applicant and the Project Ecologists please provide comment as to the level of confidence that the hydrological integrity of the raupo-dominated seepage wetlands will remain intact?

17. In relation to water abstraction, could the Applicant please provide clarification as to which map in the Ecology series shows the indigenous habitats affected by the enabling works consents?

18. In order to demonstrate the ability/confidence for the offset/compensation to be undertaken, could the Applicant please provide a copy of a draft landowner agreement for the offset/compensation habitat restoration sites?

**The following questions relate to Technical Assessment E – Air Quality**

19. Technical Assessment E – Air Quality states that it has "built on" the air quality management plans required by the Designation Conditions.

    Could the Applicant please clarify what is meant by this statement i.e. are the plans intended to form a baseline and if so, could the Applicant provide the Te Apiti Wind Farm Management Plan, National Grid Management Plan, and Ballantrae Research Station and Fertiliser Trial Management Plan?

20. In Technical Assessment E – Air Quality, the air quality assessment for the Woodville section identifies R4 and R5 as experiencing moderate to high levels of nuisance dust based on proximity and frequency of strong winds where the receptors are down wind.

Could the Applicant give consideration to including R7 as a receptor for potentially moderate to high nuisance due to proximity and the frequency that it is downwind of the north westerly? If not, please explain why?

21. There are recommendations in Technical Assessment E – Air Quality that do not appear to have been addressed in the ESCP Dust Management Procedure (DMP). For example, the sensitive receptors identified for the Woodville Section (Table 1) of the DMP differ between those identified in Technical Assessment E – Air Quality, as do the mitigation measures for site entranceways.

    Could the Applicant please advise if it is intended to update the DMP to ensure that it includes the air quality assessment recommendations?

**The following questions relate to Technical Assessment I – Natural Character**

22. The assessment states that its rating of effects has not considered mitigation measures. However, in some instances it appears that mitigation measures have influenced the assessed level of effects of the Project. For instance, in the table for Catchment 7 (page 110) it is stated that "*On balance, given the extent of stock exclusion compared to the current situation, the Project could lead to the improvement of overall water quality and hence increase the rating of this parameter to moderate high*". It would appear in this example that the mitigation measure of stock exclusion has been considered in the assessment. Similarly, the table for Catchment 8 (page 117) says the following: "*May see small improvement in the riparian margins as diversions are planted.*" In this case, the mitigation measure of riparian planting appears to have been incorporated as part of the assessment. While the table for Crossing Point 7B (page 145) states that "*Crossing involves near-complete loss of existing channel in the sub-catchment and replacement with permanent diversion. Provided this results in complete removal of stock from the catchment with revegetation/retirement of former pasture in the sub-catchment then an increase in rating may result*." In this instance it appears that the mitigation measures of stock exclusion and revegetation have been assessed as changing the existing natural character of water quality from low to moderate-low.

    Could the Applicant please confirm:

    22.1 What mitigation measures have and have not been considered as part of the assessment of effects on natural character, and which ratings include or exclude mitigation?

    22.2 If a difference in approach has been taken as between mitigation and non-mitigation of effects in any given instance, which ratings should be changed for the purpose of ensuring a consistent rating approach?

23. The assessment of natural character for the various streams affected by the Project appears to be considered at a catchment scale. The report provides the total catchment area and the length of stream under the Project footprint for each catchment. However, the report does not provide the total stream length in each catchment. This makes it difficult to ascertain the percentage or ratio of stream affected in comparison to its total length.

Could the Applicant please provide a total length of stream in each catchment?

24. The AEE states "*That Assessment concluded that the Project may lead to a significant diminishment of natural character of particular streams at the location where the Project's construction footprint crossed the stream, but that the reduction in natural character would diminish when considered at an overall stream scale*" (page 137). This appears to be inconsistent with the natural character assessment which states that the assessment was undertaken at a catchment scale (rather than an overall stream scale).

    24.1 Could the Applicant please clarify whether the AEE should say "catchment scale" rather than "overall stream scale"?

    24.2 If this is the case, could the Applicant please clarify how the effect of 'context', *which diminishes as one moves beyond the river/stream corridor*, has been considered in a catchment scale or stream scale?

25. The natural character assessment states that only Catchment 9 has an overall high existing natural character rating, with high representing the highest rating of existing natural character in the report. Catchment 6 is rated as having a moderate-high existing natural character. In the Notice of Requirement (NOR) process the natural character assessment for East QEII Crossing had an overall rating of high. This area corresponds with Catchment 6 in the natural character assessment undertaken for regional consenting purposes. Catchment 7 is rated as having a moderate-high existing natural character. In the NOR natural character assessment the QEII West Stream and lower stream/wetland had an overall rating of high. Both of these areas correspond with Catchment 7. If a catchment is not considered as having an existing natural character rating of high or above, then it is not assessed as to whether effects of the Project will be significant (as per wording in Objective 6-2(b)(ii) of the One Plan).

    Could the Applicant please clarify/explain:

    25.1 Why Catchment 6 and 7 (which include QEII East, QEII West and lower stream/wetland (raupō wetland)) are considered to have an existing natural character rating of moderate-high, while QEII East, QEII West and lower stream/wetland were identified as having high existing natural character ratings in the NOR natural character assessment prepared by NZTA and its experts?

    25.2 Why is there a decrease in existing natural character ratings between this current assessment and the ratings provided as part of the NOR natural character assessment?

26. The calibration method for the natural character assessment only provides examples of rivers and streams with existing natural character ratings of very high/outstanding, moderate and low/very low. There is a gap in the examples of high and moderate-high rivers and streams (shown in Figure 1.3).

Could the Applicant provide examples of streams or rivers in the Horizons Region that would have a high and moderate/high natural character rating and include these in the calibration section of the report?

27. In paragraph 24 (d) and 234 (d) (page 8 and 68) of the assessment it is concluded that "*Post-development, there is a reduced level of overall natural character in catchments 2, 3, 4, 5 and 7; in catchments 1, 6, 8 and 9 there is no change.*" In paragraph 134 it is stated that "*Given the scale of the works associated with construction and operation of the Project, the natural character of the waterbodies it interacts with will be affected in some way*" (page 36). There appears to be inconsistency between these paragraphs.

    Could the Applicant please explain in detail why catchments 1, 6, 8 and 9 will experience no change in natural character despite the Project affecting the natural character of the waterbodies in these catchments in some way?

28. Paragraph 237 (page 69) of the natural character assessment, identifies a number of modifications within the Project area (pasture, farm, a wind farm, Saddle Road, the railway line, and the former Gorge Road), however the report does not include a cumulative effects assessment of the Project across the different catchments, nor does it consider the cumulative effects with existing modifications in the Project area. Could the Applicant please provide a cumulative effects assessment which considers both these factors?

29. The AEE recognises that the Project alignment is within "*Two regionally outstanding natural features and landscapes being the ridgeline of the Ruahine Range and the Manawatū Gorge (Schedule G)*" (page 157). The AEE goes on to say that "*the management of competing pressures for the subdivision, use and development of land that may affect ONF and landscapes is most appropriately dealt with at a territorial level and therefore not dealt with in this application*" (page 187). The objectives, policies and methods contained within Chapter 6 (the RPS component) of the One Plan provide guidance and direction for the protection of the values identified for the areas within Schedule G, as well as any areas spatially defined within District Plans (note not all District Plans have given effect to the Regional Policy Statement at this time). In particular, Policy 6-6 requires avoidance of significant adverse cumulative effects (i.e. cumulative effects that are so adverse that they have the potential to significantly alter or damage the essential characteristics and values of the natural feature or landscape.). The assessment of effects has not considered Policy 6-6.

    Could the Applicant please provide an assessment of the Project (and its effects) against Objective 6-2 and Policy 6-6 of the One Plan? Also:

    29.1 The Landscape Management Plan (LMP) forms part of the Construction Environmental Management Plan (CEMP), which states that the LMP will be prepared in accordance with Condition 17. The CEMP provides a list of what the LMP should include but the completed LMP itself is missing. Could the Applicant please provide the LMP?

    29.2 In the CEMP (page 66), under clause b)iii)B) and C) of the LMP, it refers to "*landscape and visual amenity planting(s)*". The Ecology Management Plan

(12.2, page 128) refers to various types of planting (offsetting, compensation and revegetation). Could the Applicant please clarify if the *landscape and visual amenity planting* refers to all plantings that are to be undertaken as part of the Project (including offsetting, compensation and revegetation planting) or if this refers to a subgroup of planting in specific areas? If it refers to a subgroup, could the Applicant please define where these are to be located or alternatively what criteria/conditions will determine their location?

**The following questions relate to Appendix E Proposed Conditions and consent duration**

30. It is understood that some of the offset/compensation measures, such as revegetation and/or restoration will be permanent. However, it is noted that the duration of resource consents applied for are either 10 years or 35 years.

    Could the Applicant please clarify:

    30.1 How the permanence as to offset/compensation measures (for both terrestrial and freshwater) will be achieved relative to the particular consents applied for, the duration of any such consents, and the conditions proposed?

    30.2 How they intend to condition to affirm (through monitoring for example) that the offsets/compensations perform as they have been modelled, and what the response will be if the offsets/compensations do not achieve the modelled outcomes?

**Additional matters**

31. As per the requirements of section 89A of the Act, Maritime New Zealand ("**MNZ**") have reviewed the application and note the key concern for MNZ is Bridge "BR02" to be built over the Manawatū River at the western end of the Manawatū Gorge. MNZ advise that the application does not provide any detail around the typical use of this stretch of the navigable river by the public (whether for recreational and / or commercial activities) and what controls, apart from condition BD3, are planned to ensure the safety of any river users whilst the bridge "BR02" is being constructed in this particular location.

    Could the Applicant please provide detail around the typical use of this stretch of the navigable river by the public (whether for recreational and / or commercial activities) and what, if any, additional measures are planned to ensure the safety of any river users whilst the bridge "BR02" is being constructed in this particular location?

Under the Act, you must, within 15 working days of the date of this letter, take one of the following options:

a. provide the information; -OR-

b. advise in writing that you agree to provide the information (at which point we would negotiate a reasonable time within which the information will be provided); -OR-
c. advise in writing that you refuse to provide the information.

If you have any questions in relation to the determination or wish to discuss any aspects of this letter, please contact me on 021 271 0815.

Yours faithfully,

Mark St.Clair
**CONSULTANT CONSENTS PLANNER**
**HORIZONS REGIONAL COUNCIL**

APPROVED by,

Jasmine Mitchell
**TEAM LEADER CONSENTS**
**HORIZONS REGIONAL COUNCIL**

Taumarunui | Whanganui | Marton | Woodville | Palmerston North | Kairanga
**24 hour freephone** 0508 800 800 | **fax** 06 952 2929 | **email** help@horizons.govt.nz
Private Bag 11025 Manawatū Mail Centre, Palmerston North 4442
horizons.govt.nz

## **ATTACHMENT 2:** AQUATIC ECOLOGICAL MONITORING AND RESPONSES

| MONITORING PHASES | TRIGGERS | RESPONSE |
|---|---|---|

### Pre-construction monitoring

*To establish a baseline:*

- *Wet weather WQ monitoring*
- *Routine monitoring – macroinvertebrate and periphyton (summer and winter), sediment deposition*

Report prepared within one month of monitoring completion, including:

- Provision of all data collected and monitoring site locations
- Statistical summaries for wet weather water quality, stream deposited sediment levels, macroinvertebrate metric data as appropriate
- Recommendations for construction phase monitoring, triggers and effects thresholds

### Construction monitoring[7]

**Continuous monitoring:** *Continuous turbidity logger (inlet and outlet of two SRPs).*

<90% treatment efficiency across a rainfall trigger event[1]

- Within 24 hrs, full audit of condition of control device
- Remedy and record any obvious causes on site
- Identify opportunities to improve management of the site
- Implement improvements in consultation with Horizons

**Event based monitoring**

*Water quality*

- *During rain events at ESC devices (turbidity, clarity and pH)[1]*

*Deposited sediment*

- *At established sediment monitoring sites d/s of discharges if device failures triggered*

Rainfall >15mm/hr or >25mm over 24 hours[2]

< 0.1 m clarity measured by black disc[3]

- Site audit inspection and further monitoring by Environmental Manager and / or Environmental Supervisor / ESC Technical Specialist. Inspections of all SRPs and DEBs, with manual turbidity and pH testing of inlet and outlet flows, along with general inspection of sediment control devices

**Trigger Event Report**

Failure of ESC devices or slumping / mass movement associated with construction works[4]

Further monitoring reviewed by Project Ecologist to assess event based ecological effects

Macroinvertebrate sampling if deemed appropriate by Project Ecologist

Based on deposited sediment monitoring, further remedial or mitigation measures required if:

- Noticeable increase in median visual sediment coverage (>15%) OR
- Increase of median site re-suspendable sediment from Quorer sampling (>15%)

..compared to baseline monitoring and that persist for 2 or more consecutive quarterly monitoring occasions.

Site management responses and ecological mitigation actions required.

Report prepared by Project Ecologist describing **recommendations** for any additional monitoring or mitigation.

Reporting to Horizons as per the ESCMP.

**Routine monitoring (quarterly):**

- *Water quality (monthly)*
- *Deposited sediment*
- *Macroinvertebrates*
- *Vegetation and topsoil storage sites*

>15% decrease in mean QMCI relative to the lowest score from baseline monitoring OR

Decline in median % of EPT taxa richness of >15% compared to baseline monitoring

..that persists for 2 or more quarterly monitoring occasions.

Further triggers TBD based on baseline /pre-construction monitoring

- **Remedial and / or mitigations measures** based on assessment of cause of effect
- **Reporting:** Quarterly freshwater ecology reporting including assessment of effect[5] and review of trigger levels. Annual report to include all activities undertaken in accordance with the Aquatic Ecology Monitoring Plan and a review of the construction phase monitoring programme.
- **Recommendations**[6] for any additional monitoring, remediation, mitigation or offset if considered appropriate by Project Ecologist

**Horizons Regional Council review**

FEEDBACK LOOP

### Explanatory Notes

1. *Refer Appendix 2: Erosion and Sediment Control Monitoring Plan (ESCP) Section 1.5 SRP Treatment Efficiency Threshold*
2. *As outlined in Appendix 2: Erosion and Sediment Control Monitoring Plan (ESCP) and as recorded at Project telemetered rainfall monitoring gauges.*
3. *As outlined in Appendix 2: ESCP.*
4. *Event based monitoring can also be triggered by failure of perimeter control, failure of a SRP or DEB, and slumping or mass movement or erosion associated with construction works.*
5. *The ecological effects of sedimentation discharges associated with the Project shall be assessed by the Project Ecologist as described in section 10.7.4.3 and section 10.7.4.4 of the EMP. This assessment shall consider the effects on the stream as a whole, including spatial extent, persistence, frequency and the extent to which effects cascade through the ecosystem (e.g. effects on substrate, macrophytes, invertebrates and fish). Effects shall be interpreted in the context of results from baseline monitoring, control sites and relevant water quality monitoring. The need for further assessment will be based on the 20% deviation from the monitored parameters (as per section 10.7.4.3 and section 10.7.4.4 of the EMP).*
6. *Further monitoring, mitigation or offset may be recommended if the overall ecological effects are determined to be significant by Project Ecologist (based on triggers in Note 5). Additional mitigation or offset shall only be recommended for effects that persist for more than a year (and monitoring indicates that the effect is likely to persist) where those effects are additional to those already anticipated by the AEE (based on triggers in Note 5), and are additional to effects that are being offset or compensated through the Residual Effects Management Plan (Chapter 12 of the Ecology Management Plan).*
7. *Post construction monitoring will likely follow the routine monitoring programme for one year following completion of works but refined to any particular sites / effects observed during construction and with a potentially reduced frequency.*

## Attachment 3: Updated Erosion and Sediment Control Plan

WAKA KOTAHI NZ TRANSPORT AGENCY

**Te Ahu a Turanga**
Manawatū Tararua Highway

## Te Ahu a Turanga; Manawatū Tararua Highway

# Erosion and Sediment Control Monitoring Plan

| | |
|---|---|
| **Document Number** | TAT-0-EV-06030-CO-RP-0005 |
| **Revision** | B |
| **Date** | 28/04/2020 |

# Document Control

## Document History and Status

| Revision | Date Issued | Author | Reviewed By | Approved By | Status |
|---|---|---|---|---|---|
| **A** | 21/02/2020 | Lorraine Pennington / C Stewart | | | Draft |
| **B** | 28/02/20 | C Stewart | | | Draft |
| | Role | | | | |

## Revision Details

*Provide a brief statement on what the updates are for each revision.*

| Revision | Details |
|---|---|
| **A** | Draft |
| **B** | Draft |
| | |

## Purpose of Issue

*Provide the reason for issue e.g. 85% report for peer review etc.*

| Revision | Details |
|---|---|
| **A** | Draft |
| **B** | Adding pH and clarity target ranges in response to Horizons s92 questions |
| | |

# Table of Contents

# 1 Introduction

The purpose of this Erosion and Sediment Control Monitoring Plan (ESCMP) is to detail the erosion and sediment control (ESC) management and monitoring system that will be implemented for the duration of the earthworks period of Te Ahu A Turanga; Manawatū Tararua Highway project (the Project). It is to be read in conjunction with the Aquatic Ecology Monitoring Protocols (Section 10 of the Ecological Management Plan). The ESCMP includes details of process and procedures that will be followed and confirms how the ESC management and monitoring will be undertaken and the methods used in the context of the Project to ensure that effects and performances are managed appropriately.

This ESCMP has been written to detail how we propose to manage and monitor ESC measures during construction, to ensure management of performance of the Project's ESC measures and to provide rapid and real time information and control to the Project team. Our iwi partners will be included throughout the development of this ESCMP and will be involved onsite throughout the construction phase.

The ongoing monitoring and reporting that is proposed in this ESCMP, creates a continuous feedback loop of the performance of the Project's ESC site and device management. This ESCMP provides the approaches to be followed in regard to ESC maintenance, monitoring and reporting and will be reviewed on receipt of the finalised consent conditions and updated as may be necessary to be consistent with those conditions.

This document will be reviewed on an annual basis. Any material changes to this document will require certification by Horizons Regional Council (Horizons).

The ESCMP covers:

- Site management structures, practices and procedures.
- Weather Monitoring.
    - Prior to commencement of construction works two automated weather stations will be installed onsite (at the eastern and western rises of the Ruahine Range).
- Erosion and Sediment Control Monitoring
    - Scheduled site visits, pre and post rain event monitoring and water sampling.
    - Automated turbidity recording on two selected Sediment Retention Ponds which will include rainfall event triggered manual turbidity monitoring.
    - Chemical treatment will be monitored in accordance with the Project's Chemical Treatment Management Plan (Appendix 1 to the Erosion and Sediment Control Plan (ESCP)).
- Reporting
    - Rainfall trigger event reporting following a rainfall trigger event (as defined in Section 3.2 of the ESCMP).
    - Recommendations of changes that need to be implemented on site and modifications to any ESC devices or practices will also be included.
- Annual Reporting
    - A Monitoring and Maintenance annual report will be completed and issued to Horizons and iwi partners by the end of June after the completion of each earthworks season. This report will contain all the monitoring results and interpretation of the fluctuations

and observations recorded over the previous year, as well as any changes or modifications that are proposed to this ESCMP.

## 1.1 Site Specific Erosion and Sediment Control Implementation

The construction of all erosion and sediment controls will be managed as follows:

- The Environmental Technical Specialist will prepare a Site-Specific Erosion and Sediment Control Plan (SSESCP) in conjunction with the relevant construction zone Project Engineer, Site Engineer and the Environmental and Site Supervisor’s.
- The SSESCP will be approved by the Environmental Manager and then submitted to Horizons for certification against GD05 and the consent conditions.
- Once certified, the Environmental Manager will issue an approved SSESCP to the appropriate earthworks zone Site Supervisor responsible for implementation.
- A pre-construction meeting will be held by the Environmental Management Team where the sediment controls to be built will be discussed and specific direction given on construction.
- The location of the controls and requirements of the relevant SSESCP will be confirmed on site with the construction team and the Environmental Management Team.
- The construction of the controls will be overseen by the Site Supervisors and members of the Environmental Management Team.
- Hold points for construction will be established for each control whereby the Environmental Management Team will inspect the work completed, for example the installation of anti-seep collars or the installation of primary outlet.
- Each control will be ‘as built’ certified by the Environmental Management Team to confirm compliance with the SSESCP prior to bulk earthworks commencing in the catchment of the device(s).
- Copies of the 'as-built' certifications will be submitted to Horizons.

## 1.2 Erosion and Sediment Control Inspections

The Environmental Manager and / or Environmental Supervisor will conduct routine (minimum weekly) inspections of the site. These inspections will take place with adequate time allocated and will be thorough and systematic. Members of the construction team including the relevant zone's Project Engineer and/or Site Engineer and/or /Site Supervisor, will accompany the Environmental Manager or Environmental Supervisor on these inspections so that the Environmental Manager or Environmental Supervisor can better understand the work occurring at that time and that programmed to take place. It is also useful for the Project Engineers to be reminded of their ESC obligations and for both parties to recognise good performance and outcomes, and where performance has not been to the standard expected or required by consents and GD05. This is particularly relevant in identifying how communication between personnel can be improved to avoid a recurrence of an issue.

Communication is critical to the successful implementation of SSESCPs. Internal inspections will cover all areas of the Project, even those that may have been dormant for some time, to ensure that the controls are still operating properly. These internal inspections will be captured in writing and will include actions and timeframes for close out.

## 1.3 Weather Monitoring

### 1.3.1 Rain Forecast

Rain forecasts relevant to the site will be checked daily using the MetService / MetVuw online forecasting systems. Close monitoring of the rain forecast will be necessary to ensure the appropriate site works can be implemented prior to rainfall trigger events.

The daily weather forecast checks will be forwarded to all Project Engineers, Site Engineers and Site Supervisors every morning and will be recorded in the daily prestart job sheets.

If the forecasts show more than 20mm of rainfall over a 24-hour period, then this will trigger the pre-rain event environmental team inspections as outlined in section 3.2 of this ESCMP (pre-rain event with forecast >20mm over 24 hours). This is in addition to the routine pre-rain event inspections undertaken by Site Engineers and Site Supervisors as detailed in section 3.3 of this ESCMP below. Note the pre-rain forecast trigger of >20mm over 24 hours is less than the rainfall trigger monitoring (referred below) to provide a buffer and to ensure no actual rain event of 25mm is "missed" by the construction team.

### 1.3.2 Rain Gauges

Two telemetered rainfall monitoring stations will be installed on site to provide real-time continuous rainfall intensity and volume data which will be able to be observed online by Project personnel. Email and/or text notifications will be programmed to ensure relevant staff, including the Environmental Management Team, are alerted when rainfall trigger events occur onsite.

## 1.4 Erosion and Sediment Control Device Monitoring

### 1.4.1 Site inspections

Routine inspections are undertaken during and post instalment of ESC devices. During construction certain stages are identified for inspection, such as during the installation of anti-seep collars, level spreaders, and T-bars.

Post construction monitoring is undertaken once a SRP or DEB is operational, and the rainfall activated chemical treatment system is operational for the first time. Monitoring will take place as soon as practicable following the first rainfall event that generates a discharge. This is to assess the performance of the device and chemical treatment system and the resulting quality of treated water being discharged from the site.

The site will be inspected weekly as a minimum by the Environmental Manager and / or Environmental Supervisor and/or Environmental (ESC) Technical Specialist during the course of the works. These inspections will ensure that all ESC devices are installed correctly and then operate effectively throughout the duration of the works. This inspection programme will provide certainty to all parties that appropriate measures are being undertaken to ensure compliance with conditions of consent and the SSESCPs. The inspection regime will keep ESC management at the forefront of works on site. Any potential problems will be identified immediately, and remedial works will be promptly carried out.

The inspection programme shall consist of:

- Weekly site walkovers involving the Environmental Management Team to inspect all ESC measures, identify any maintenance or corrective actions necessary, assign timeframes for completion, and identify any devices that are not performing as anticipated through the SSESCP.
- Pre-rain event: Prior to all forecast rainfall events (as detailed above in section 3.2 of this ESCMP), additional inspections will be made of ESC devices, including chemical treatment systems and automated monitoring devices, to ensure that they are fully functioning in preparation for the forecast event. These will be undertaken by the Site Engineers and Site Supervisors.
- Pre-rain event with forecast > 20mm over 24 hours: Prior to forecast rainfall "trigger" events the site will be inspected by the Environmental Management Team (in addition to the business as usual pre-rain inspections undertaken by the Site Engineers and Site Supervisors). The aim of the inspection will be targeted at any additional ESC measures that are required to be installed

to ensure that the site's ESC management system performs effectively during an expected larger event.

- **Rainfall Trigger** Inspections: In addition to the general post rainfall event monitoring, during or immediately after rainfall trigger events (subject to health and safety restrictions) inspections will be made of all SRPs and DEBs, with manual turbidity and pH testing of the inlet and outlet flows undertaken along with a general inspection of the sediment control devices. Clarity of the water within the device adjacent to the decant outlet will be measured using either a clarity tube or black disc indicator. The purpose of these inspections is to confirm the performance of devices under the stress of heavy rainfall, obtain a spot check efficiency of the device and to compare the field results with the results gained from the automated turbidity monitoring stations set up on two SRPs, as described below in section 1.4.2 to this ESCMP.

The rainfall trigger alerts will be generated via the on-site rainfall gauge and will be linked to the mobile phones of the Environmental Management and Construction Teams.

The key rainfall event triggers driving specific device monitoring are as follows:

  - >25mm rainfall over any 24-hour period
  - >15mm rainfall within an hour

### 1.4.2 Automated Monitoring

Continuous turbidity monitoring will be undertaken at the inlet and outlet of two SRPs. The location of these monitoring stations will be determined in consultation with Horizons. The purpose of this automated monitoring is to provide real time performance indicator of the treatment efficiency of the device for all rainfall events that result in a discharge. This information will inform the overall likely performance of the devices across the site, when used in conjunction with manual turbidity monitoring undertaken during rainfall trigger events.

The inlet sensor will be located upstream of the SRP forebay and upstream of the chemical application point.

The outlet sensor will be located within the discharge manhole or an alternative location at the discharge point of the SRP.

This data will be accessible online in real-time.

The use of turbidity allows for the Project to observe live real time data and formulate decisions based on data obtained throughout the entire rain event.

### 1.4.3 Clarity Monitoring

As well as manual turbidity recording, manual clarity checks will be made at each SRP and DEB. A clarity target of 100 mm or greater will be used to assess discharge performance in accordance with the Chemical Treatment Management Plan (Appendix 1 of the ESCP), using the following procedure:

Black disc

- A 50-80mm diameter is attached to a 1m long stick with a centimetre scale starting at the disc is lowered vertically into the water to be tested until it disappears, and then is raised until it just reappears. The depth of reappearance is recorded as the clarity of the water.

Clarity Tube

- A clarity tube including a magnetic back disc will be filled with water from the device. The tube will be laid horizontal and disc is moved down the tube until it disappears, and the distance is recorded. The disc is then moved back until it reappears, and the distance is recorded.
- Readings should be taken in diffuse sunlight or shade. If it is impossible to avoid bright sunlight, work with the tube perpendicular to the sun's plane.
- Readings will not be taken in very low light conditions (insufficient for colour perception)

### 1.4.4 pH Monitoring

pH will be recorded at each device receiving chemical treatment to ensure that the device discharges are within the acceptable pH range of 5.5 to 8.5 and will not change the baseline pH beyond +/-1 in accordance with the Chemical Treatment Management Plan (Appendix 1 of the ESCP), using the following procedure:

1. Ensure that the pH meter has been calibrated and that the calibration has not expired.
2. Use the pond water (or water that is to be discharged) to rinse out a small container then half fill with water from the same source.
3. Immerse the pH meter in the water and leave for up to 1 minute or until the reading stabilises and doesn't change. Place the container in a shaded place (out of direct sunlight) while it stabilises.
4. Record the pH reading given on the meter along with the date, time, and source of the water (e.g. SRP 4).

## 1.5 SRP Treatment Efficiency Threshold

Treatment efficiencies of the two continuously monitored SRPs will be assessed against ~~a~~n average efficiency of 90% across a rainfall trigger event. The average efficiency will be calculated from the inlet and outlet readings taken over the duration of the event. Where an efficiency of 90% across a rainfall trigger event is not achieved, the following will occur:

- Within 24hrs of a threshold exceedance, a full audit of the condition of the control device and its contributing catchment will be carried out and recorded in writing.
- Remedy and record any obvious causes on site that may have contributed to a threshold exceedance as soon as practicable.
- Identify any additional reasons for the exceedance and opportunities to modify the management of the site to improve overall efficiency which may include:
  - Consider additional ESC;
  - Refinement of chemical treatment systems;
  - Progressive stabilisation in sub-catchments;
  - Increase maintenance of controls; and
  - Amendments to methodologies and sequencing of works and refinement of controls necessary (check that a further approval is not required from Horizons).
- In consultation with Horizons, implement alterations to ESC measures and methodologies.

### 1.5.1 Data Interpretation

All data will be compiled to allow for the analysis of device efficiency in relation to rainfall, earthworks area and overall ESC management. This will also inform potential for modification of site ESC practices to better retain sediment within the site, if that is deemed necessary.

# 2 Management Responses

In addition to the SRP treatment efficiency exceedance responses detailed above, if one of the following cases occur, additional management responses will be triggered as outlined below. In some instances, responses may need to be discussed and agreed with Horizons to ensure the most appropriate outcomes are achieved.

i. A failure of a perimeter control that has resulted in visible discharge of sediment to a stream.
ii. A failure of a SRP or DEB that has resulted in a visible discharge of sediment to a stream.
iii. Slumping / mass movement or erosion associated with the works, but which is outside the catchment of a sediment control device or has resulted in a device being over-topped by sediment, where that sediment has discharged to a stream.

- Remedy the failure or event to prevent further uncontrolled discharges.
- Implement the Event Based ecology and water quality monitoring described in Section 1.1.5.3 of the Aquatic Ecology Monitoring Protocols, Section 10 of the Ecological Management Plan.

# 3 Reporting

## 3.1 Site Auditing

Daily inspections will be undertaken by the ESC Foremen.

An internal audit will be undertaken by the Environmental Manager and / or Environmental (ESC) Technical Specialist weekly at a minimum. Any maintenance actions will be undertaken that day where practical.

Actions will be loaded into the Environmental Management system and Work Instructions with details and timeframes will be issued by the Environmental Supervisor to the relevant ESC Foreman, with specific actions and closeout timeframes. The ESC Foreman will report completion of those actions and the Environmental Supervisor will inspect the works and close-out the items in the management system.

For programmed Horizons inspections, a member of the Environmental Management Team will accompany the Horizons inspector in all audits. Usually a member of the Construction Team will also be present.

As for internal audits, all ESC maintenance actions identified by the Council inspector will be recorded into the Project Environmental Management system. Work Instructions, with details and timeframes, will be issued to the ESC Foreman by the Environmental Supervisor, based on the Council's instructions. The ESC Foreman will report back the completion of those actions to the Environmental Supervisor who will inspect the works and confirm that those actions have been completed. Confirmation will be emailed to the Council inspector.

## 3.2 Rainfall Trigger Event Report

Following a rainfall trigger event, a report will be produced to provide Horizons and iwi partners a summary of the performance of SRPs, DEBs and overall ESC system observed during the rainfall event. The report will include:

- A summary of the rainfall (total and intensity)
- Summary of the data acquired from the automated turbidity monitors from the two SRPs, including summary of event-based efficiency.
- A summary of the manual monitoring undertaken and comparison of manual monitoring results with automated results.

- Identification if a threshold exceedance occurred. This will outline what exceedance occurred, the extent of the exceedance, any actions taken to mitigate the effects of the event and a proposed management response if required.
- A record of any other matters which may have compromised the overall ESC performance during the rain event and the identified mitigation, maintenance and management response.

The Rainfall Trigger Event Report will be provided to Horizons and iwi partners within 10 days of the rainfall trigger event.

## 3.3 Annual Report

An annual report containing monitoring results and an assessment of discharge compliance will be provided to Horizons within the month of July of each year. This report will contain the following details.

- A summary of the results of all monitoring within that period.
- A summary of any threshold exceedances that occurred and the response actioned.
- Any proposed changes or updates to the ESCMP are to be discussed with Horizons. Written certification from Horizons must be provided if any significant changes to the ESCMP are made.

# Te Ahu a Turanga: Manawatū Tararua Highway – Baseline Freshwater Monitoring Plan

EOS Ecology Report No. NZT02-18064-01 | Sept 2018

SCIENCE + ENGAGEMENT

EOS ECOLOGY

# Te Ahu a Turanga: Manawatū Tararua Highway – Baseline Freshwater Monitoring Plan

**EOS Ecology Report No.** NZT02-18064-01 | Sept 2018


**Prepared for** New Zealand Transport Agency

**Prepared by** EOS Ecology
Alex James

**Reviewed by** Shelley McMurtrie

## EXECUTIVE SUMMARY

With the proposed SH3 replacement route for the Manawatu Gorge cutting through an area of steep topography that includes several Manawatu River tributary streams, erosion and sediment control will be a significant component of the construction process. EOS Ecology was engaged by NZTA to design and implement a baseline freshwater monitoring programme focussed on fine sediment. An ecological values-based approach has been taken, where the level of monitoring effort depends on the relative catchment ecological value – meaning that catchments with higher ecological value will have a greater level of monitoring. Methodologies include installation of telemetered turbidity loggers, quantitative macroinvertebrate sampling, deposited sediment monitoring, and the collection of water quality samples (for laboratory analysis of total suspended solids and turbidity with onsite measurement of water clarity).

Based on the project ecological data collected by Boffa Miskell and a basic construction risk metric the catchments affected by the road alignment were divided into three value categories (high, medium, and low). The high value catchments will receive the full list of sampling methodologies, the medium value catchments include all methods except turbidity logging tailored to individual catchment characteristics, and low value catchments will have no monitoring.

Ideally each catchment would have a series of monitoring sites located upstream and downstream of the road alignment in reaches with similar channel morphology and flow characteristics. However, this was not possible for many catchments as the road alignment is located in the upper headwaters meaning a reliable upstream site was not possible. Site selection has thus been pragmatic.

The baseline freshwater monitoring programme is intended to run for a minimum of one year in order to capture seasonal variation. Turbidity loggers will initially be installed for one year, with a decision regarding leaving them longer to be made towards the end of that period. During that first year of baseline monitoring macroinvertebrate samples will be collected on two occasions (early spring and late summer), deposited sediment measured on six occasions, and water quality sampling on 12 occasions (a mix of wet and dry events).

At the conclusion of the baseline freshwater monitoring programme all data will be analysed to determine the existing state of suspended sediment, deposited sediment, and the macroinvertebrate communities across the project area. Project-relevant triggers/limits will then be determined that can be included in construction phase resource consent conditions.

# 1 INTRODUCTION

The preferred "Te Ahu a Turanga: Manawatū Tararua Highway" is proposed for the steep hill country to the north of the Gorge. This route crosses several small stream catchments, most of which discharge directly to the Manawatu River (Figure 1). The steep topography will require extensive cut and fill during construction, which will expose large areas of bare earth. Consequently, a major potential adverse effect during construction will be the mobilisation of fine sediment during rain events and their subsequent deposition on the beds of the predominantly stony-bottomed streams downstream. A major focus during construction will be the control of such sediment mobilisation. Following early discussions with Horizons Regional Council, NZTA will be implementing a sediment-focussed baseline freshwater monitoring programme along the proposed alignment.

EOS Ecology was engaged by NZTA to design and implement this programme, which has the aim of characterising the baseline fine sediment characteristics of watercourses to be affected by Te Ahu a Turanga. This document outlines the monitoring plan and how it will be implemented.

# 2 METHODS

## 2.1 Approach

Rather than a simple monitoring programme whereby the same parameters are measured at all monitoring sites, an ecological values-risk based approach has been taken. This effectively differentiates among the affected catchments based on their ecological value and an estimate of construction risk based on the length of the project within the catchment. A level of baseline monitoring effort is then assigned based on ecological value, with higher value sites having a higher level of effort than lower value sites.

## 2.2 Catchment & Site Names

None of the eight catchments directly affected by Te Ahu a Turanga appear to have formal recognised names. For project consistency we have adopted the catchment and tributary numbering assigned by Boffa Miskell. Freshwater monitoring sites have been named based on the catchment they are within (e.g. C2 for Catchment 2 and so on) with lettering used to indicate the channel within that catchment that the site is located on (e.g. C2A for Catchment 2, channel A) and a prefix dependent on where they are located in relation to the project area, either US for upstream or DS for downstream (e.g., C2A-DS). Where there is more than one downstream site within a catchment they are given a number (e.g., C2A-DS1 and C2A-DS2).

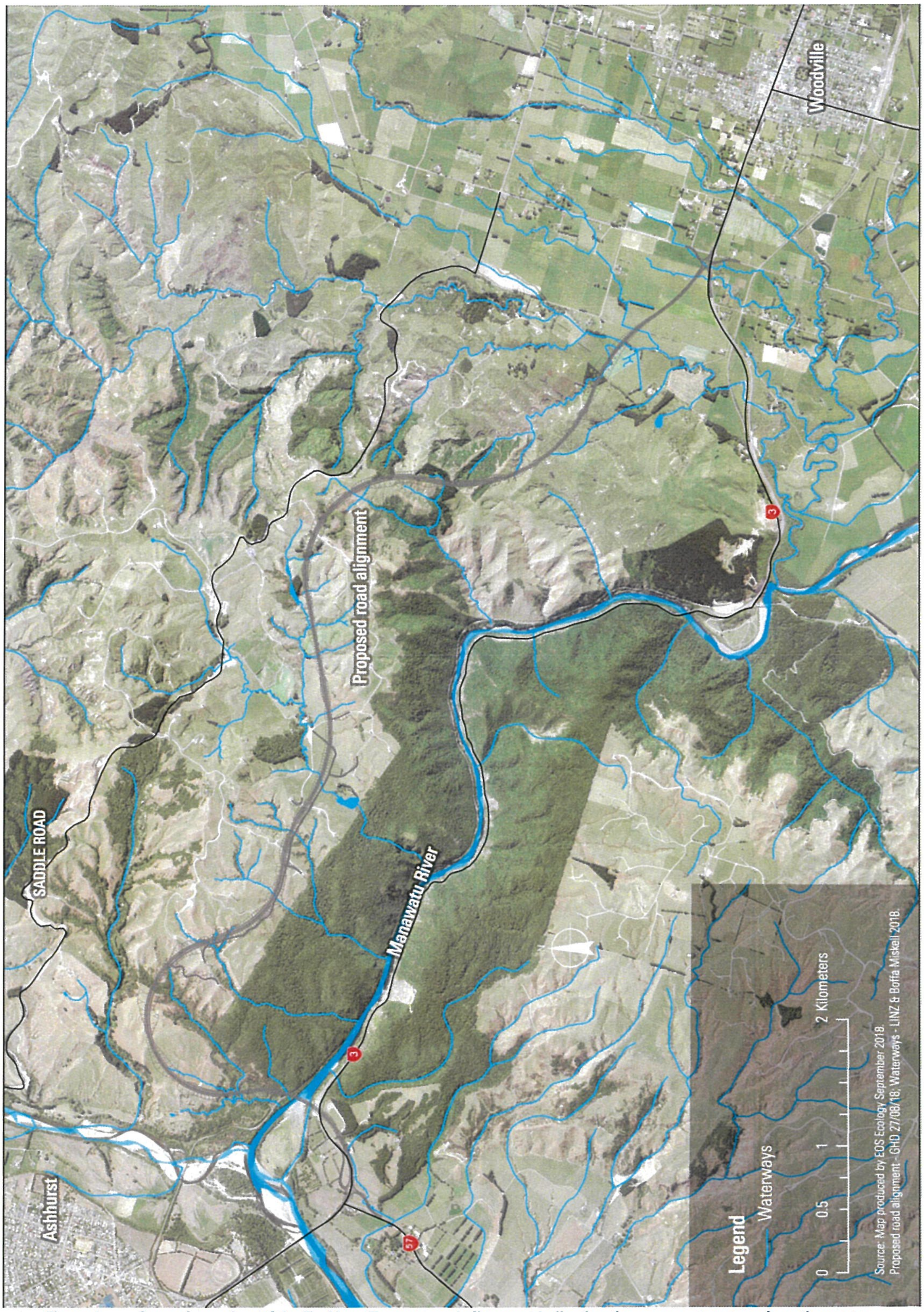


Figure 1 General overview of the Te Ahu a Turanga road alignment indicating the many waterways along the route.

## 2.3 Data Sources & Ranking Procedure

Boffa Miskell has collected ecological data including aquatic macroinvertebrates (ranked abundance data, July 2018), fish (February and July 2018), Stream Ecological Valuation (SEV; July 2018), and sediment quality (July 2018) from representative sites in the affected catchments. They also undertook a site walkover and took numerous photos of watercourses and the general landscape. The streams they visited have been designated as permanent or intermittent, however note that these are based on a wintertime site visit and the length of intermittent or ephemeral sections may be longer during summer. From this information macroinvertebrate, fish, and SEV data were used, along with two other metrics, to rank the ecological value of catchments, which are outlined below:

» **Fish species richness.** The number of freshwater fish species known from the catchment - with a higher ranking given for catchments with greater numbers of fish species.

» **"At Risk" or "Threatened" species richness.** The number of fish species or invertebrate taxa that are classified "At Risk" or "Threatened" based on the latest freshwater conservation status classifications of Dunn *et al.* (2018) and Grainger *et al.* (2014) respectively. Catchments with such species were given a higher ranking than those where they are not currently known from. Longfin eel (*Anguilla dieffenbachii*) was the only species found during the survey that met this criterion.

» **Semi-quantitative MCI (SQMCI).** The macroinvertebrate community index (MCI) is a community health index based on the taxa-specific tolerances to organic pollution (see Stark & Maxted, 2007), that is calculated based on presence-absence data. The semi-quantitative MCI (SQMCI) takes into account coded abundance data so includes consideration of the abundance of each taxon (see Stark & Maxted, 2007). SQMCI scores were assigned the quality classes of Stark & Maxted (2007) and catchments with higher site SQMCI quality classes were given higher ranking than those with lower ones.

» **Ephemeroptera-Plecoptera-Trichoptera (EPT) taxa richness.** The EPT taxa comprise three freshwater macroinvertebrate orders (Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies)), which are generally considered sensitive to pollution and habitat degradation. This sensitivity leads them to be used widely in biomonitoring. Catchments with higher numbers of EPT taxa found at sampling sites were given higher ranking than those with fewer EPT taxa.

» **Stream ecological valuation (SEV).** SEV was developed to quantify the ecological functioning of stream sections so as to use this information to calculate appropriate mitigation or biodiversity offsets in circumstances where human activity is causing a loss in ecological function (see Storey *et al.* 2011). For the ranking exercise we have used the overall SEV site scores to rank catchments based on their ecological function, with higher scoring catchments ranking higher than lower scoring ones. Note the macroinvertebrate fauna functions were not included in SEV calculations due to a lack of suitable reference site data from the Manawatu region (Kieran Miller, Boffa Miskell, pers. comm.).

» **Native forest downstream.** The approximate linear stream length that flows through native forest downstream of the project area. It is more than likely the ecological values of these reaches are relatively high compared to the upstream agricultural land use that the project area is within. These sections are worthy of consideration here due to being the downstream receiving environment from the project area.

» **Length of project.** The approximate length of the project area in each stream catchment was included as a proxy for catchment earthworks area and construction duration. Catchments with a greater project length ranked higher than those with a lesser length, with the higher value being associated with a higher risk of sediment release during construction. It was not possible to work out any other project-based ranking, as there was no information available regarding the area of construction/earthworks within each catchment. Given this was the only measure for construction risk, a multiplier was applied to this ranking to increase its weighting.

Eight of the affected stream catchments were ranked for each of the parameters described above with higher ranks being given for higher ecological value (i.e., a rank of 1 indicates higher value than a rank of 2 and so on) and higher risk during construction (i.e., a rank of 1 indicates higher construction risk than a rank of 2 and so on). This results in a summation of ranks for each site that is a composite of ecological value and construction risk such that a final overall ecological value-risk ranking is derived for the affected catchments. All parameters were given the same weighting with the exception of the construction risk parameter "Length of project", which had a multiplier applied to increase its influence. Where data was not available from a particular catchment, the relevant data from the most similar catchment was used to fill this information gap. This was required in only two instances (a lack of macroinvertebrate and SEV data from Catchments 3 and 8, whereby data from Catchment 2 (Boffa Miskell Site 2D) and Catchment 1 (Boffa Miskell Site 1) were used, respectively). These sites had similar habitat characteristics (Kieran Miller, Boffa Miskell, pers. comm.). Catchment 9 was not subject to the ranking scheme, as it was not affected by the project until a late change in road alignment and no ecological information has yet been collected.

## 2.4 Monitoring Methods

The suite of baseline monitoring methods to be selected from is listed below. These effectively form a 'methodological menu', where methods will be chosen for catchments based on their ecological value ranking (with more effort/more baseline monitoring methods applied to catchments with higher ecological value rankings).

» **Installation of continuous turbidity loggers.** These would be installed and maintained by NIWA and allow real time access to turbidity measurements via a website. For those sites where they are installed a baseline turbidity profile will be determined and inform realistic turbidity limits during the construction period.

» **Quantitative aquatic macroinvertebrate sampling.** The macroinvertebrate communities from high quality stony-bottomed streams contain taxa that are vulnerable to elevated levels of fine sediment deposition. Therefore macroinvertebrate sampling will form an important part of the suite of monitoring options. In situations where there will (or may be) some discharge to water and the macroinvertebrate community is to be monitored, Schedule E of the One Plan states "there must be no more than a 20% reduction in Quantitative Macroinvertebrate Community Index (QMCI) score between appropriately matched habitats upstream." Therefore where macroinvertebrate sampling is deemed appropriate we will undertake quantitative Surber sampling. Because the monitoring is focused on fine sediment mobilisation and deposition, macroinvertebrate sampling will only be undertaken at sites and habitats where taxa sensitive to increased fine sediment are likely to be present (i.e., riffle or fast run habitat in hard-bottomed stony streams).

» **Deposited sediment monitoring.** Elevated levels of fine sediment deposition in stony-bottomed streams (especially high quality streams) can have negative impacts on those species that prefer or require relatively "clean" substrate (e.g., most mayflies and stoneflies, as well as many caddisflies).

Deposited fine sediment will be monitored using the "SAM 2 – In-stream visual assessment of sediment" and "SAM 5 – Resuspendable sediment (Shuffle index)" methods of Clapcott *et al.* (2011), however we will take twice as many measurements as suggested. Deposited sediment monitoring will only be undertaken at sites with a hard-bottomed stony streambed.

» **Water quality monitoring.** The collection of spot water samples with analysis for total suspended solids (TSS) and turbidity at an accredited laboratory. Water clarity will also be measured on site using a clarity tube. Samples will be collected during both wet and dry events. This data will provide a baseline dataset to inform realistic limits during the construction period.

## 2.5 Site Selection

Within each of the affected stream catchments ideally monitoring locations would have consisted of sites upstream and downstream of the project area that were matched in terms of channel morphology and instream habitat. However, the location of the road alignment means that for some catchments the selection of suitable upstream and downstream sites was impossible for those catchments. In these catchments, where their ecological value is high enough to warrant some form of baseline monitoring, only a downstream site or sites have been selected. While not allowing the before-after, control-impact (BACI) data analysis afforded by having sites upstream and downstream of the project area, these downstream sites will still provide valuable baseline information that can be compared to any construction and post-construction monitoring that may be undertaken.

No sites have been included on the Manawatu River itself due to the difficult access and safety concerns in the general vicinity of the new bridge site. The river appears generally non-wadeable at that location with no viable location for a temporary turbidity logger installation that would not be destroyed/damaged by floods or viable upstream–downstream monitoring sites for any macroinvertebrate sampling or deposited sediment monitoring. Additionally concentrating the monitoring within the small tributaries directly affected by the project will provide a more accurate reflection of sediments originating from the project area than samples from the Manawatu River with its large catchment area upstream.

# 3 CATCHMENT RANKING

Seven parameters were used to rank catchments as per Section 2.3, with the raw data used in the ranking exercise shown in Table 1. For most catchments the fish, macroinvertebrate, and SEV data is based on a single site (Table 1). For Catchments 2 and 7 there were two macroinvertebrate and SEV sites with the values for these sites being averaged for use in catchment ranking.

**Table 1** The raw data used to rank catchments affected by Te Ahu a Turanga. For SQMCI scores the quality class of Stark & Maxted (2007) are shown (Exc. = Excellent) with the scores shown in parentheses. For each parameter the weighting applied to the ranking is shown in square brackets.

| Catchment | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9# |
|---|---|---|---|---|---|---|---|---|---|
| Type and number of Boffa Miskell sampling sites in catchment | Fish/ Inverts/ SEV: 1 | Fish: 1 Inverts/ SEV: 2 | Fish: 1 | Fish/ Inverts/ SEV: 1 | Fish/ Inverts/ SEV: 1 | Fish/ Inverts/ SEV: 1 | Fish: 1 Inverts/ SEV: 2 | Fish: 1 | None |
| Fish spp. richness [1] | 1 | 4 | 1 | 1 | 1 | 0 | 2 | 2 | |
| At risk/threatened taxa richness [1] | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | |
| SQMCI* [1] | Poor (2.58) | Exc. (5.91) | Good (5.52) | Poor (3.54) | Exc. (6.63) | Exc. (7.55) | Exc. (7.22) | Poor (2.58) | |
| EPT taxa richness* [1] | 1 | 9 | 2 | 5 | 5 | 7 | 7 | 1 | |
| SEV overall score* [1] | 0.347 | 0.684 | 0.813 | 0.515 | 0.612 | 0.847 | 0.787 | 0.347 | |
| Native forest downstream (m) [1] | 0 | 500 | 700 | 830 | 1280 | 960 | 1100 | 0 | 0 |
| Approximate length of project in catchment (m) [4] | 320 | 3250 | 1200 | 2250 | 1500 | 520 | 2000 | 430 | 180 |

#This catchment was only recently added to the project area as a result of a recent alteration to the project alignment. Subsequently there is no biological data available for this site. We have used expert opinion to score this based on the final ecological value-risk groupings shown in Table 2.

* A lack of macroinvertebrate and SEV data from Catchments 3 and 8 meant that surrogate information from the most similar catchment (Catchment 2 (Boffa Miskell Site 2D) and Catchment 1 (Boffa Miskell Site 1), respectively) was used instead.

Based on the sum of the ranked parameters three ecological value-risk groupings were apparent (Table 2; Figure 2; Figure 3). Catchments 2 and 7 had the lowest sum of ranks (indicating the highest ecological value-risk conditions) and were clearly separated from all other sites (Table 2). These two catchments had relatively high fish and macroinvertebrate values, moderate to high overall SEV scores, and relatively long sections of the project within their catchments (Table 1). Catchments 5, 4, 3, and 6 form a medium ecological value-risk grouping (Table 2). These four sites include a range of conditions with Catchment 6 scoring relatively high for the macroinvertebrate and SEV parameters but only having a small section of the project within its catchment in contrast to Catchment 4, which scored low for macroinvertebrates and SEV but has some 2,250 m of project length with its catchment. Catchments 1 and 8 form a low ecological value-risk grouping with sum of ranks substantially higher than all other catchments (Table 2). An additional catchment, Catchment 9, was not included in the ranking procedure, as no ecological data has been collected from this catchment to date. This catchment was not affected by the project until recently. A change in the alignment to minimise disturbance to the neighbouring Catchment 7 meant the project area now includes a small area of this catchment just upstream of its confluence with the Manawatu River (Figure 2). Given the catchment has 100% forest cover and is predominantly within the Manawatu Gorge Scenic Reserve it likely has relatively high ecological values. However as the project footprint is the least of all catchments (Table 1) we have categorised Catchment 9 as a medium ecological value-risk (Table 2; Figure 2).

Table 2 A ranking of catchments affected by Te Ahu a Turanga based on ecological parameters and project lineal length. Lower values represent a higher value or greater risk (for length of project in catchment). Columns are coloured to reflect the ecological value groupings of the catchments (green = highest, yellow = medium, and red= low).

| | Catchment | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Parameter | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9# |
| Fish spp. richness | 4 | 1 | 4 | 4 | 4 | 8 | 2 | 2 | |
| At risk/threatened taxa richness | 4 | 1 | 1 | 4 | 1 | 4 | 1 | 4 | |
| SQMCI* | 6 | 1 | 5 | 6 | 1 | 1 | 1 | 6 | |
| EPT taxa richness* | 7 | 1 | 6 | 4 | 4 | 2 | 2 | 7 | |
| SEV overall score* | 7 | 4 | 2 | 6 | 5 | 1 | 3 | 7 | |
| Native forest downstream | 7 | 6 | 5 | 4 | 1 | 3 | 2 | 7 | 7 |
| Length of project in catchment | 32 | 4 | 20 | 8 | 16 | 24 | 12 | 28 | 36 |
| Sum of ranks | 67 | 18 | 43 | 36 | 32 | 43 | 23 | 61 | |
| **Overall rank** | **8** | **1** | **5** | **4** | **3** | **5** | **2** | **7** | |

# This catchment was only recently added to the project area as a result of a recent alteration to the project alignment. Subsequently there is no biological data available for this site. We have used expert opinion to score this in the medium category (yellow) as a result of the catchment having a relatively minor project length and this being at the downstream end.

* A lack of macroinvertebrate and SEV data from Catchments 3 and 8 meant that surrogate information from the most similar catchment (Catchment 2 (Boffa Miskell Site 2D) and Catchment 1 (Boffa Miskell Site 1) respectively was used instead.

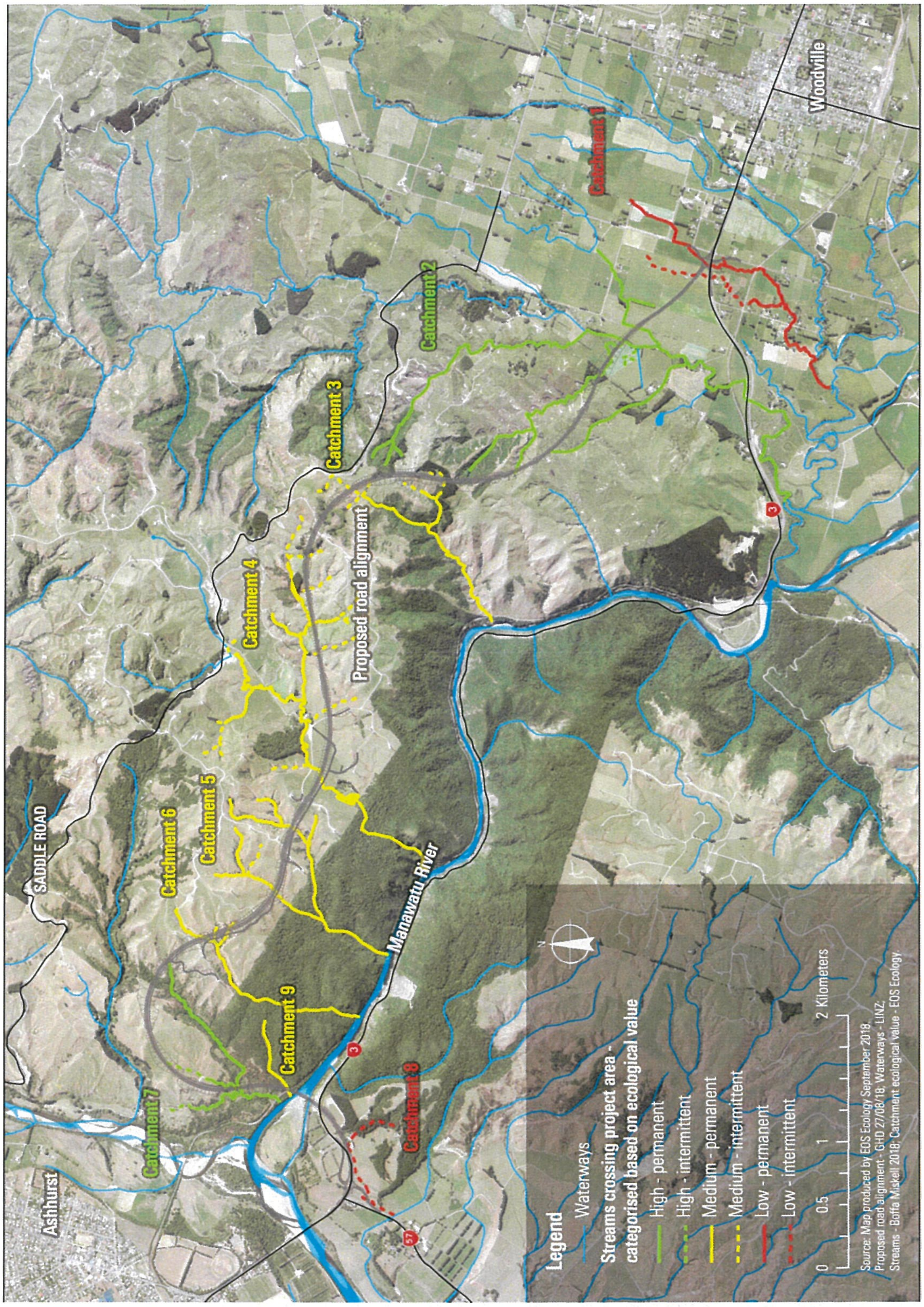


Figure 2 Map showing ecological values –risk ranking categories of the catchments affected by Te Ahu a Turanga.

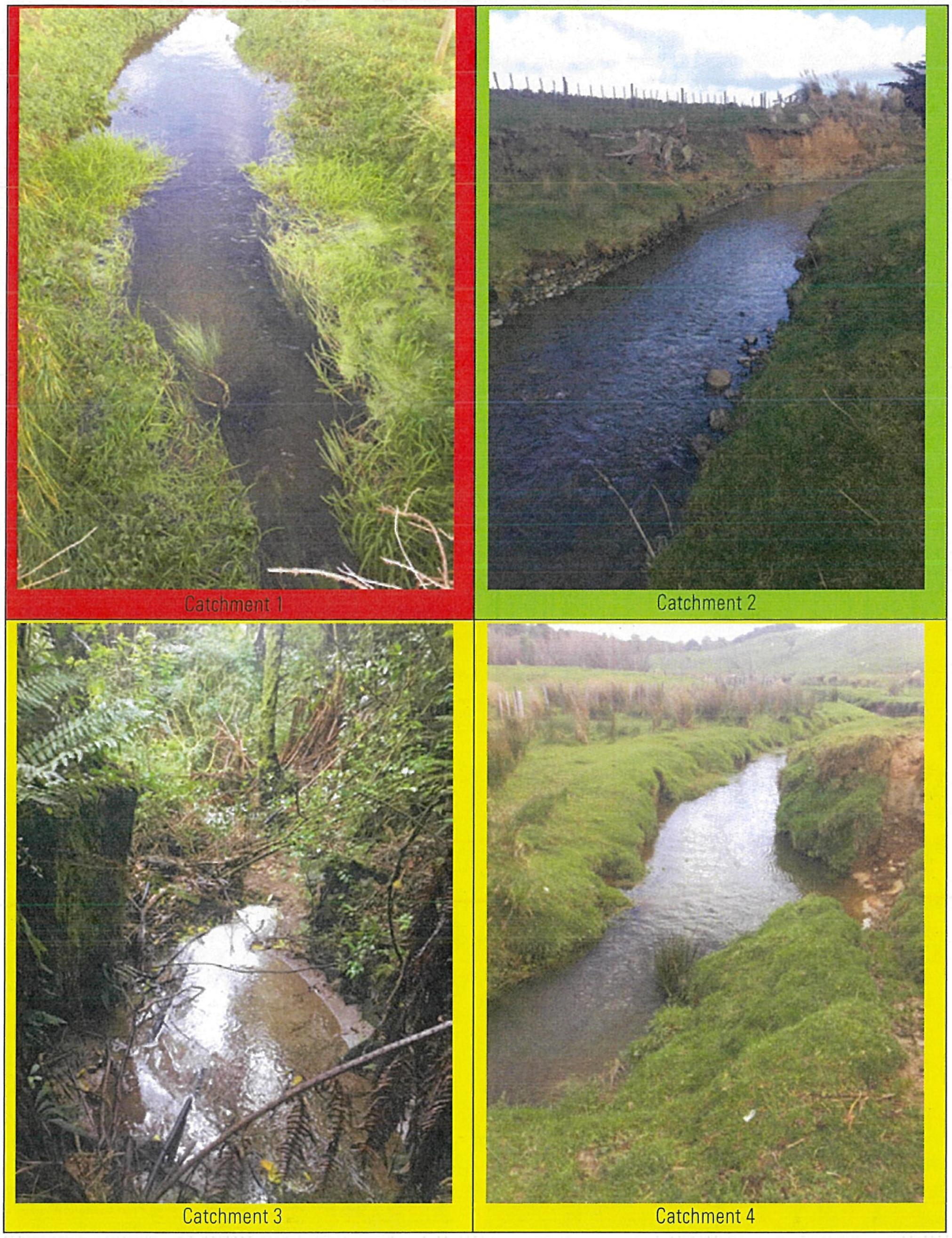
Catchment 1
Catchment 2
Catchment 3
Catchment 4


Figure 3 Representative images of each catchment affected by Te Ahu a Turanga. All images taken 16–20 July 2018 by Boffa Miskell. Shading reflects the ecological value groupings of the catchments (green = highest, yellow = medium, and red = low values) as identified in Table 2. An image of Catchment 9 is missing as to date no one has visited this catchment.

# 4 VALUES BASED MONITORING PROGRAMME

## 4.1 High Value Catchments

Catchments 2 and 7 were identified as having the highest ecological values-risk ranking of the nine catchments directly affected by Te Ahu a Turanga. Catchments 2 and 7 will therefore be subjected to the highest monitoring effort which will include all of the monitoring methodologies outlined in Section 2.4. The monitoring sites outlined below are indicative based on information available at the time of writing with the final locations to be confirmed during the first round of water quality monitoring.

### 4.1.1 Catchment 2

Catchment 2 is the largest of the nine catchments affected by Te Ahu a Turanga and has a relatively large area upstream of the project area. It is one of the few catchments where it is possible to have paired sites upstream and downstream of the project area with very similar channel morphology and flow characteristics. Monitoring proposed for Catchment 2 includes:

» **Installation of continuous turbidity loggers.** A logger will be installed just downstream of the confluence of 2A (main channel) and the downstream-most affected tributary (Site C2A-DS1; Figure 4). This is downstream of all tributaries that will potentially receive fine sediment runoff from the project area and approximately 450 m downstream of where the road will cross 2A (the main channel). Data for this will provide a pre-construction turbidity profile with an option to leave the logger *in situ* or reinstall at the same site for real-time construction period monitoring.

» **Quantitative aquatic macroinvertebrate sampling.** Macroinvertebrate sampling will be undertaken in Catchment 2 in the main stem (channel 2A). To increase the ability to detect any effects (or conversely indicate there are none) we have opted to have four sampling sites with two upstream (Sites C2A-US1 and C2A-US2) and two downstream (Site C2A-DS1 and Site C2A-DS2) of all potential project-related fine sediment inputs (Figure 4). The precise locations of macroinvertebrate sampling at each site will be selected to ensure the same instream habitat types (i.e., riffles) are sampled. Sampling will consist of taking five quantitative Surber samples at each site and, coupled with further monitoring during and after the construction period, affords the opportunity to undertake before-after, control-impact (BACI) type data analysis.

» **Deposited sediment monitoring.** Deposited sediment will be monitored in Catchment 2 from the four aquatic macroinvertebrate sites mentioned above (Figure 4) using the "SAM 2 – In-stream visual assessment of sediment" and "SAM 5 – Resuspendable sediment (Shuffle index)" methods of Clapcott *et al.* (2011).

» **Water quality monitoring.** Spot water quality samples will be collected and water clarity measured with a clarity tube in Catchment 2 from the four aquatic macroinvertebrate sites mentioned above (Figure 4).

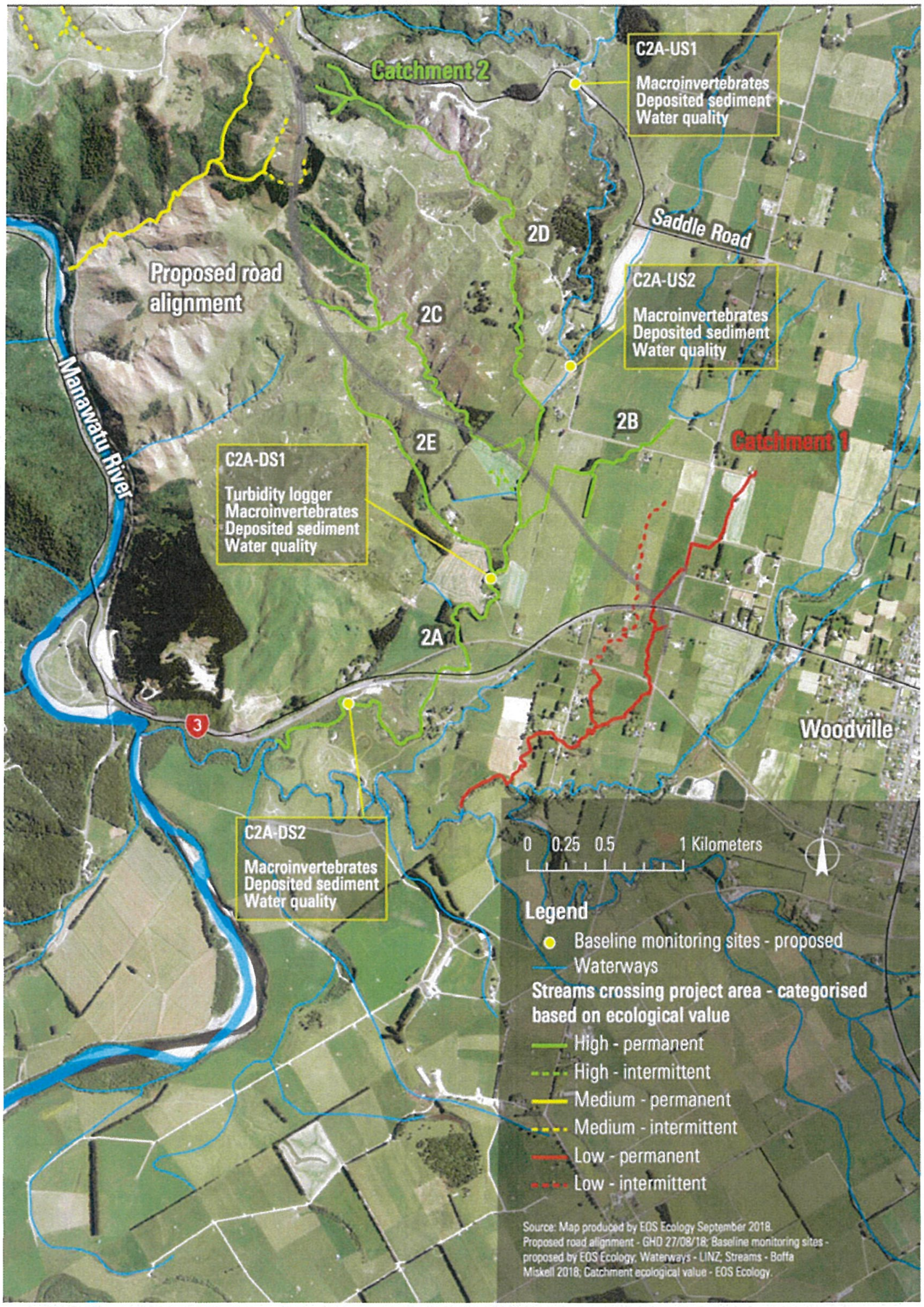


Figure 4 Proposed Catchment 2 freshwater monitoring sites. Note the green colouration is based on the waterway layer produced by Boffa Miskell and does not show the entire catchment. EOS Ecology added the "2E" channel line and label, as this channel was unlabelled in the Boffa Miskell GIS information.

### 4.1.2 Catchment 7

Of the nine affected catchments, Catchment 7 will undergo the most modification with the road alignment cutting through the mid-lower reaches as well as the upper catchment as it loops around to cross the Manawatu River. With the cut through the upper part of the main branch (7A) there is no opportunity to have paired monitoring sites upstream and downstream of the project area with similar channel morphology and flow characteristics. Monitoring proposed for Catchment 7 includes:

» **Installation of continuous turbidity loggers.** A logger will be installed near the bottom of Catchment 7 just upstream of the railway track and confluence with the Manawatu River (Site C7A-DS3; Figure 5). Data for this will provide a pre-construction turbidity profile with an option to leave the logger in situ or reinstall at the same/similar site for real-time construction period monitoring.

» **Quantitative aquatic macroinvertebrate sampling.** Macroinvertebrate sampling will be undertaken in Catchment 7 from two sites (Sites C7A-DS1 and C7A-DS3; Figure 5). Sampling will consist of taking five quantitative Surber samples and the data will form a baseline against which construction period and post-construction monitoring can be compared.

» **Deposited sediment monitoring.** Deposited sediment will be monitored in Catchment 7 from the two above-mentioned aquatic macroinvertebrate sites plus two additional sites (C7A-DS2 and C7B-DS) using the "SAM 2 – In-stream visual assessment of sediment" and "SAM 5 – Resuspendable sediment (Shuffle index)" methods of Clapcott *et al.* (2011). The data will form a baseline against which construction period and post-construction monitoring can be compared.

» **Water quality monitoring.** Spot water quality samples will be collected and water clarity measured with a clarity tube in Catchment 7 from five sites, three on the main stem (Sites C7A-DS1, C7A-DS2, and C7A-DS3), and two from small tributaries (C7B-DS and C7C-US). The C7C-US site is upstream of the project and will be a catchment control site (Figure 5). If possible samples will also be taken from the top of the catchment in the main branch (7A) from Site C7A-US although this will depend on sufficient surface water for accurate sampling being present.

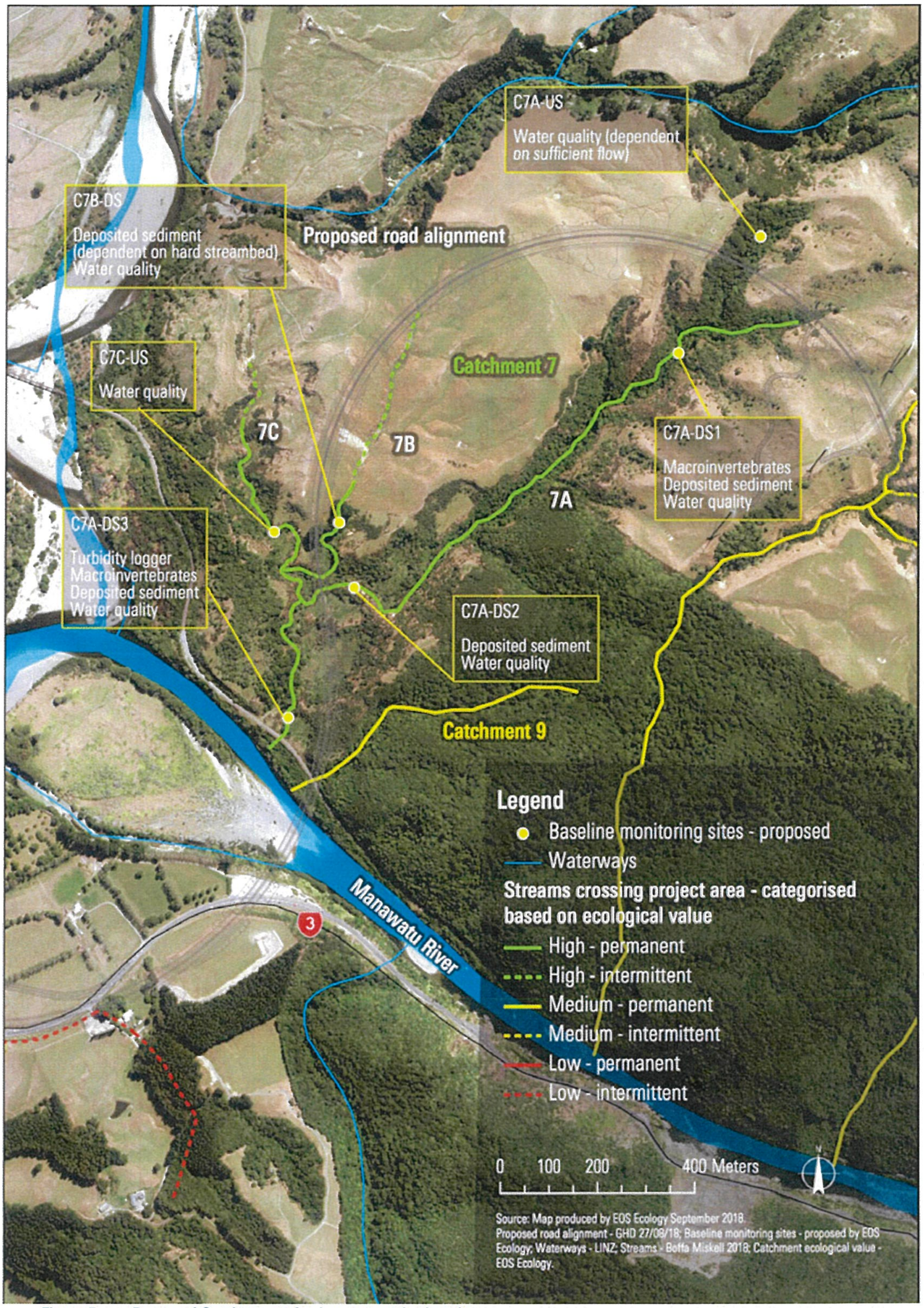


Figure 5 Proposed Catchment 7 freshwater monitoring sites.

## 4.2 Medium Value Catchments

Catchments 3, 4, 5, 6, and 9 were identified as having medium ecological value-risk ranking and will be subject to a moderate level of monitoring with the sites and methodologies used depending on individual catchment characteristics. The monitoring sites outlined below are indicative based on information available at the time of writing with the final locations to be confirmed during the first round of water quality monitoring.

### 4.2.1 Catchment 3

The road alignment crosses the upper intermittent parts of Catchment 3 meaning there is no opportunity to have paired monitoring sites upstream and downstream of the project area with similar channel morphology and flow characteristics. Monitoring proposed for Catchment 3 includes:

» **Quantitative aquatic macroinvertebrate sampling.** Macroinvertebrate sampling will be undertaken in Catchment 3 from two sites downstream of the road alignment, one in each branch (Sites C3A-DS and C3B-DS; Figure 6). Note the ability to safely access Site C3B-DS will be determined during the first water quality sampling visit. Sampling will consist of taking five quantitative Surber samples and the data will form a baseline against which construction period and post-construction monitoring can be compared.

» **Deposited sediment monitoring.** Deposited sediment will be monitored in Catchment 3 at the same sites as the macroinvertebrate sampling using the "SAM 2 – In-stream visual assessment of sediment" and "SAM 5 – Resuspendable sediment (Shuffle index)" methods of Clapcott *et al.* (2011). The data will form a baseline against which construction period and post-construction monitoring can be compared.

» **Water quality monitoring.** Spot water quality samples will be collected and water clarity measured with a clarity tube in Catchment 3 from the same sites as the macroinvertebrate sampling. The data will form a baseline against which construction period and post-construction monitoring can be compared.

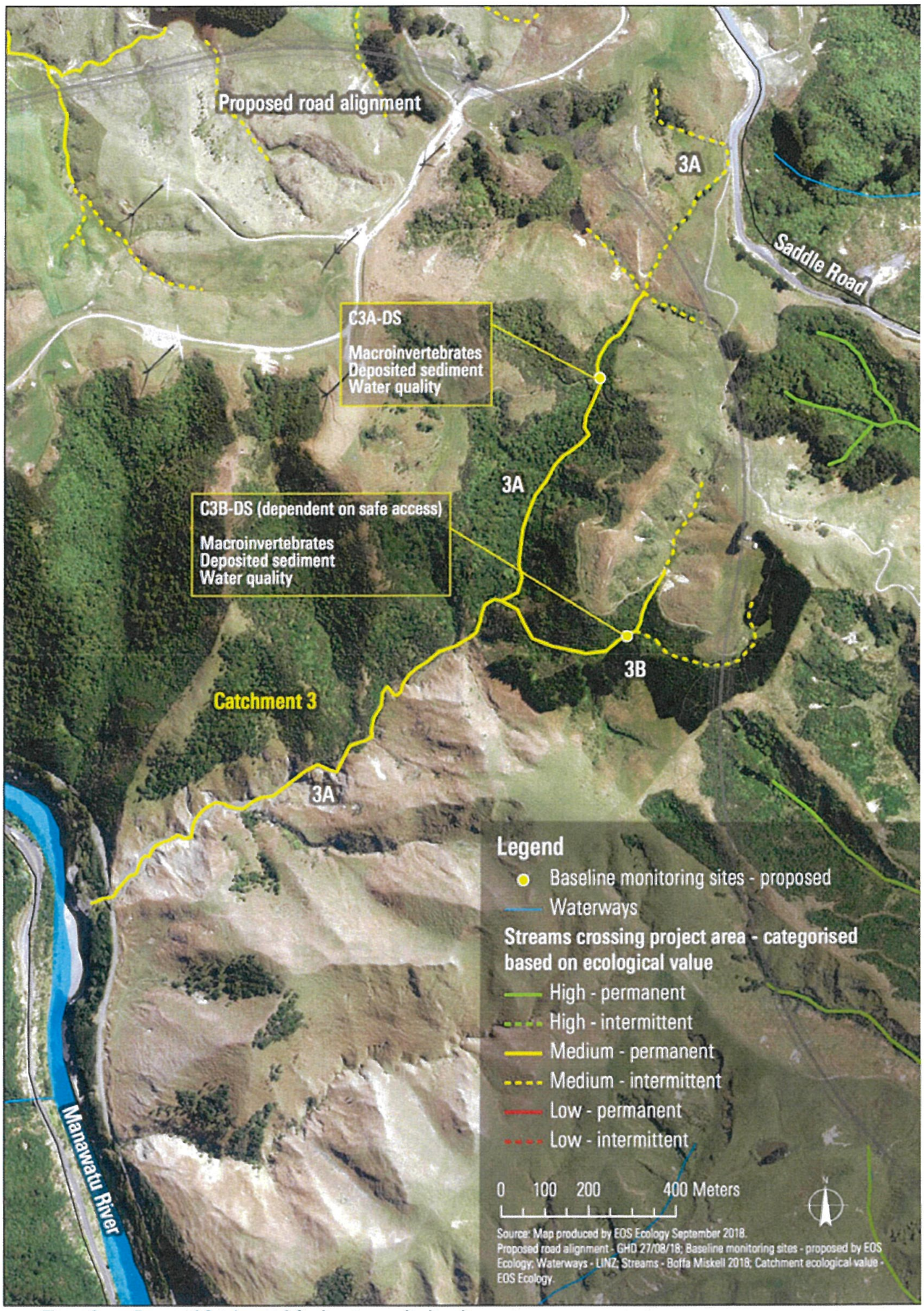


Figure 6 Proposed Catchment 3 freshwater monitoring sites.

### 4.2.2 Catchment 4

The proposed alignment will cross the main Catchment 4 channel (4A) as well as most of the tributary waterways (that are mostly intermittent) that flow into 4A, with only two permanently flowing tributaries falling outside (upstream) of the alignment (Figure 7). The lower section of Catchment 4 flows through the Manawatu Gorge Scenic Reserve and these forested reaches may be more sensitive to the impacts of elevated fine sediment deposition hence an additional sampling site within the Reserve is worthwhile in this catchment. However, the majority of the main channel and its tributaries are upstream of the Reserve where the catchment is greatly affected by agricultural land use, and there is a large (approximately 170 m by 80 m) artificial pond just upstream of where the channel enters the Reserve. This pond likely has some function as a sediment trap. While the upper parts of this catchment is effected by agricultural land use, it is the catchment with the second greatest project footprint length (Table 1) so we have opted to undertake water quality, deposited sediment and macroinvertebrate sampling at sites upstream and downstream of the road alignment. Monitoring proposed for Catchment 4 includes:

» **Quantitative aquatic macroinvertebrate sampling.** Macroinvertebrate sampling will be undertaken in Catchment 4 from one site upstream and two sites downstream of the project area (Sites C4H-US2, C4A-DS2, and C4A-DS4; Figure 7). Note that Site C4A-DS2 is upstream of where the road will cross the main channel (4A) but downstream of a significant area of earthworks where several tributaries intersect with the alignment. Sampling will consist of taking five quantitative Surber samples and the data will form a baseline against which construction period and post-construction monitoring can be compared.

» **Deposited sediment monitoring.** Deposited sediment will be monitored in Catchment 4 at six sites, including the above described macroinvertebrate sites plus additional upstream and downstream sites (Sites C4H-US1, C4H-DS1, and C4A-DS3; Figure 7) using the "SAM 2 – In-stream visual assessment of sediment" and "SAM 5 – Resuspendable sediment (Shuffle index)" methods of Clapcott *et al.* (2011).

» **Water quality monitoring.** Spot water quality samples will be collected and water clarity measured with a clarity tube in Catchment 4 at the same deposited sediment sites mentioned above (Figure 7).

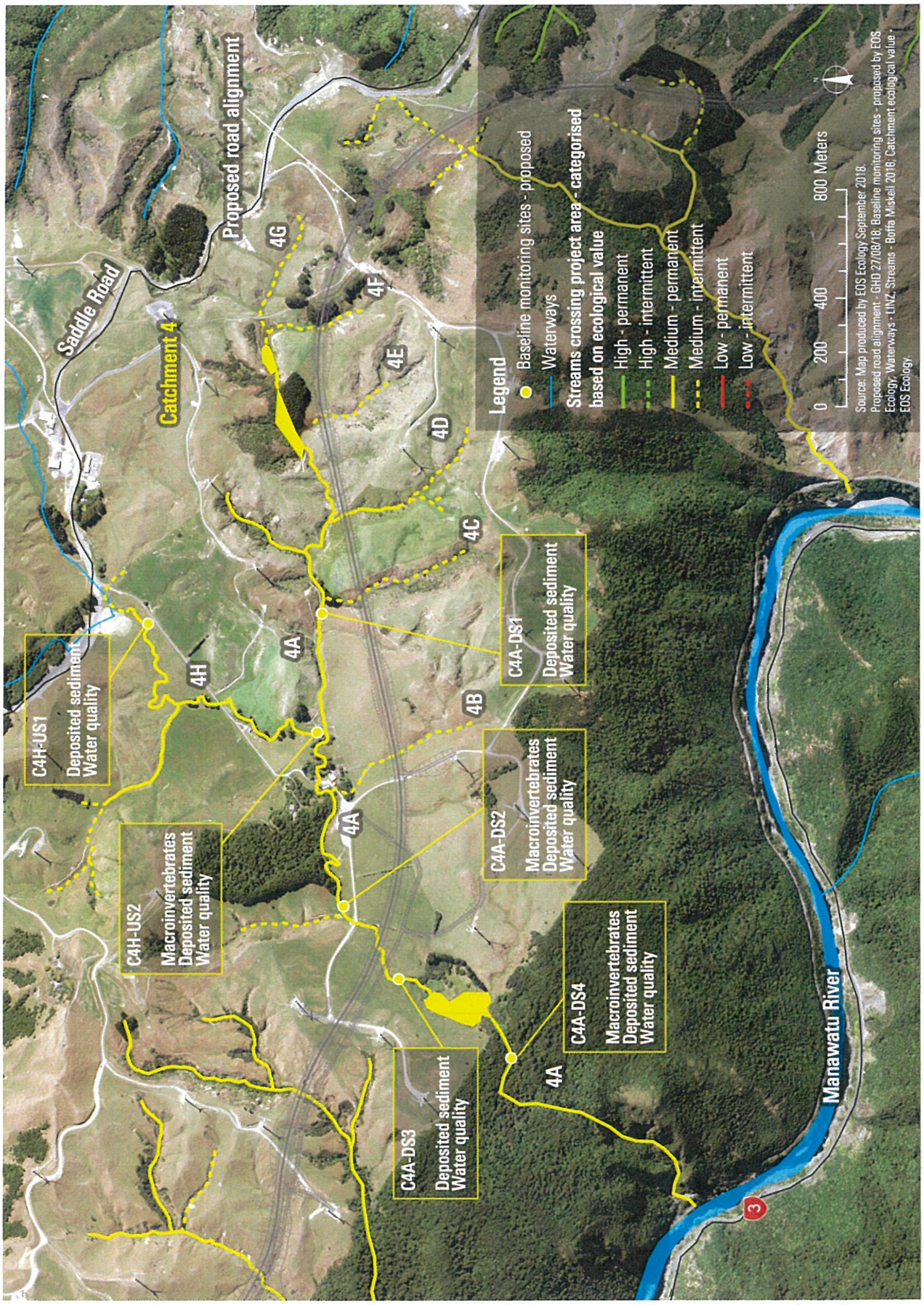


Figure 7 Proposed Catchment 4 freshwater monitoring sites. EOS Ecology added the "4H" channel label, as this channel was unlabelled in the Boffa Miskell GIS information.

### 4.2.3 Catchment 5

The road alignment crosses two main branches of Catchment 5 (5A and 5B), which merge downstream of the project area within the Manawatu Gorge Scenic Reserve. For the purposes of baseline aquatic macroinvertebrate sampling the 5A branch has been chosen to be representative. This catchment provides the opportunity of sites upstream and downstream of the project area, however the higher quality riparian and instream habitat occurs in the lower reaches within the Reserve. These lower, forested reaches may be more sensitive to the impacts of elevated fine sediment deposition hence an additional sampling site within the Reserve is worthwhile in this catchment. Monitoring proposed for Catchment 5 includes:

» **Quantitative aquatic macroinvertebrate sampling.** Macroinvertebrate sampling will be undertaken from two sites in the 5A branch (Sites C5A-US and C5A-DS1; Figure 8) and an additional site within the Manawatu Gorge Scenic Reserve, potentially just downstream of where the two main branches merge (Site C5A-DS2; Figure 8). Sampling will consist of taking five quantitative Surber samples at each site, and coupled with further monitoring during and after the construction period this affords the opportunity to undertake before-after, control-impact (BACI) type data analysis.

» **Deposited sediment monitoring.** Deposited sediment will be undertaken at the same sites as macroinvertebrate sampling (Sites C5A-US, C5A-DS1, and C5A-DS2) plus two sites on the 5B branch (Sites C5B-US and C5B-DS; Figure 8) using the "SAM 2 – In-stream visual assessment of sediment" and "SAM 5 – Resuspendable sediment (Shuffle index)" methods of Clapcott *et al.* (2011).

» **Water quality monitoring.** Spot water quality samples will be collected and water clarity measured with a clarity tube in Catchment 5 at the same five deposited sediment monitoring sites mentioned above (Figure 8).

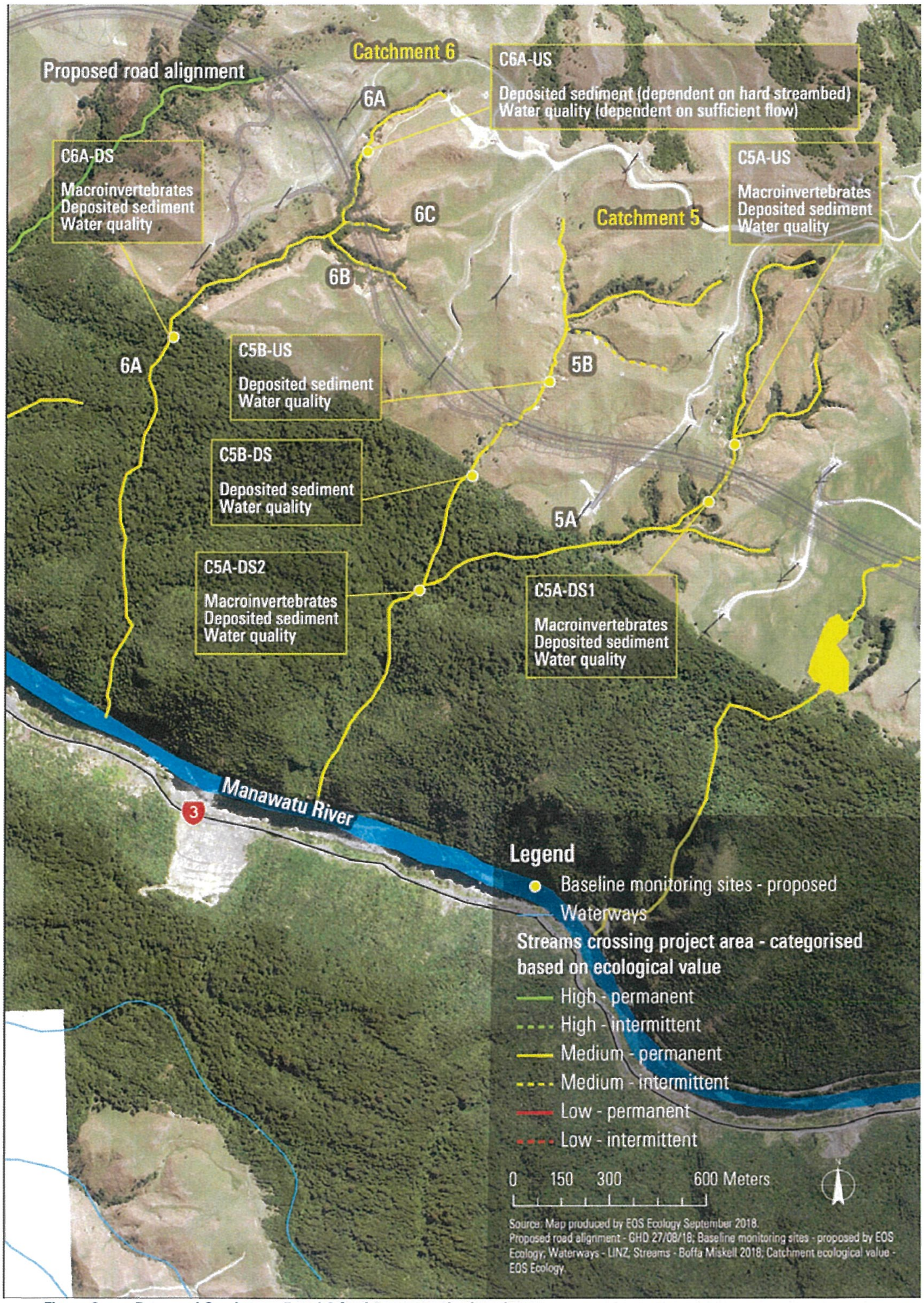


Figure 8 Proposed Catchment 5 and 6 freshwater monitoring sites.

### 4.2.4 Catchment 6

The proposed road alignment cuts through the upper tributaries of Catchment 6 meaning there is no opportunity to have paired monitoring sites upstream and downstream of the project area with similar channel morphology and flow characteristics. Catchment 6 also has one of the shortest project footprint lengths of the affected catchments (Table 1). Like Catchment 5 the lower part of Catchment 6 flows through the Manawatu Gorge Scenic Reserve, which has higher quality riparian and instream habitat than the upper reaches including the project area. These lower, forested reaches may be more sensitive to the impacts of elevated fine sediment deposition. Two deposited sediment/water quality sites and a single macroinvertebrate site are proposed for Catchment 6. It is worth noting the C5A-US Catchment 5 site is likely representative of conditions in Catchment 6 upstream of the Reserve and macroinvertebrate data from those sites can be utilised in data analysis. Monitoring proposed for Catchment 6 includes:

» **Quantitative aquatic macroinvertebrate sampling.** Macroinvertebrate sampling will be undertaken in the Catchment 6 main branch (6A) from one site downstream of the project area within the Manawatu Gorge Scenic Reserve (Site C6A-DS; Figure 8). Sampling will consist of taking five quantitative Surber samples and the data will form a baseline against which construction period and post-construction monitoring can be compared.

» **Deposited sediment monitoring.** Deposited sediment will be monitored in Catchment 6 at a site upstream (Site C6A-US) and a site downstream (Site C6A-DS; Figure 8) of the project area using the "SAM 2 – In-stream visual assessment of sediment" and "SAM 5 – Resuspendable sediment (Shuffle index)" methods of Clapcott *et al.* (2011). Note the collection of data from the upstream site will depend on suitable hard-bottomed stony streambed being present.

» **Water quality monitoring.** Spot water quality samples will be collected and water clarity measured with a clarity tube in Catchment 6 from the two deposited sediment monitoring sites mentioned above (Figure 8). Note the collection of water samples from the upstream site will depend on sufficient surface water being present.

### 4.2.5 Catchment 9

Catchment 9 is the least impacted by the project, with the Manawatu River bridge to land interface and a relatively small area of earthworks occurring near the bottom of the catchment. No ecological information has been collected from Catchment 9 to date but given the catchment has 100% forest cover and is predominantly within the Manawatu Gorge Scenic Reserve it likely has relatively high ecological values. However, as the project footprint is the least of all catchments (Table 1) we have categorised Catchment 9 as a medium ecological value-risk. Given the small size of this catchment it is probably intermittent or ephemeral in the upper reaches. We had proposed deposited sediment and water quality monitoring in this catchment however access to the bottom of the catchment requires entry of the rail corridor. Enquiries with KiwiRail indicated the time and cost associated with obtaining access on a regular basis would be significant and out of proportion with the value of the data collected from this least impacted catchment. Therefore we have opted not to perform any baseline freshwater monitoring in this catchment for practical reasons.

## 4.3 Low Value Catchments

Catchments 1 and 8 have very low ecological value-risk rankings relative to the other affected catchments (Figure 2; Table 2). No baseline freshwater monitoring is proposed for these catchments.

## 5 MONITORING SUMMARY

The baseline freshwater monitoring programme includes comprehensive coverage along the length of the project area as summarised in Table 3.

**Table 3 Summary of the Te Ahu a Turanga baseline freshwater monitoring programme.**

| Catchment | Monitoring Methods | Number of Sites | Monitoring Frequency |
|---|---|---|---|
| 2 | Continuous turbidity logging | 1 | Installation in October 2018 and left in situ for minimum of one year |
| | Quantitative macroinvertebrate sampling | 4 | Two times over a year – early spring & late summer |
| | Deposited sediment monitoring | 4 | Six times over a year |
| | Water quality monitoring | 4 | Twelve times a year (mix of dry and wet events) |
| 7 | Continuous turbidity logging | 1 | Installation in October 2018 and left in situ for minimum of one year |
| | Quantitative macroinvertebrate sampling | 2 | Two times over a year – early spring & late summer |
| | Deposited sediment monitoring | 4 | Six times over a year |
| | Water quality monitoring | 5 (6 if possible) | Twelve times a year (mix of dry and wet events) |
| 3 | Quantitative macroinvertebrate sampling | 2 | Two times over a year – early spring & late summer |
| | Deposited sediment monitoring | 2 | Six times over a year |
| | Water quality monitoring | 2 | Twelve times a year (mix of dry and wet events) |
| 4 | Quantitative macroinvertebrate sampling | 3 | Two times over a year – early spring & late summer |
| | Deposited sediment monitoring | 6 | Six times over a year |
| | Water quality monitoring | 6 | Twelve times a year (mix of dry and wet events) |
| 5 | Quantitative macroinvertebrate sampling | 3 | Two times over a year – early spring & late summer |
| | Deposited sediment monitoring | 5 | Six times over a year |
| | Water quality monitoring | 5 | Twelve times a year (mix of dry and wet events) |
| 6 | Quantitative macroinvertebrate sampling | 1 | Two times over a year – early spring & late summer |
| | Deposited sediment monitoring | 2 | Six times over a year |
| | Water quality monitoring | 2 | Twelve times a year (mix of dry and wet events) |
| 9 | Deposited sediment monitoring | 0 | No baseline freshwater monitoring due to rail corridor entry time/cost implications |
| | Water quality monitoring | 0 | |
| 1 | No baseline freshwater monitoring | | |
| 8 | No baseline freshwater monitoring | | |

## 6 MONITORING TIMELINE

The baseline freshwater monitoring programme is intended to assist in forming fine sediment limits for the project that are relevant and realistic in the affected catchments. In order to create sufficient data to allow this to happen the monitoring programme will begin as soon as Horizons Regional Council approval is received. Table 4 provides an indicative 12-month timeline. Where wet weather water quality sampling is proposed, the exact timing of this will be dependent on suitable rain events. We will endeavour to sample during at least one extreme rain event but the ability to do this will depend on the timing of the event and health and safety considerations given site topography and access. It is likely any extreme event sampling would concentrate on certain catchments (e.g., Catchment 4 as it has a large project footprint and likely would be representative of extreme conditions in neighbouring catchments, Catchment 7 if safely accessible, and Catchment 2 as this has easy/safe access). Also some sites in Catchment 4, 5, and 6 are within the Manawatu Gorge Scenic Reserve and will require a research and collection authorisation from the Department of Conservation before any sampling can take place.

**Table 4** Indicative Te Ahu a Ruranga baseline freshwater monitoring programme timeline. Note the actual timing of water quality sampling will depend on timing of suitable rain events, as the aim is capture wet and dry events.

| Month | Monitoring Tasks |
|---|---|
| October 2018 | 1. Site visit to confirm and mark monitoring sites and confirm turbidity logger locations.<br>2. First macroinvertebrate sampling.<br>3. First water quality sampling.<br>4. First deposited sediment sampling. |
| November 2018 | 1. Second water quality sampling.<br>2. Installation of turbidity loggers by NIWA. |
| December 2018 | 1. Third water quality sampling<br>2. Second deposited sediment sampling. |
| January 2019 | 1. Fourth water quality sampling. |
| February 2019 | 1. Fifth water quality sampling.<br>2. Third deposited sediment sampling. |
| March 2019 | 1. Second macroinvertebrate sampling.<br>2. Sixth water quality sampling. |
| April 2019 | 1. Seventh water quality sampling.<br>2. Fourth deposited sediment sampling. |
| May 2019 | 1. Eighth water quality sampling. |
| June 2019 | 1. Ninth water quality sampling.<br>2. Fifth deposited sediment sampling. |
| July 2019 | 1. Tenth water quality sampling. |
| August 2019 | 1. Eleventh water quality sampling.<br>2. Sixth deposited sediment sampling. |
| September 2019 | 1. Twelfth water quality sampling.<br>2. Make decisions about whether to continue baseline freshwater monitoring programme including if turbidity loggers should be left in situ for construction period. |

# 7 BASELINE FRESHWATER MONITORING REPORTING

At the conclusion of the baseline freshwater monitoring programme all data will be analysed to determine the existing state of suspended sediment, deposited sediment, and the macroinvertebrate communities across the project area. Analyses will consist of:

» Calculation of relevant statistics for total suspended solids, turbidity, and water clarity for dry weather and wet weather events to allow realistic and achievable triggers/limits to be included in construction resource consent conditions. For turbidity where there will be continuous data from two catchments trigger values will likely be calculated using the 80th percentile, which is the methodology used in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ADAWR, 2018). If suitable rainfall data is available separate values for dry periods and rain events will be generated.

» Calculation of relevant statistics for deposited fine sediments to allow realistic and achievable triggers/limits to be included in construction resource consent conditions.

» Characterisation of macroinvertebrate communities via calculation of community metrics (e.g., QMCI, taxa richness, EPT). Multivariate analysis (e.g., non-metric multidimensional scaling) will be undertaken to indicate any variation in the assemblages over time and between sites while any taxa that are particularly sensitive to elevated levels of fine sediment deposition will be identified and highlighted.

Results will be presented in a succinct technical report that will provide recommended triggers/limits and outline a proposed construction period monitoring programme.

# 8 ACKNOWLEDGEMENTS

Thank you to Adam Forbes (Forbes Ecology) for providing background information and assistance and to Kieran Miller (Boffa Miskell) for providing freshwater ecological survey data, information on access and document review. Thank you also to my EOS Ecology colleagues Kirsty Brennan for producing the site maps, Shelley McMurtrie for peer review, and Emily Demchick for proof reading. I also appreciate the review comments of Carol Bannock and Greg Lee ( both NZTA).

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# Te Ahu a Turanga: Manawatū Tararua Highway – Baseline Freshwater Monitoring Results

**EOS Ecology Report No.** NZT02-18064-03 | November 2019

**Prepared for** New Zealand Transport Agency

**Prepared by** EOS Ecology – Alex James

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## EXECUTIVE SUMMARY

The proposed route of the "Te Ahu a Turanga: Manawatū Tararua Highway" will impact several small Manawatū River tributary catchments as it traverses the Ruahine Range just to the north of the Manawatū Gorge. Following early discussions with Horizons Regional Council, NZTA agreed to implement a sediment-focussed baseline freshwater monitoring programme along the proposed alignment. Data collection began in December 2018, with the majority of data collected by the end of September 2019. This report presents the results of the baseline monitoring programme data collected over this period and provides some guidance on appropriate construction phase monitoring methods and limits.

The baseline monitoring programme included 19 sites across six catchments where visual water clarity, total suspended solids (TSS), and turbidity were measured on eight occasions during dry weather and deposited fine sediment was recorded on six occasions. Total and dissolved aluminium along with pH were added to the sampling programme later and were measured on four or five dry weather occasions depending on the catchment. Wet weather samples were to be collected on four occasions from all sites in three catchments, however two catchments are yet to be sampled a fourth and final time. During wet weather visual water clarity, TSS, turbidity, total and dissolved aluminium, and pH were measured. Three macroinvertebrate sampling rounds were planned for 17 of the 19 sites. To date two have been completed (summer: February 2019; and winter: May-June 2019) with the third spring sampling planned for November 2019.

There were clear differences in baseline visual water clarity, TSS, turbidity, and deposited fine sediment among the catchments, indicating that it is worthwhile deriving catchment-specific limits or trigger values for the catchments affected by construction activities that take into account baseline data. For dissolved aluminium, over half of samples had concentrations below laboratory detection limits, however all catchments had at least one measurement above the ANZG (2018) toxicant 95% level of protection default guideline value for when pH is greater than 6.5 (all pH measurements during baseline monitoring were >6.5). This guideline value is stated to be of "low" reliability; hence we do not recommend it is used as a limit or trigger value for this project. Instead, any dissolved aluminium limits should be based on baseline data. We have purposely not tried to calculate any specific limits or trigger values as derivation of realistic numbers will depend on the locations of any construction period discharge points and the expected treatment efficiency and discharge water quality of any sediment control features (e.g., detention ponds).

Aquatic macroinvertebrate assemblages varied among catchments, with multivariate analysis (non-metric multidimensional scaling (NMS)) indicating three groupings of sampling sites, which generally reflected the quality of instream habitat observed on site. One catchment (Catchment 4) was particularly impacted by agricultural land use with high levels of fine sediment covering the streambed. This catchment has a macroinvertebrate assemblage dominated by taxa that prefer or are tolerant of degraded conditions and hence had the lowest Quantitative Macroinvertebrate Community Index (QMCI) values of all surveyed sites (generally indicative of "poor" conditions compared to "excellent" scores in the less impacted catchments). Options for determining any impact on macroinvertebrate communities based on regular construction-phase monitoring are presented (e.g., QMCI percentage change, sensitive taxa metrics, and multivariate NMS ordination and associated analyses). It is noted the method used may differ among catchments (e.g., looking at QMCI percentage change is not sensible in catchments or sites with pre-existing very low scores indicative of "poor" conditions).

# 1 INTRODUCTION

With the proposed route of the "Te Ahu a Turanga: Manawatū Tararua Highway" traversing the Ruahine Range just to the north of the Manawatū Gorge, several small catchments, all of which are tributaries of the Manawatū River, will be impacted (Figure 1). The landscape is steep, and the extensive cut and fill required during construction will expose large areas of bare earth. Hence, one of the main potential adverse effects during construction will be sediment runoff into the predominantly stony-bottomed streams draining these catchments. Following early discussions with Horizons Regional Council, NZTA agreed to implement a sediment-focussed baseline freshwater monitoring programme along the proposed alignment. EOS Ecology was engaged by NZTA to design and implement this programme. The development and rationale of this baseline monitoring programme is fully described in James (2019). The current report presents the results of the baseline monitoring programme and provides some guidance on appropriate construction phase monitoring methods and limits.

# 2 METHODS

Methodology around site selection and data collection is fully described in James (2019) and only summarised here.

## 2.1 Catchment & Site Names

None of the small catchments directly affected by Te Ahu a Turanga appear to have formal recognised names, with the exception of what we have called Catchment 2, the mainstem of which is known as the Mangamanaia Stream. For project consistency we have adopted the catchment and tributary numbering assigned by Boffa Miskell during the Notice of Requirement phase of the project. Freshwater monitoring sites have been named based on the catchment they are within (e.g. C2 for Catchment 2 and so on) with lettering used to indicate the channel within that catchment that the site is located on (e.g. C2A for Catchment 2, channel A) and a prefix dependent on where they are located in relation to the project area, either US for upstream or DS for downstream (e.g., C2A-DS). Where there is more than one downstream site within a catchment, they are given a number (e.g., C2A-DS1 and C2A-DS2). Note the proposed alignment has been shifted since sites were established such that site C5B-US is no longer actually an upstream site.

## 2.2 Site Selection

Ideally, monitoring locations would have been situated upstream and downstream of the project area in each of the affected catchments. However, the location of the road alignment means that for some catchments the selection of suitable upstream and downstream sites was impossible. In these catchments, only a downstream site or sites have been selected. While not allowing the before-after, control-impact (BACI) data analysis afforded by having sites upstream and downstream of the project area, these downstream sites will still provide valuable baseline information that can be compared to any construction and post-construction monitoring that may be undertaken. Overall there were 19 monitoring sites spread over six catchments (Figure 2–7). No sites were included on the Manawatū River itself due to the difficult access and safety concerns in the general vicinity of the new bridge site.

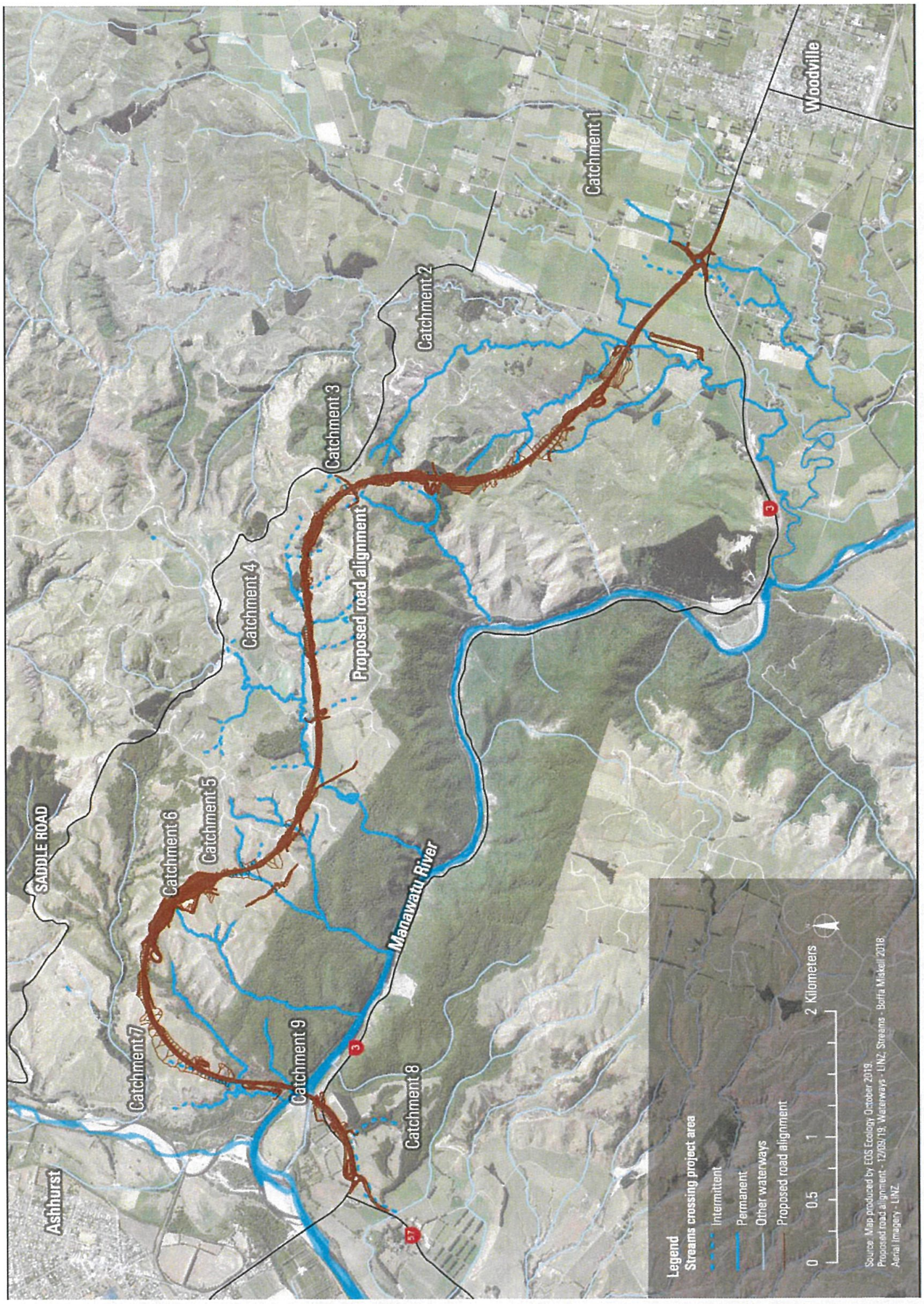



Figure 1 General overview of the Te Ahu a Turanga road alignment and location of affected catchments.

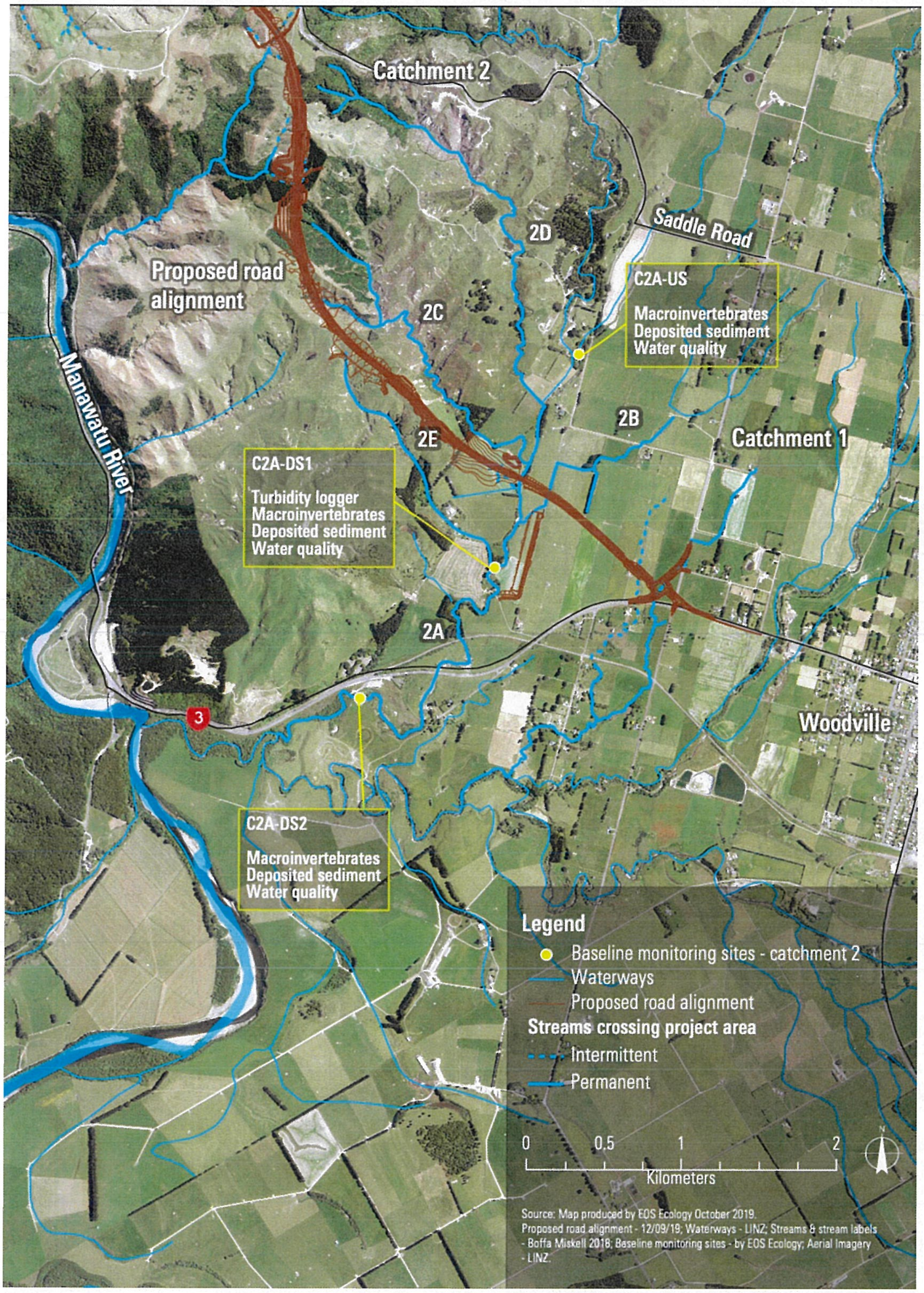



Figure 2 Catchment 2 showing locations of baseline water quality monitoring sites and proposed Te Ahu a Turanga alignment.

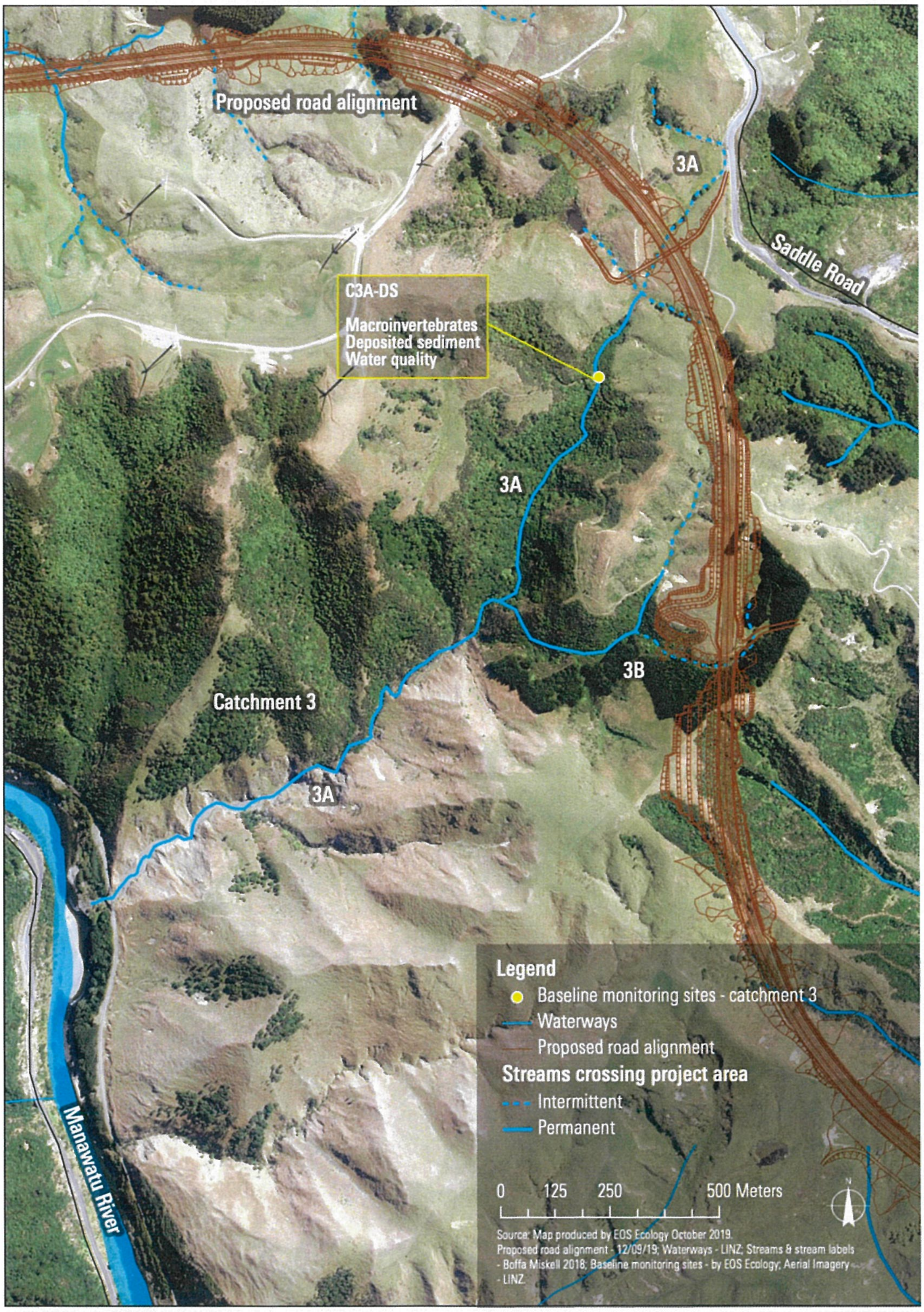



Figure 3 Catchment 3 showing location of the baseline water quality monitoring site and proposed Te Ahu a Turanga alignment.

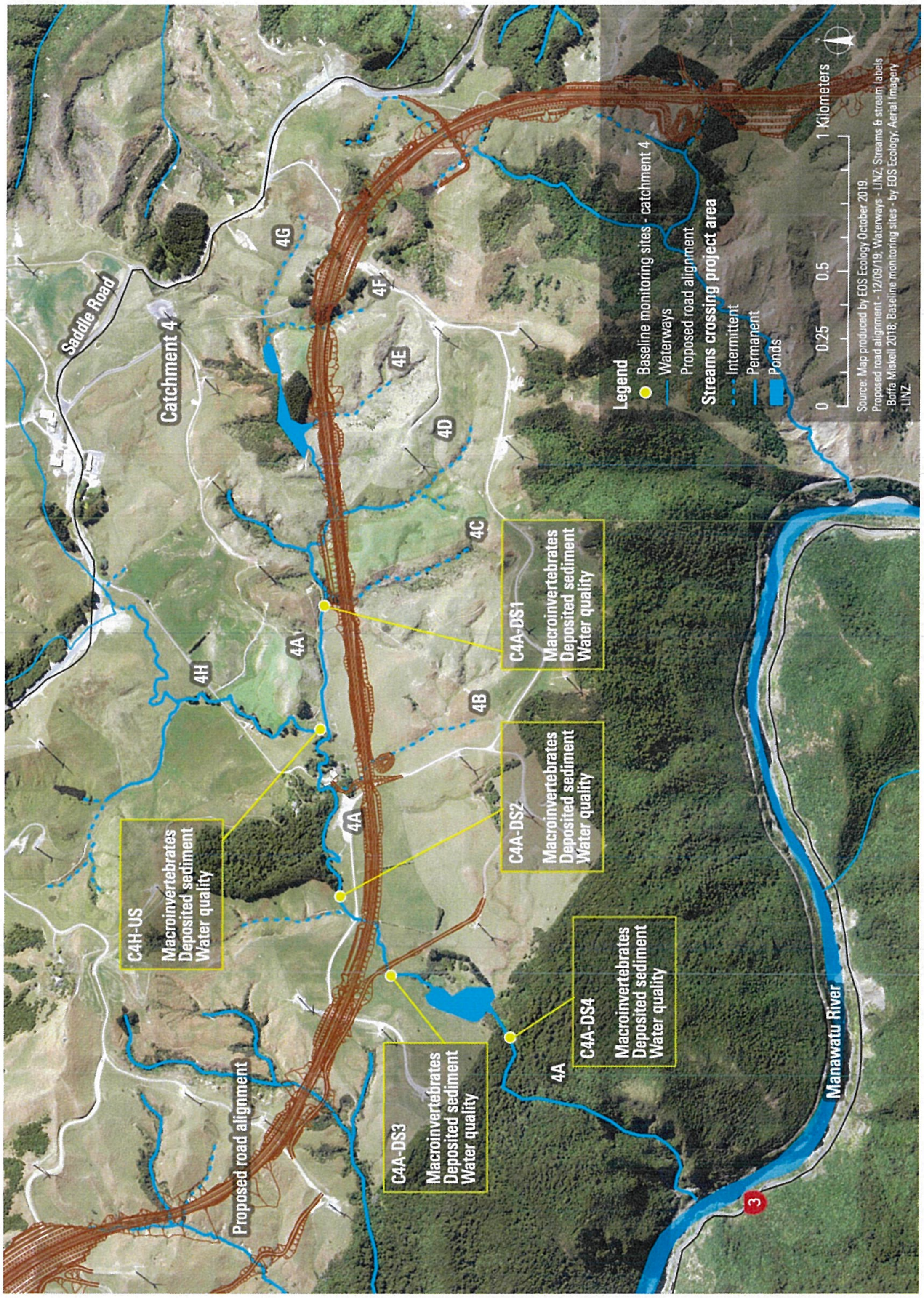



Figure 4 Catchment 4 showing location of baseline water quality monitoring sites and proposed Te Ahu a Turanga alignment.

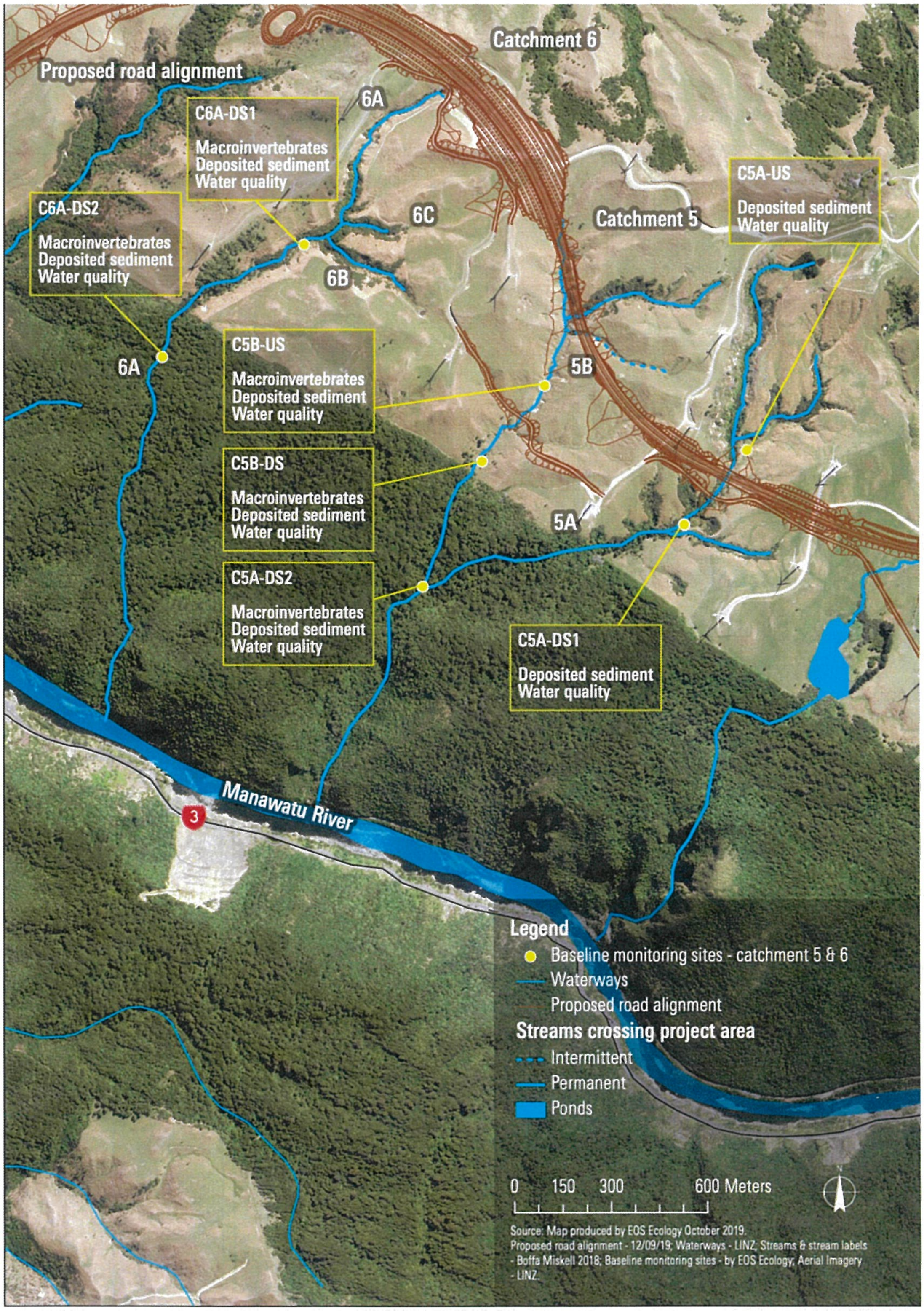



Figure 5 Catchments 5 and 6 showing location of baseline water quality monitoring sites and proposed Te Ahu a Turanga alignment. Note the proposed alignment has been shifted since sites were established such that site C5B-US is no longer upstream.

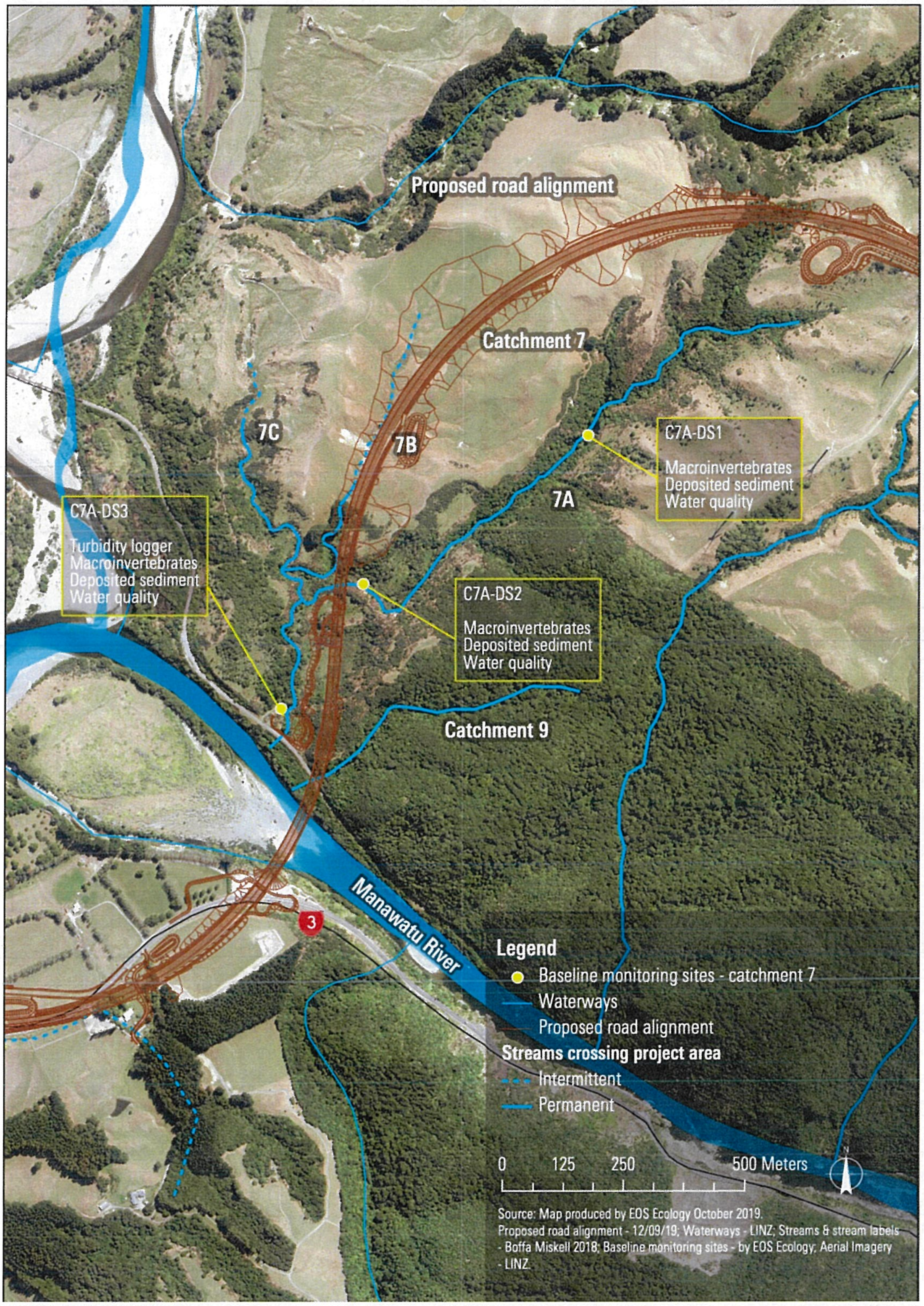



Figure 6 Catchment 7 showing location of baseline water quality monitoring sites and proposed Te Ahu a Turanga alignment.


Catchment 2 – C2A-US (10 April 2019)


Catchment 2 – C2A-DS1 (10 April 2019)


Catchment 2 – C2A-DS2 (10 April 2019)


Catchment 3 – C3A-DS (10 April 2019)


Catchment 4 – C4H-US (10 May 2019)


Catchment 4 - C4A-DS1 (10 May 2019)


Catchment 4 - C4A-DS2 (10 May 2019)


Catchment 4 - C4A-DS3 (10 May 2019)

**Figure 7 Representative images of each Te Ahu a Turanga baseline water quality monitoring site.**


Catchment 4 - C4A-DS4 (10 May 2019)


Catchment 5 – C5A-US (11 April 2019)


Catchment 5 – C5A-DS1 (11 April 2019)


Catchment 5 – C5A-DS2 (11 April 2019)


Catchment 5 – C5B-US (11 April 2019)


Catchment 5 – C5B-DS (11 April 2019)


Catchment 6 – C6A-DS1 (11 April 2019)


Catchment 6 – C6A-DS2 (11 April 2019)

**Figure 7 continued**

Catchment 7 – C7A-DS1 (10 April 2019)

Catchment 7 – C7A-DS2 (10 April 2019)

Catchment 7 – C7A-DS3 (10 April 2019)

**Figure 7 continued**

## 2.3 Monitoring Methods

### 2.3.1 Continuous Turbidity Loggers

Continuous turbidity loggers were installed at one site in each of Catchment 2 and Catchment 7 in August and September 2019 by NIWA. It had been hoped that these would have been installed much earlier in the baseline monitoring programme (i.e., summer 2018-2019) to capture turbidity records over at least the autumn-winter period but factors beyond our control meant this did not occur.

### 2.3.2 Quantitative Aquatic Macroinvertebrate Sampling

Freshwater macroinvertebrates were sampled at 17 of the 19 baseline monitoring sites following "Protocol C3 – Hard-bottomed, quantitative" of Stark *et al.* (2001). Three rounds of sampling were planned (summer, autumn, and winter), however only two have been completed (summer: February 2019 and winter: May (Catchment 2 only) and June 2019) due to prolonged low flows at many of the sites during autumn, making sampling too difficult. The third round will be undertaken in November 2019 (spring). At each site five Surber samples were collected generally from riffle or fast run habitats (Figure 8). At two sites (C2A-DS2 and C4H-US) in February, water levels were so low that riffles had stopped flowing. At these sites, samples were collected as close as possible to the upstream and downstream ends of these dry riffles. Macroinvertebrate samples were processed following our in-house EOS Ecology full count with subsampling option methodology. This is analogous to the "Protocol P3 – Full count with subsampling option" of Stark *et al.* (2001) except subsampling involves the entire sample rather than just abundant taxa. Macroinvertebrates were identified to a taxonomic level we utilise when processing state of the environment samples from six North Island regional councils. This is to a lower level of classification for several taxa compared to the more commonly used Macroinvertebrate Community Index (MCI) level of identification.

### 2.3.3 Deposited Fine Sediment Monitoring

Deposited fine sediment was measured on six occasions at each site using the "SAM 2 – In-stream visual assessment of sediment" of Clapcott *et al.* (2011). As most of the streams were too small to enable measurements across transects, we instead recorded deposited fine sediment cover percentage within 20 quadrats along a 50 m stream reach (Figure 8). We had originally planned to also use the "SAM 5 – Resuspendable sediment (Shuffle index)" method, however the small size and shallow water depths of most of the streams did not allow this to be effective. One site (C5A-US), which had an intermittently flowing channel and appeared to have a naturally bare earth streambed was not monitored, as this method is only for use in hard-bottomed, stony streams. Additionally, at another site (C4H-US) we missed a single sampling round as at the time of sampling the water was too turbid to adequately observe the stream bed. This was during low flow conditions and all other sites in the catchment were not overly turbid so there may have been cattle in the channel or some other disturbance upstream.

### 2.3.4 Water Quality Monitoring

Spot water quality samples were collected at all sites and tested for total suspended solids (TSS) and turbidity by Central Environmental Laboratories (CEL) (Figure 8). At the same time, three replicate measurements of visual water clarity were taken using a clarity tube. Dry weather conditions were sampled on eight occasions from all sites, except for the intermittent site (C5A-US) which was only sampled when flowing. Wet weather samples were collected during rainfall events at all sites in Catchments 2 (four occasions), 4 (three occasions), and 7 (three occasions). After the programme had begun, we were asked by NZTA to add aluminium to the analysis, to obtain baseline concentrations of this metal which is often a component of flocculants used in sediment control systems. At this time pH was also added as the toxicity of aluminium varies with pH.


Visually estimating deposited fine sediment cover


Collecting a macroinvertebrate Surber sample


Collecting a water sample during rain event


Pink wooden stakes were used to mark sites

**Figure 8 Some methods used during the Te Ahu a Turanga baseline freshwater monitoring survey.**

## 2.4 Sampling Schedule

The baseline water quality sampling programme ran between 5 December 2018 and 24 September 2019 (Table 1). Macroinvertebrate sampling was undertaken in summer (February) and winter (May (Catchment 2 only) and June) (Table 1).

**Table 1 Baseline freshwater quality monitoring programme sampling schedule. Shading is used to separate each sampling event, each of which was undertaken over one to six days depending on the data being collected.**

| Date | Sites | Deposited sediment | Macroinverte-brates | Water quality (Dry or Wet) |
|---|---|---|---|---|
| 5/12/2018 | Catchment 4 (C4H-US, C4A-DS1, C4A-DS2, C4A-DS3, C4A-DS4)<br>Catchment 5 (C5A-US, C5A-DS1, C5B-US, C5B-DS) | × | × | ✓ (Dry) |
| 6/12/2018 | Catchment 6 (C6A-DS1, C6A-DS2)<br>Catchment 7 (C7A-DS1, C7A-DS2, C7A-DS3) | × | × | ✓ (Dry) |
| 7/12/2018 | Catchment 2 (C2A-US, C2A-DS1, C2A-DS2)<br>Catchment 3 (C3A-DS) | × | × | ✓ (Dry) |
| 15/2/2019 | Catchment 7 (C7A-DS1, C7A-DS2, C7A-DS3) | ✓ | ✓ | ✓ (Dry) |
| 18/2/2019 | Catchment 6 (C6A-DS1, C6A-DS2) | ✓ | ✓ | ✓ (Dry) |
| | Catchment 5 (C5A-DS1) | ✓ | × | ✓ (Dry) |
| | Catchment 5 (C5A-US) | × | × | ✓ (Dry) |
| 19/2/2019 | Catchment 4 (C4H-US, C4A-DS2, C4A-DS3, C4A-DS4) | ✓ | ✓ | ✓ (Dry) |
| 20/2/2019 | Catchment 5 (C5A-DS2, C5B-US, C5B-DS) | ✓ | ✓ | ✓ (Dry) |
| 21/2/2019 | Catchment 2 (C2A-US), Catchment 3 (C3A-DS)<br>Catchment 4 (C4A-DS1) | ✓ | ✓ | ✓ (Dry) |
| 22/2/2019 | Catchment 2 (C2A-DS1, C2A-DS2) | ✓ | ✓ | ✓ (Dry) |
| 13/3/2019 | Catchment 5 (C5A-DS1, C5A-DS2, C5B-US, C5B-DS)<br>Catchment 6 (C6A-DS1, C6A-DS2) | ✓ | × | ✓ (Dry) |
| | Catchment 5 (C5A-US) | × | × | ✓ (Dry) |
| 14/3/2019 | Catchment 2 (C2A-US, C2A-DS1, C2A-DS2)<br>Catchment 3 (C3A-DS) | ✓ | × | ✓ (Dry) |
| | Catchment 7 (C7A-DS1, C7A-DS2, C7A-DS3) | × | × | ✓ (Wet) |
| 15/3/2019 | Catchment 4 (C4A-DS1, C4A-DS2, C4A-DS3, C4A-DS4) | ✓ | × | ✓ (Dry) |
| | Catchment 4 (C4H-US) | × | × | ✓ (Dry) |
| 10/4/2019 | Catchment 2 (C2A-US, C2A-DS1, C2A-DS2), Catchment 3 (C3A-DS), Catchment 7 (C7A-DS1, C7A-DS2, C7A-DS3) | ✓ | × | ✓ (Dry) |
| 11/4/2019 | Catchment 5 (C5A-DS1, C5A-DS2, C5B-US, C5B-DS)<br>Catchment 6 (C6A-DS1, C6A-DS2) | ✓ | × | ✓ (Dry) |
| | Catchment 5 (C5A-US) | × | × | ✓ (Dry) |
| 12/4/2019 | Catchment 2 (C2A-US, C2A-DS1, C2A-DS2), Catchment 4 (C4H-US, C4A-DS1, C4A-DS2, C4A-DS3, C4A-DS4) | × | × | ✓ (Wet) |

Table 1 continued

| Date | Sites | Deposited sediment | Macroinvertebrates | Water quality (Dry or Wet) |
|---|---|---|---|---|
| 8/5/2019 | Catchment 2 (C2A-US, C2A-DS1, C2A-DS2) Catchment 7 (C7A-DS1, C7A-DS2, C7A-DS3) | ✓ | × | ✓ (Dry) |
| 9/5/2019 | Catchment 5 (C5A-DS1, C5A-DS2, C5B-US, C5B-DS) Catchment 6 (C6A-DS1, C6A-DS2) | ✓ | × | ✓ (Dry) |
| | Catchment 5 (C5A-US) | × | × | ✓ (Dry) |
| 10/5/2019 | Catchment 3 (C3A-DS), Catchment 4 (C4H-US, C4A-DS1, C4A-DS2, C4A-DS3, C4A-DS4) | ✓ | × | ✓ (Dry) |
| 30/5/2019 | Catchment 2 (C2A-US, C2A-DS1, C2A-DS2) | ✓ | ✓ | ✓ (Dry) |
| 31/5/2019 | Catchment 2 (C2A-US, C2A-DS1, C2A-DS2), Catchment 4 (C4H-US, C4A-DS1, C4A-DS2, C4A-DS3, C4A-DS4), Catchment 7 (C7A-DS1, C7A-DS2, C7A-DS3 | × | × | ✓ (Wet) |
| 24/6/2019 | Catchment 7 (C7A-DS1, C7A-DS2, C7A-DS3) | ✓ | ✓ | ✓ (Dry) |
| 25/6/2019 | Catchment 6 (C6A-DS1, C6A-DS2) | ✓ | ✓ | ✓ (Dry) |
| | Catchment 5 (C5A-DS1) | ✓ | × | ✓ (Dry) |
| | Catchment 5 (C5A-US) | × | × | ✓ (Dry) |
| 26/6/2019 | Catchment 5 (C5A-DS2, C5B-US, C5B-DS) | ✓ | ✓ | ✓ (Dry) |
| 27/6/2019 | Catchment 4 (C4A-DS2, C4A-DS3, C4A-DS4) | ✓ | ✓ | ✓ (Dry) |
| 28/6/2019 | Catchment 3 (C3A-DS), Catchment 4 (C4H-US, C4A-DS1) | ✓ | ✓ | ✓ (Dry) |
| 24/7/2019 | Catchment 2 (C2A-US, C2A-DS1, C2A-DS2), Catchment 7 (C7A-DS1, C7A-DS2, C7A-DS3) | ✓ | × | ✓ (Dry) |
| 25/7/2019 | Catchment 3 (C3A-DS), Catchment 4 (C4H-US, C4A-DS1, C4A-DS2, C4A-DS3, C4A-DS4) | ✓ | × | ✓ (Dry) |
| 30/7/2019 | Catchment 5 (C5A-DS1, C5A-DS2, C5B-US, C5B-DS) Catchment 6 (C6A-DS1, C6A-DS2) | ✓ | × | ✓ (Dry) |
| | Catchment 5 (C5A-US) | × | × | ✓ (Dry) |
| 28/8/2019 | Catchment 5 (C5A-US, C5A-DS1, C5A-DS2, C5B-US, C5B-DS), Catchment 6 (C6A-DS1, C6A-DS2) | × | × | ✓ (Dry) |
| 29/8/2019 | Catchment 2 (C2A-US, C2A-DS1, C2A-DS2), Catchment 3 (C3A-DS) | × | × | ✓ (Dry) |
| | Catchment 4 (C4H-US, C4A-DS1, C4A-DS2, C4A-DS3, C4A-DS4) | ✓ | × | ✓ (Dry) |
| 30/8/2019 | Catchment 7 (C7A-DS1, C7A-DS2, C7A-DS3) | ✓ | × | ✓ (Dry) |
| 6/9/2019 | Catchment 2 (C2A-US, C2A-DS1, C2A-DS2) Catchment 4 (C4H-US, C4A-DS1, C4A-DS2, C4A-DS3, C4A-DS4) | × | × | ✓ (Wet) |
| 13/9/2019 | Catchment 4 (C4H-US, C4A-DS1, C4A-DS2, C4A-DS3, C4A-DS4), Catchment 7 (C7A-DS1, C7A-DS2, C7A-DS3) | × | × | ✓ (Dry) |

Table 1 continued

| Date | Sites | Deposited sediment | Macroinverte-brates | Water quality (Dry or Wet) |
|---|---|---|---|---|
| 24/9/2019 | Catchment 2 (C2A-US, C2A-DS1, C2A-DS2)<br>Catchment 7 (C7A-DS1, C7A-DS2, C7A-DS3) | × | × | ✓ (Wet) |

## 2.5 Data Analysis

### 2.5.1 Deposited Fine Sediment

Fine deposited sediment data was summarised by box and whisker graphs. Graphs showing the distribution of percentage cover estimates for each sampling occasion and of all sampling dates combined was produced for each site. The One Plan Schedule E deposited sediment cover water quality target (see Table 2) was superimposed on each graph to give context to the results.

Table 2 Horizons Regional Council One Plan water management zones and relevant Schedule E surface water quality targets for the surveyed Te Ahu a Turanga catchments.

<table>
<tr><th rowspan="3">TAaT catchment numbers</th><th rowspan="3">Water Management Zone</th><th rowspan="3">Sub-zone</th><th colspan="7">Relevant One Plan Schedule E surface water quality targets</th></tr>
<tr><th colspan="2">pH</th><th>Deposited sediment cover (%)</th><th>MCI</th><th colspan="2">Visual clarity (m)</th><th>Toxicants</th></tr>
<tr><th>Range</th><th>Change</th><th>≤</th><th>></th><th><50th %tile</th><th>%change</th><th>% level of protection</th></tr>
<tr><td>Catchments 3, 4, 5, 6, & 7</td><td>Middle Manawatu (Mana_10)</td><td>Middle Manawatu (Mana_10a)</td><td>7 to 8.5</td><td>0.5</td><td>20</td><td>100</td><td>2.5</td><td>30</td><td>95</td></tr>
<tr><td>Catchment 2</td><td>Upper Gorge (Mana_9)</td><td>Mangapapa (Mana_9b)</td><td>7 to 8.5</td><td>0.5</td><td>20</td><td>100</td><td>2.5</td><td>30</td><td>95</td></tr>
</table>

### 2.5.2 Water Quality Data

Visual clarity site means were calculated (separately for wet and dry events for those catchments subject to wet weather sampling) and compared to the Stream Health Monitoring and Assessment Kit (SHMAK; NIWA undated) interpretative categories to provide context to the results (Table 3). Within each catchment, all sites and dry vs. wet event sampling (where available) were compared using analysis of variance (ANOVA). One-way ANOVA with site as the factor was used in those catchments with greater than one sampling site where only dry weather data was collected (i.e., Catchments 5 and 6). Two-way ANOVA with site and event type (dry or wet) as the factors was used in Catchments 2, 4, and 7. Where necessary, data was square root transformed to meet the ANOVA assumptions of normality and equal variance.

Turbidity and total suspended solids (TSS) data was summarised by box and whisker graphs. Separate one-way ANOVA were completed for dry weather and wet weather data comparing catchments as not all catchments had wet weather data. One-way ANOVAs did not meet the assumption of normality and equal variance despite data transformation; hence the non-parametric Kruskal-Wallis procedure was used. Additionally, two-way ANOVA with event (wet or dry) and catchment as the factors was undertaken for those catchments where wet weather data was available (Catchments 2, 4, and 7).

No statistical analysis was performed on aluminium and pH data due to the small size of the data set and the fact that so many of the aluminium concentrations were below the laboratory detection level.

**Table 3 Visual water clarity Stream Health Monitoring and Assessment Kit (SHMAK) interpretative categories. Adapted from NIWA (undated).**

| SHMAK category | Rating | Description |
|---|---|---|
| Clear to bottom (100 cm+) | Excellent | Clear water for a farm/rural stream. |
| 70 to 99 cm | Good | Slightly turbid. May inhibit plant growth and the suspended solids could settle on the stream bed. |
| 55 to 69 cm | Fair | Moderately turbid water. It will be difficult to see the bottom of pools and this level is probably starting to affect stream life through light restricting photosynthesis and settlement of sediment on streambed. A review of what is happening upstream is needed. |
| 35 to 54 cm | Poor | Very turbid water. Likely to silt up streambed and be detrimental to most stream life. A review of what is happening upstream is needed and such low clarity will almost certainly be caused by obvious disturbance. |
| Less than 35 cm | Very Poor | Extremely turbid water that will result in a silty streambed and be detrimental to most stream life. An immediate review of what is happening upstream is needed and such low clarity will almost certainly be caused by obvious disturbance. |

### 2.5.3 Macroinvertebrate Data

Raw macroinvertebrate data was summarised by taxa richness, total abundance, and abundance of the five most common taxa, and non-metric multidimensional scaling (NMS). Invertebrate community metrics calculated were the number of Ephemeroptera-Plecoptera-Trichoptera taxa (EPT taxa richness), %EPT abundance, and the Macroinvertebrate Community Index (MCI and QMCI). The points below provide brief clarification of these metrics.

» Taxa richness is the number of different taxa identified in each sample. Taxa is generally a term for taxonomic groups, and in this case refers to the lowest level of classification that was obtained during the study. Taxa richness is a useful community metric related to habitat diversity, with sites with more diverse habitats often having greater richness. However, there are numerous aquatic invertebrate taxa that prefer or tolerate degraded instream conditions such that taxa richness on its own should not be used to infer stream health.

» EPT refers to three Orders of invertebrates that are generally regarded as 'cleanwater' taxa. These Orders are Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies); forming the acronym EPT. These taxa are relatively intolerant of organic enrichment or other pollutants and habitat degradation, including excessive deposition of fine sediments in stony-bottomed watercourses. The exceptions to this are the hydroptilid caddisflies (e.g. Trichoptera: Hydroptilidae: *Oxyethira, Paroxyethira*), which are algal piercers and often found in high numbers in nutrient enriched waters with high algal content. These taxa were not found in the project area. In general, the disappearance and reappearance of EPT taxa can also provide evidence of whether a site is impacted or recovering from a disturbance. EPT taxa are generally more diverse in less-impacted, more pristine systems, although there is a small set of EPT taxa that are tolerant of degraded stream conditions.

» In the mid-1980s the MCI was developed as an index of community integrity for use in stony riffles in New Zealand streams and rivers and can be used to determine the level of organic enrichment for these types of streams (Stark, 1985). Although developed to assess nutrient enrichment, the MCI will respond to any disturbance that alters macroinvertebrate community composition (Boothroyd & Stark, 2000), and as such is used widely to evaluate the general health of waterways in New Zealand. Recently a variant for use in streams with a streambed of sand/silt/mud (i.e. soft-bottomed) was developed by Stark & Maxted (2007a) and is referred to as the MCI-sb. Both the hard-bottomed (MCI-hb) and soft-bottomed (MCI-sb) versions calculate an overall score for each sample, which is based on pollution-tolerance values for each invertebrate taxon that range from 1 (very pollution tolerant) to 10 (pollution-sensitive). MCI-hb and MCI-sb are calculated using presence/absence data and a quantitative version has been developed that incorporates abundance data and so gives a more accurate result by differentiating rare taxa from abundant taxa (QMCI-hb, QMCI-sb). MCI (QMCI) scores of ≥120 (≥6.00) are interpreted as 'excellent', 100–119 (5.00–5.99) as 'good', 80–99 (4.00–4.99) as 'fair', and <80 (<4.00) as 'poor' (Stark & Maxted, 2007b). The hard-bottomed variant was used for all sites in this report as the substrate was predominantly stony.

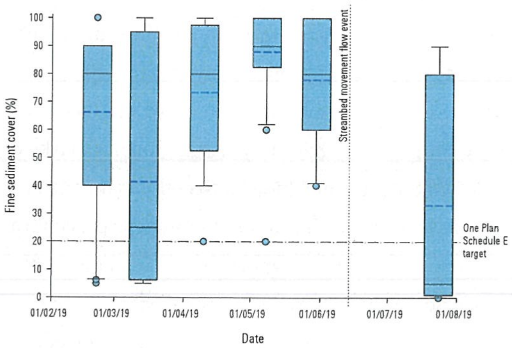
» NMS is a non-metric statistical technique that condenses sample data (in this case macroinvertebrate community data) to a single point in low-dimensional ordination space using some measure of community dissimilarity (Bray-Curtis metric in this instance). Interpretation is straightforward such that points on an x-y plot that are close together represent samples that are more similar in community composition than those further apart (Clarke & Gorley, 2006). Significant differences in macroinvertebrate community composition between catchment and season were tested using the analysis of similarities (ANOSIM) procedure, which is a non-parametric procedure, applied to the similarity matrix that underlies the NMS ordination. ANOSIM is an approximate analogue of the standard ANOVA (analysis of variance) and compares the similarity between groups (in this instance between catchments and season) using the R test statistic. R=0 where there is no difference in macroinvertebrate community between groups, while R=1 where the groups have completely different communities. Where ANOSIM results showed significant or near-significant differences in macroinvertebrate community compositions, the similarity percentages (SIMPER) procedure was used to determine which taxa where responsible. NMS, ANOSIM, and SIMPER were all carried out in PRIMER v6.1.5 (Clarke & Gorley, 2006).

# 3 RESULTS

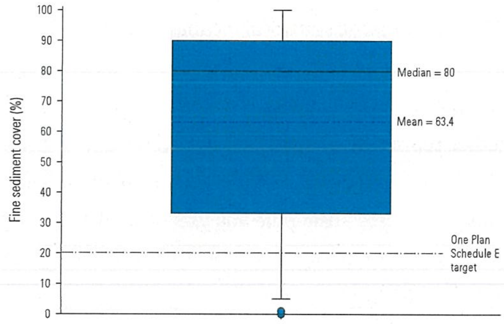
## 3.1 Deposited Fine Sediment

### 3.1.1 Catchment 2

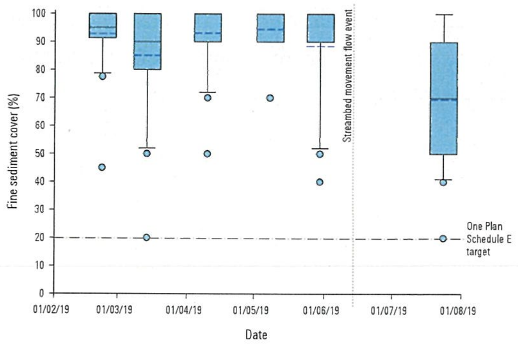
Deposited fine sediments at all three sites in Catchment 2 were generally well above the One Plan Schedule E target of 20% cover (Figure 9). The large flow event in mid-June resulted in redistribution of streambed substrates and thus reduced the fine sediment cover at all sites. With its steep upper catchment of predominantly agricultural land use, it is anticipated that deposited fine sediment cover will increase with time to levels seen prior to this flow event. The upstream site had the most variable fine sediment cover, while the two downstream sites were not far from complete cover of the streambed, at least prior to the mid-June high flow event (Figure 9). Combining sampling dates, median values increased in a downstream direction and mean values were higher at the downstream sites (Figure 9).



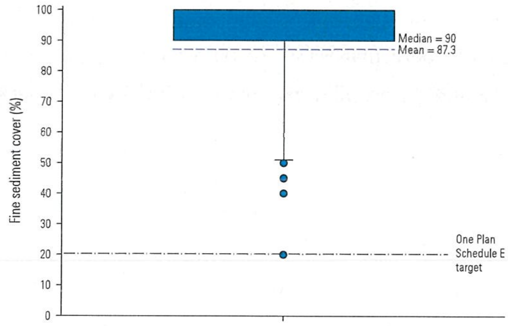

Upstream (C2A-US) – Variation over time



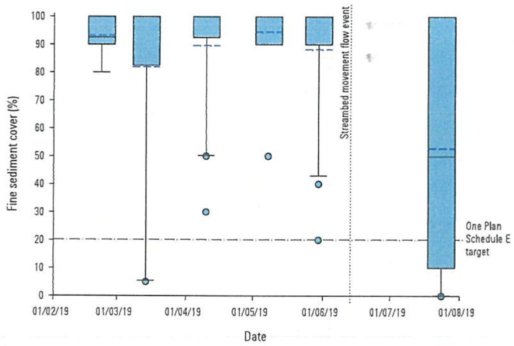

Upstream (C2A-US) – Sampling dates combined



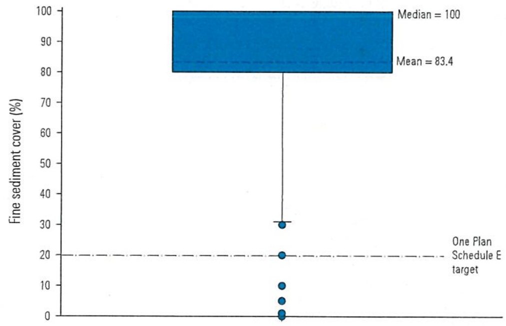

Downstream (C2A-DS1) – Variation over time




Downstream (C2A-DS1) – Sampling dates combined




Downstream (C2A-DS2) – Variation over time

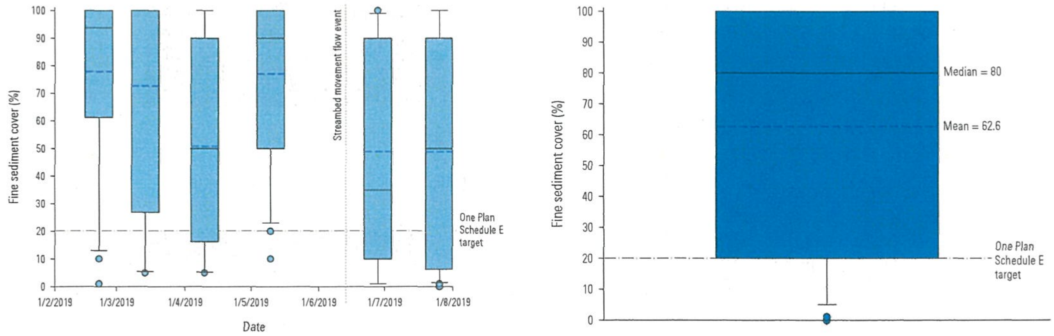



Downstream (C2A-DS2) – Sampling dates combined

**Figure 9** Deposited fine sediment cover at the three Catchment 2 sampling sites. The graphs in the left column show results over time, while the right column combines sampling dates. The variation over time graphs also include a line indicating when a large rain event that caused streambed movement at some sites occurred. Dashed blue lines indicate mean values. All data collected by EOS Ecology.

### 3.1.2 Catchment 3

The single Catchment 3 sampling site generally had fine deposited sediment percentages well above the One Plan Schedule E target of 20% cover, even after the mid-June high flow event (Figure 10). Combining sampling dates median and mean values were very similar to the upstream Catchment 2 site (C2A-US) (Figure 9, Figure 10).



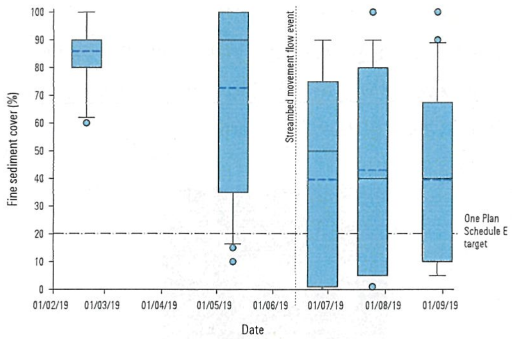

Downstream (C3A-DS) – Variation over time

Downstream (C3A-DS) – Sampling dates combined

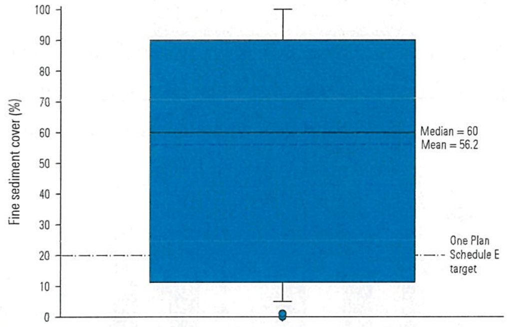
**Figure 10** **Deposited fine sediment cover at the single Catchment 3 sampling site. The graph on the left shows results over time, while the right graph combines sampling dates. The variation over time graph also includes a line indicating when a large rain event that caused streambed movement at some sites occurred. Dashed blue lines indicate mean values. All data collected by EOS Ecology.**

### 3.1.3 Catchment 4

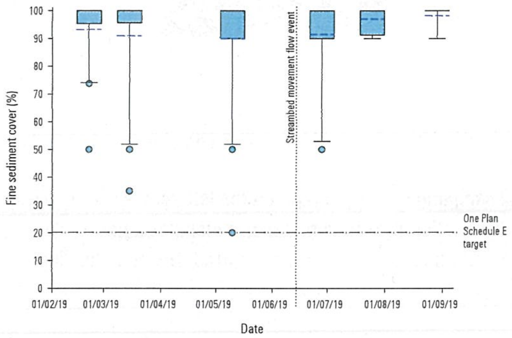
The five Catchment 4 sampling sites generally had fine deposited sediment percentages well above the One Plan Schedule E target of 20% cover (Figure 11). There were obvious reductions in fine sediment cover following the mid-June high flow event at the upstream site (CH4-US), and two of the downstream sites (C4A-DS2 & C4A-DS3) (Figure 11). The morphology and bed material of the C4A-DS1 site indicate the section of stream in which it is located may be naturally soft bottomed and likely had its natural course modified historically. Extensive macrophyte growths were present at the C4A-DS3 site prior to the mid-June high flow event. This flood almost completely cleared the bed of macrophytes at this site, and it is anticipated these will regrow over spring and summer. The upstream site had the most variable fine deposited sediment cover, and it is notable that riffles at this site had ceased flowing in February 2019. Combining sampling dates, the upstream site had the lowest median and mean fine sediment cover, while three of the four downstream sites had median values of 100% cover (Figure 11). The downstream-most site (C4A-DS4) was within the Manawatū Gorge Scenic Reserve and consistently had high deposited fine sediment cover despite being of a higher gradient and faster flow velocities than the four sites further upstream. This site was particular notable in that even fast flowing sections over bedrock, habitat that typically is not amenable to fine sediment deposition, had high sediment coverage. The large artificial pond/lake directly upstream of the farmland-Scenic Reserve boundary would appear to generate chronically turbid water, leading to excessive fine sediment deposition downstream. Agricultural land use, a general lack of riparian fencing, and numerous zones of actively slumping and undercut stream bank are the causes of the high fine deposited sediment cover observed in Catchment 4.



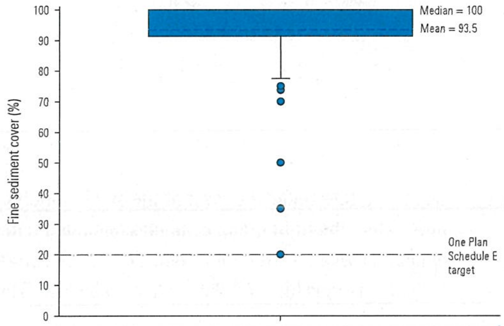
Upstream (C4H-US) – Variation over time



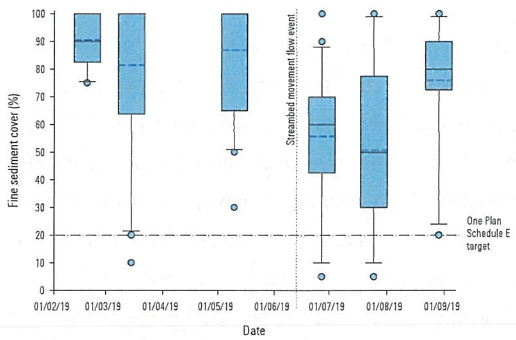
Upstream (C4H-US) – Sampling dates combined



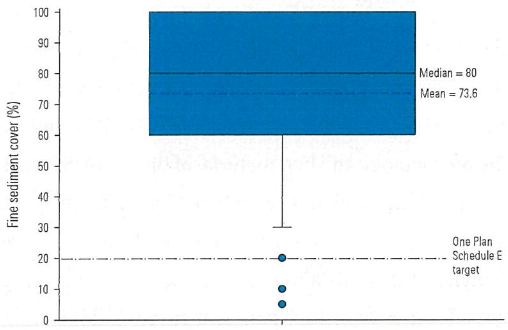
Downstream (C4A-DS1) – Variation over time



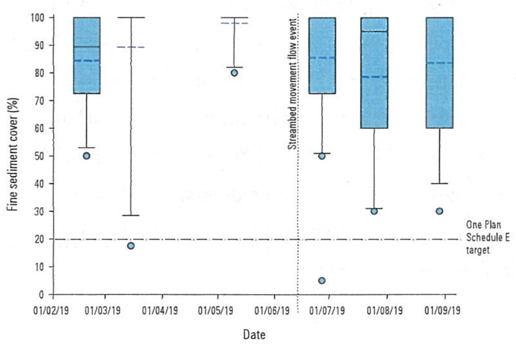
Downstream (C4A-DS1) – Sampling dates combined



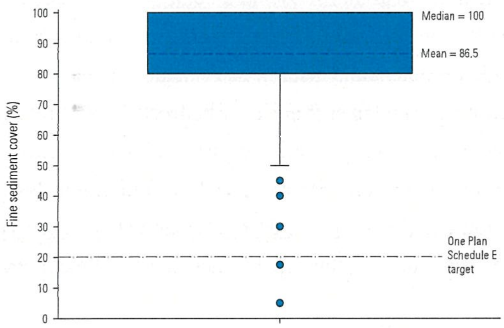
Downstream (C4A-DS2) – Variation over time



Downstream (C4A-DS2) – Sampling dates combined

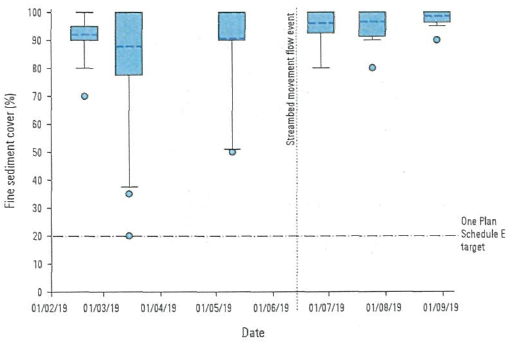


Downstream (C4A-DS3) – Variation over time

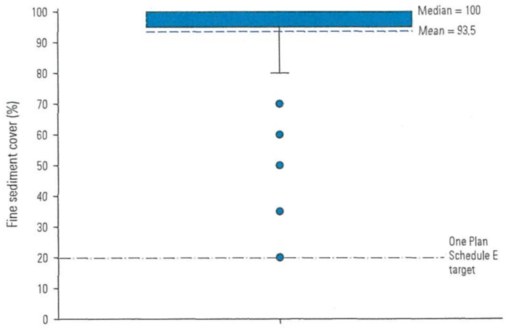


Downstream (C4A-DS3) – Sampling dates combined

**Figure 11** Deposited fine sediment cover at the five Catchment 4 sampling sites. The graphs in the left column show results over time, while the right column combines sampling dates. The variation over time graphs also include a line indicating when a large rain event that caused streambed movement at some sites occurred. Dashed blue lines indicate mean values. All data collected by EOS Ecology.




Downstream (C4A-DS4) – Variation over time




Downstream (C4A-DS4) – Sampling dates combined

**Figure 11 continued**

### 3.1.4 Catchment 5

Of the five sampling sites in Catchment 5, fine deposited sediment was surveyed at four sites. The fifth site (C5A-US) is an intermittent section that did not have any flowing water until after the mid-June high flow event, which reformed a defined channel by removing vegetation that had grown through the channel. Additionally, the streambed substrate was predominantly bare earth rather than stony cobbles, so was not viable for the method of fine deposited sediment survey used. The three sites (C5B-US, C5B-DS, C5A-DS1) where stock (sheep and cattle) had full access to the channel had far higher levels of fine deposited sediments than the forested site in the Manawatū Gorge Scenic Reserve (C5A-DS2) (Figure 12). The Scenic Reserve site was the only one in the catchment to have an overall median fine sediment percentage cover below the One Plan Schedule E target, although the overall mean value was just above the target (Figure 12). The mid-June high flow event only noticeably decreased fine sediment cover at the C5B-DS site (Figure 12). Overall, the Catchment 5 sites within the farmed part of the catchment have relatively high levels of deposited fine sediment cover, while the much lower levels observed further downstream within the Manawatū Gorge Scenic Reserve would imply the dense forest and lack of stock access "heals" degraded stream conditions to some extent.

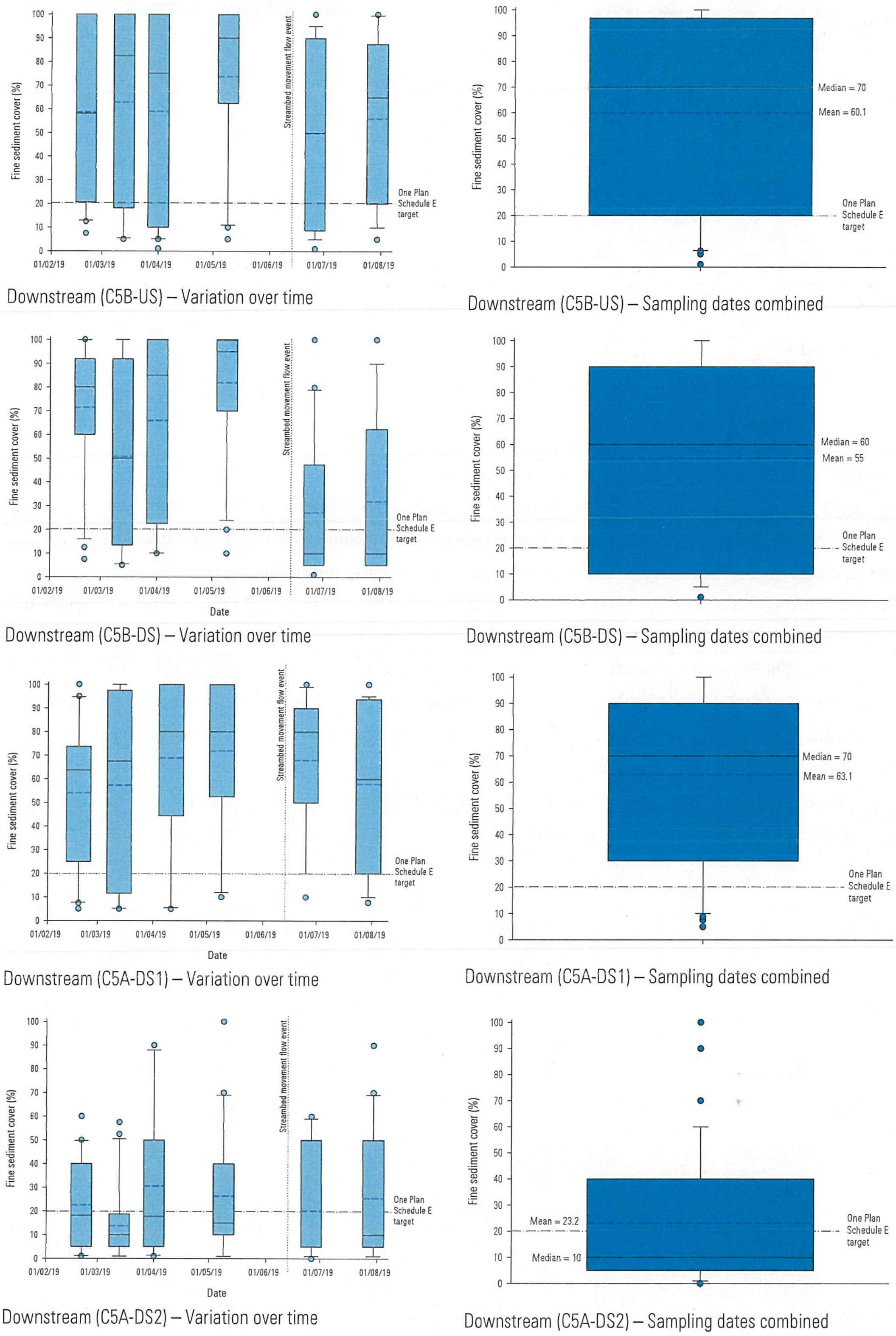



**Figure 12** Deposited fine sediment cover at four Catchment 5 sampling sites. The graphs in the left column show results over time, while the right column combines sampling dates. The variation over time graphs also include a line indicating when a large rain event that caused streambed movement at some sites occurred. Dashed blue lines indicate mean values. All data collected by EOS Ecology.

### 3.1.5 Catchment 6

In Catchment 6, fine deposited sediment percentage cover was greater at the site upstream of the Scenic Reserve (C6A-DS1) primarily because of relatively high levels observed during surveys in April and May (Figure 13). As observed in Catchment 5, the site within the Scenic Reserve (C6A-DS2) had lower fine sediment cover, with the overall combined survey median and mean values at that site being below the One Plan Schedule E target of 20% cover (Figure 13). The mid-June high flow event appears to have "cleaned" the substrate at the C6A-DS1 site, however had no great impact on levels at the C6A-DS2 site further downstream within the Scenic Reserve, which maintained low levels of fine deposited sediment over the survey period (Figure 13).

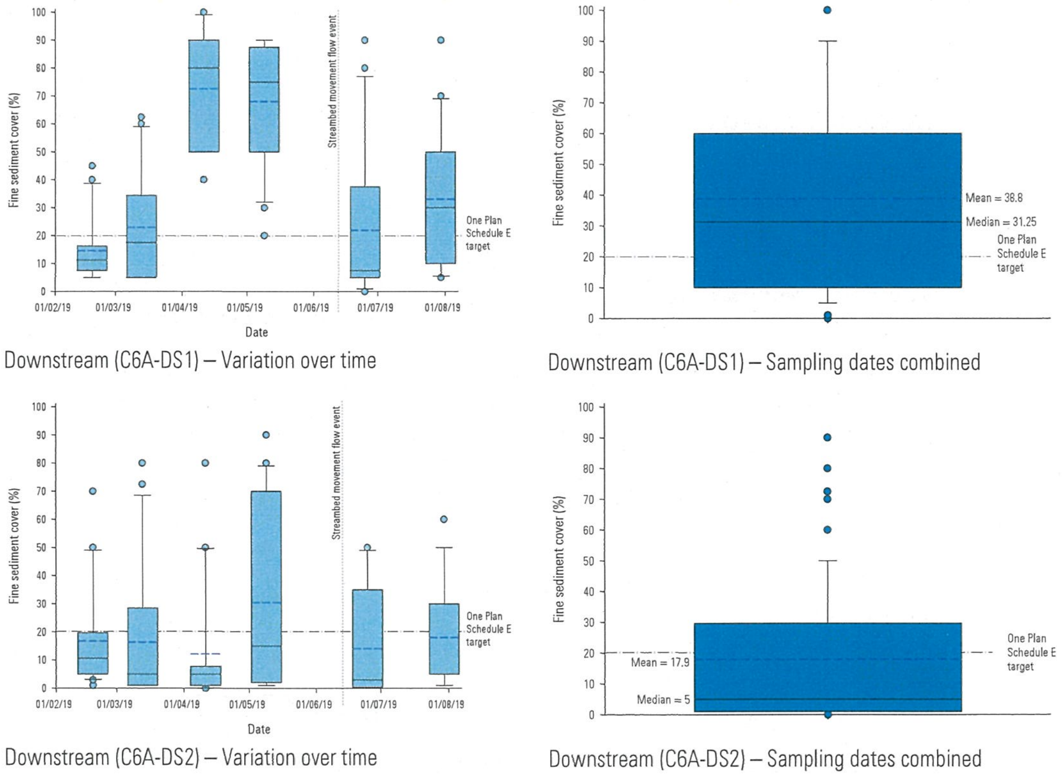
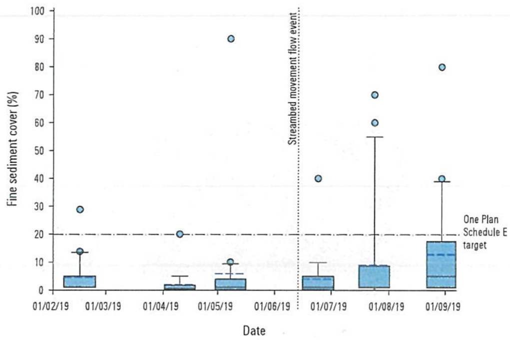


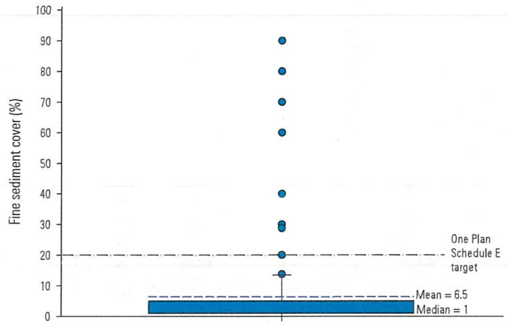

**Figure 13** **Deposited fine sediment cover at the two Catchment 6 sampling sites. The graphs in the left column show results over time, while the right column combines sampling dates. The variation over time graphs also include a line indicating when a large rain event that caused streambed movement at some sites occurred. Dashed blue lines indicate mean values. All data collected by EOS Ecology.**

### 3.1.6 Catchment 7

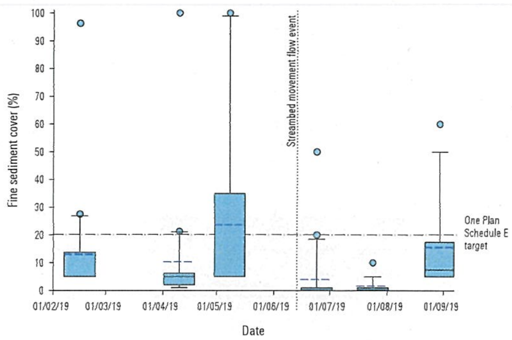
Catchment 7 had the lowest deposited fine sediment levels of all the surveyed catchments. The upstream-most site (C7A-DS1), which was the only site in the catchment free from stock access, maintained very low levels even during a period of prolonged low flows (Figure 14). In contrast, the downstream-most site (C7A-DS3) had relatively high levels of fine sediment prior to the mid-June high flow event, primarily due to the growth of periphyton over a prolonged period of low flow that trapped fine sediments and the presence of a herd of beef cows with their calves for a time in the catchment (Figure 14). Combining all sampling dates, all three sites had median values and two sites had mean values below the One Plan Schedule E target of 20% cover (Figure 14).



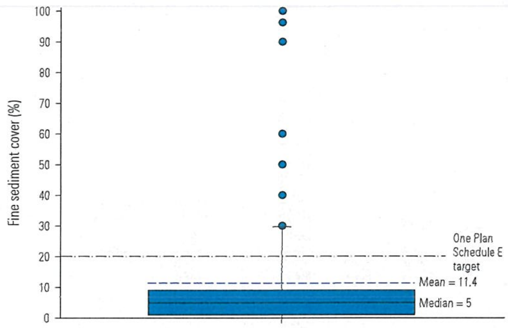

Downstream (C7A-DS1) – Variation over time



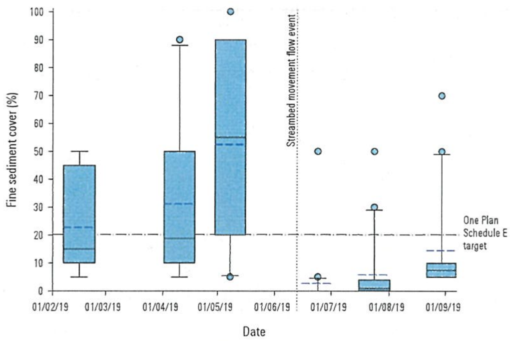

Downstream (C7A-DS1) – Sampling dates combined



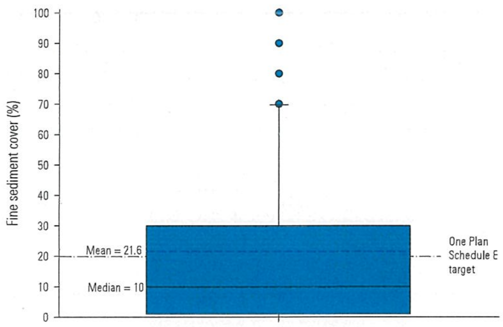

Downstream (C7A-DS2) – Variation over time




Downstream (C7A-DS2) – Sampling dates combined




Downstream (C7A-DS3) – Variation over time




Downstream (C7A-DS3) – Sampling dates combined

**Figure 14** Deposited fine sediment cover at the three Catchment 7 sampling sites. The graphs in the left column show results over time, while the right column combines sampling dates. The variation over time graphs also include a line indicating when a large rain event that caused streambed movement at some sites occurred. Dashed blue lines indicate mean values. All data collected by EOS Ecology.

## 3.2 Water Quality

### 3.2.1 Visual Clarity

#### Catchment 2

Mean water clarity in Catchment 2 during normal dry weather flows was in the "good" (C2A-US and C2A-DS1) to "fair" (C2A-DS2) categories (Figure 15; Figure 21). During rain events water clarity was in the "very poor" category, and there was a statistically significant difference between dry weather and wet weather samples (Figure 15; Figure 21; Table 4). Following rainfall, Catchment 2 had the lowest clarity values recorded across all catchments.

Site C2A-DS2, 14 March 2019 – dry weather

Site C2A-DS2, 6 September 2019 – wet weather

**Figure 15 Representative images of Catchment 2 during dry weather conditions and wet weather events.**

#### Catchment 3

Mean water clarity at the single Catchment 3 site was in the "fair" category during dry weather conditions (Figure 16; Figure 21)

C3A-DS, 28 June 2019

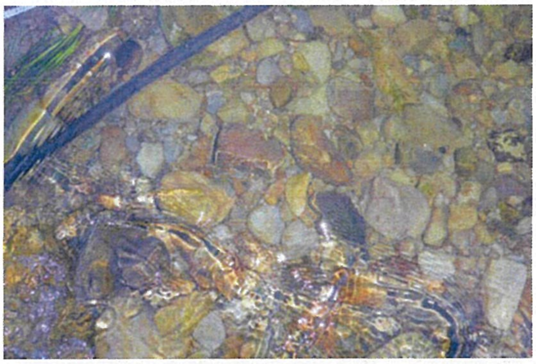
C3A-DS, 29 August 2019

**Figure 16 Representative images of Catchment 3 during dry weather conditions.**

#### Catchment 4

In Catchment 4, the downstream-most site (C4A-DS4) had much lower water clarity ("very poor" category) than the other four sites (all at the boundary of "poor" and "fair" categories) during dry weather flow conditions (Figure 21). The two upstream-most sites had statistically significant higher water clarity than the downstream-most site (Table 4). The very low water clarity of the downstream-most site is likely primarily a result of the constant high turbidity conditions of the large artificial pond just upstream of the farmland boundary with the Manawatū Gorge Scenic

Reserve. During rain events all sites in this catchment are in the "very poor" category and have statistically significant lower water clarity than during dry flow conditions (Table 4; Figure 17; Figure 21).



C4H-US, 28 June 2019 – dry weather

C4H-US, 6 September 2019 – wet weather

C4A-DS2, 27 June 2019 – dry weather

C4A-DS2, 6 September 2019 – wet weather

Figure 17 Representative images of Catchment 4 during dry weather conditions and wet weather events.

## Catchment 5

Mean water clarity at all the Catchment 5 sites were in the "poor" category during dry weather conditions, with no statistically significant differences among the sites (Figure 18; Figure 21; Table 4).

C5A-DS2, 11 April 2019

C5B-US, 11 April 2019

Figure 18 Representative images of Catchment 5 during dry weather conditions.

## Catchment 6

Mean water clarity at the two Catchment 6 sites were in the "fair" category during dry weather conditions, with no statistically significant differences between the sites (Figure 19; Figure 21; Table 4).

C6A-DS2, 18 February 2019

C6A-DS1, 18 February 2019

Figure 19 Representative images of Catchment 6 during dry weather conditions.

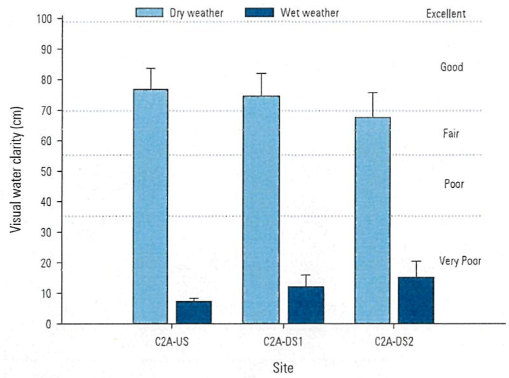
## Catchment 7

During dry weather conditions, mean water clarity in Catchment 7 was greatest (in the "good" category) at the upstream-most site (C7A-DS1), while the other two sites were in the "fair" category (Figure 21). Water clarity had statistically significant higher measurements at the upstream-most site (C7A-DS1) compared to the middle site (C7A-DS2) (Table 4). All sites in the catchment had significantly lower water clarity during rain events than during dry conditions (Figure 20; Figure 21; Table 4). However, during rain events the upstream-most site had average water clarity near the top of the "poor" category, which contrasts strongly with the "very poor" clarity observed at the other two sites (Figure 21).

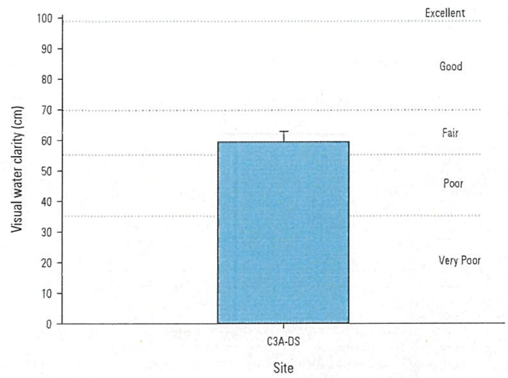
C7A-DS3, 13 September 2019 – dry weather

C7A-DS3, 14 March 2019 – wet weather

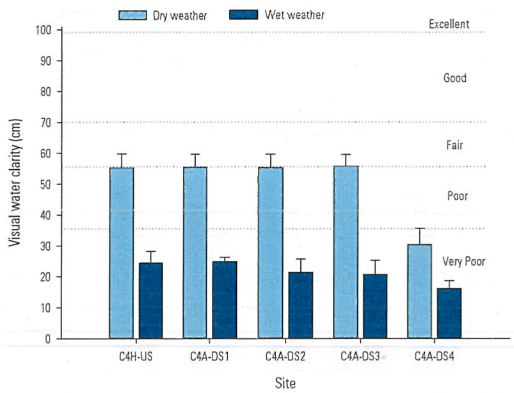
Figure 20 Representative images of Catchment 7 during dry weather conditions and wet weather events.



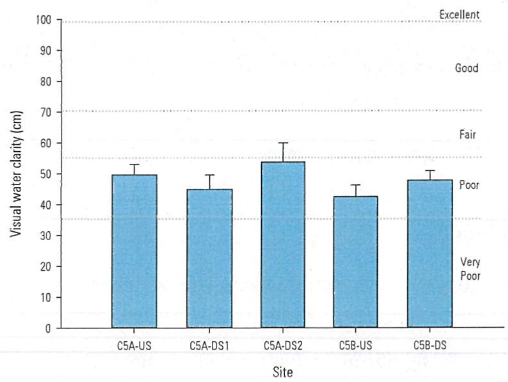

Catchment 2



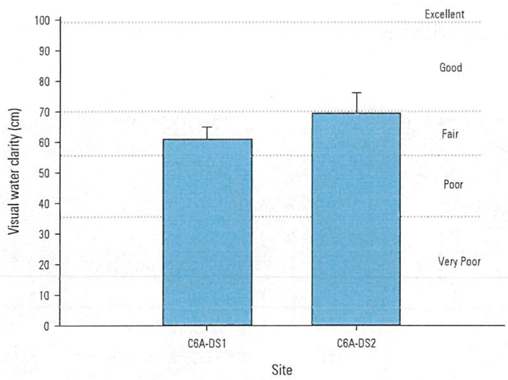

Catchment 3



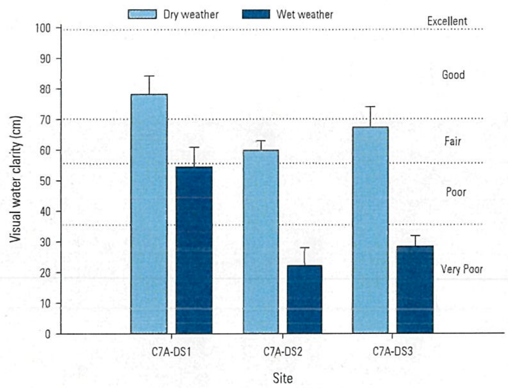

Catchment 4




Catchment 5




Catchment 6




Catchment 7

**Figure 21** Visual water clarity results from the 19 Te Ahu a Turanga baseline freshwater quality monitoring sites. Wet weather sampling was only undertaken in Catchments 2, 4, and 7, hence other catchment graphs only show dry weather data. Error bars are one standard error. Also shown are the Stream Health and Monitoring Assessment Kit (SHMAK) visual clarity interpretative categories to give context to the results.

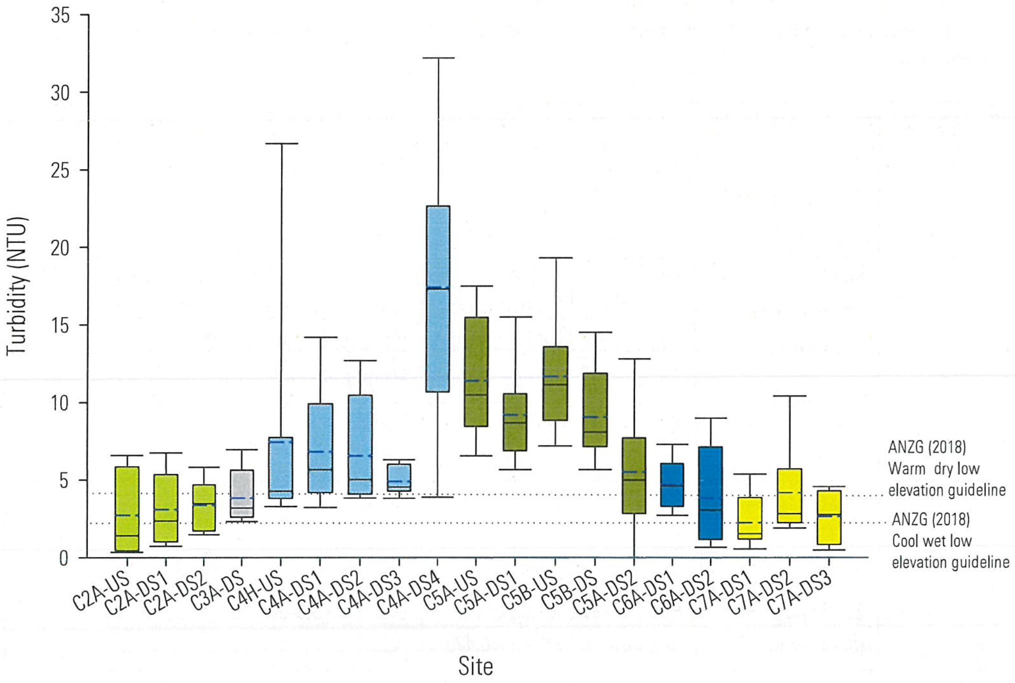
Table 4 Visual water clarity analysis of variance (ANOVA) results. Each catchment was analysed separately. Catchments 2, 4, and 7 had a second factor (sampling event) as they were the catchments where wet weather sampling was undertaken.

| Catchment | Factors | ANOVA Results | Pairwise Multiple Comparison Results |
|---|---|---|---|
| 2 | Site (three sites)<br>Sampling event<br>(dry or wet) | Site: F=0.03, p=0.969<br>Event: F=91.94, p<0.001<br>Site x Event: F=0.6, p=0.557 | Event: Dry>Wet |
| 4 | Site (five sites)<br>Sampling event<br>(dry or wet) | Site: F=3.4, p=0.016<br>Event: F=69.3, p<0.001<br>Site x Event: F=1.2, p=0.333 | Site: C4H-US>C4H-DS4, C4A-DS1>C4H-DS4, C4H-US=C4A-DS1= C4A-DS2= C4A-DS3, C4A-DS2= C4A-DS3=C4A-DS4<br>Event: Dry>Wet |
| 5 | Site (five sites) | Site: F=0.9, p=0.454 | None |
| 6 | Site (two sites) | Site: F=1.2, p=0.295 | None |
| 7 | Site (three sites)<br>Sampling event<br>(dry or wet) | Site: F=7.3, p=0.003<br>Event: F=35.8, p<0.001<br>Site x Event: F=0.8, p=0.479 | Site: C7A-DS1>C7A-DS2 =C7A-DS3<br>Event: Dry>Wet |

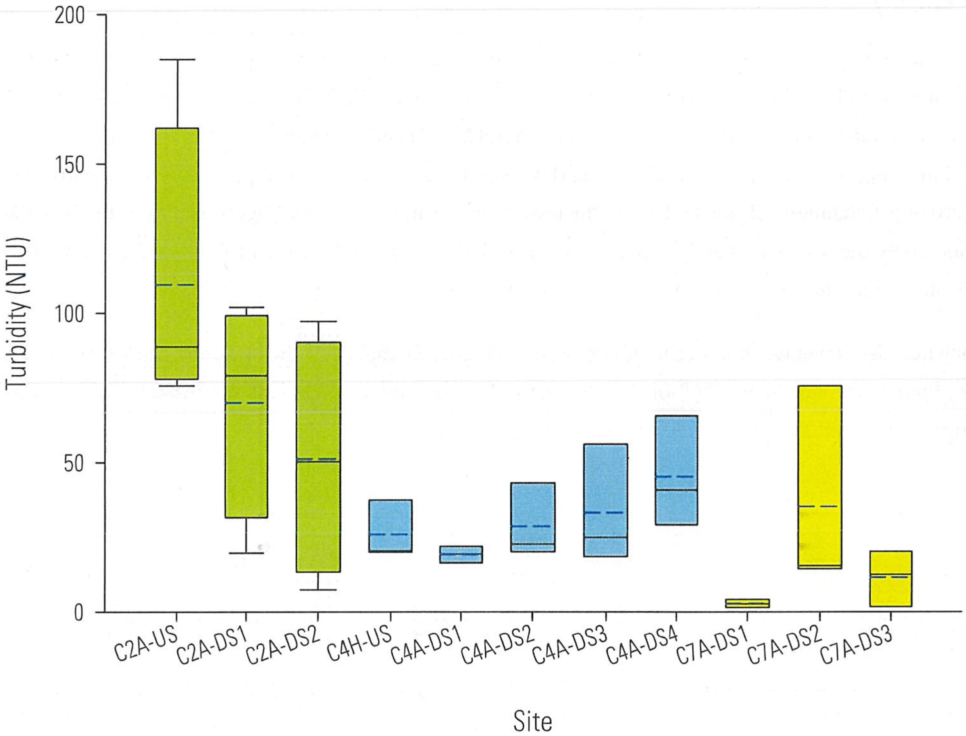
### 3.2.2 Turbidity

During dry weather there were some obvious catchment differences in turbidity, with Catchment 5 having a significantly greater overall turbidity than the other five catchments (Figure 22; Table 5). However, on a site by site basis, the downstream-most sampling site within Catchment 4 (C4A-DS4) had the highest overall turbidity during dry weather conditions. This is the result of this site being downstream of a large artificial pond that appears to have chronic high turbidity. Catchments 2, 3, 6 and 7 had the lowest dry weather turbidity (Figure 22). In terms of ANZG (2018) guidelines, only the upstream Catchment 2 site (C2A-US) and the three Catchment 7 sites were below their respective guideline values during dry weather conditions (Figure 22).

Based on a small number of wet weather events, Catchment 2 (Figure 22), especially the upstream site, tends to have higher turbidity than Catchments 4 and 7 (Table 5). The upstream-most site in Catchment 7 (C7A-DS1) had very low turbidity during wet weather compared to all other sample sites (Figure 22).




Dry weather sampling




Wet weather sampling

**Figure 22** Turbidity box and whisker plots from spot sampling during dry weather (N=8) and wet weather (Catchment 2: N=4, Catchment 4 & 7: N=3). The dry weather plot shows two guideline values from ANZG (2018); "warm, dry, low elevation" applies to Catchment 7, while "cool, dry, low elevation" applies to all other sampled catchments. These guidelines are not shown on the wet weather graph because of the larger range on the y-axis scale. The dashed blue lines show means.

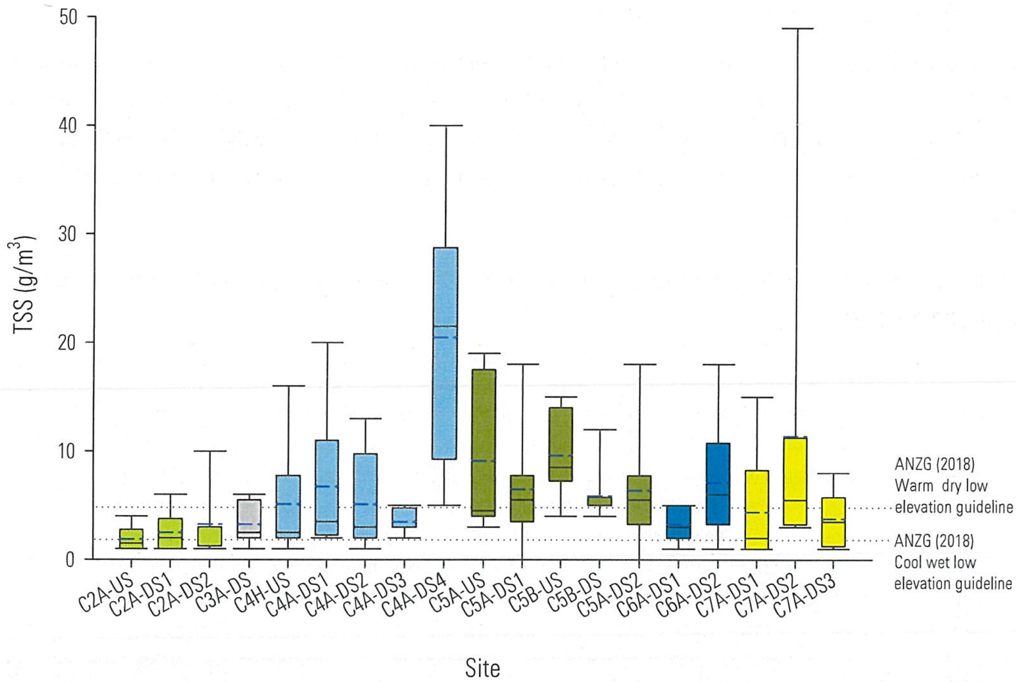
### 3.2.3 Total Suspended Solids

During dry weather conditions total suspended solids (TSS) were least in Catchment 2 and overall greatest in Catchment 5 (Figure 23). The only statistically significant differences were Catchments 4 and 5 having greater TSS concentrations than Catchment 2 (Table 5). As with turbidity, on a site by site basis, the downstream-most Catchment 4 site had higher TSS than all other sites (Figure 23). Only Catchment 2 and Catchment 7 had dry weather TSS below ANZG (2018) guidelines (Figure 23).

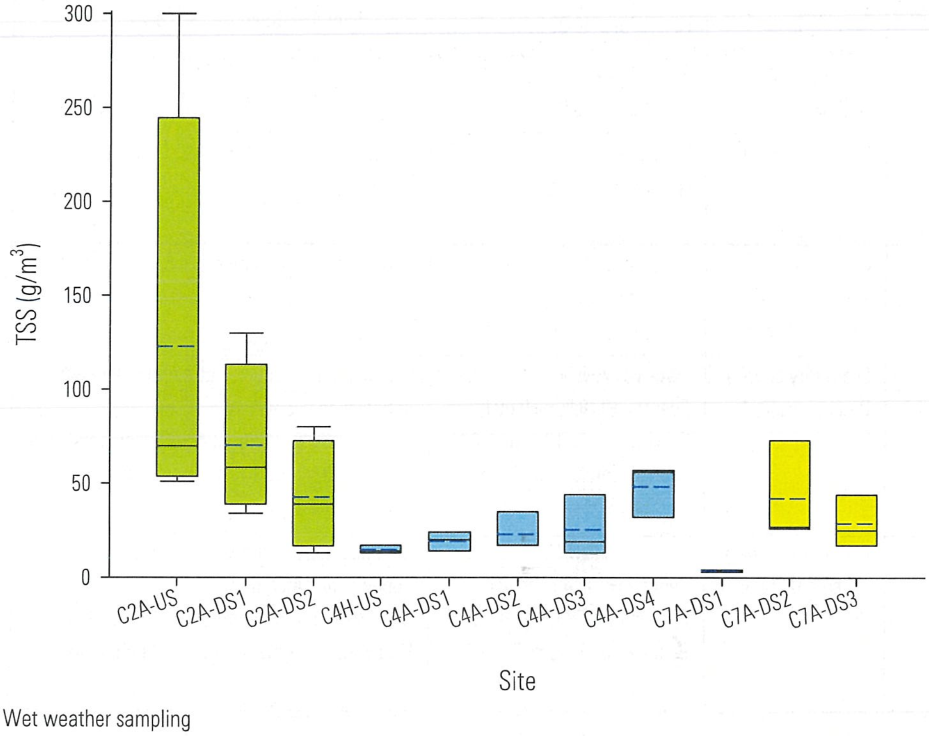
Based on limited wet weather sampling, during rain events Catchment 2 had significantly greater TSS than Catchments 4 and 7 (Figure 23, Table 5).

Table 5 Turbidity and total suspended solids (TSS) analysis of variance (ANOVA) results. Separate one-way ANOVA were completed for dry weather and wet weather data comparing catchments due to not all catchments having wet weather data. Additionally, two-way ANOVA with event (wet or dry) and catchment as the factors was undertaken. One-way ANOVAs did not meet the assumption of normality and equal variance despite data transformation; hence the non-parametric Kruskal-Wallis procedure was used. For pairwise comparison only those results with significant differences are shown – if a comparison between individual catchments is not shown, it can be assumed there is no difference.

| Test | Factors | ANOVA Results | Pairwise Multiple Comparison Results |
|---|---|---|---|
| Dry weather data (all sites) - turbidity | Catchment (2, 3, 4, 5, 6, 7) | Kruskal-Wallis H=67.93, p<0.001 | Catchment 5 > Catchments 2, 3, 4, 6, & 7; Catchment 4 > Catchments 2 & 7 |
| Dry weather data (all sites) - TSS | Catchment (2, 3, 4, 5, 6, 7) | Kruskal-Wallis H=34.38, p<0.001 | Catchment 5 > Catchment 2; Catchment 4 > Catchment 2 |
| Wet weather data (Catchment 2, 4, & 7 sites only) – turbidity | Catchment (2, 4, 7) | Kruskal-Wallis H=16.26, p<0.001 | Catchment 2 > Catchment 7 |
| Wet weather data (Catchment 2, 4, & 7 sites only) – TSS | Catchment (2, 4, 7) | Kruskal-Wallis H=11.34, p=0.003 | Catchment 2 > Catchment 4 & 7 |
| Dry & wet weather data (Catchment 2, 4, & 7 sites only) – turbidity | Event (dry or wet) Catchment (2, 4, 7) | Two-way ANOVA Event: F=148.5, p<0.001 Catchment: F=18.6, p<0.001 Event x Catchment: F=16.8, p<0.001 | Significant interaction - effect of catchment depends on event Dry weather: Catchment 4 > Catchments 2 & 7 Wet weather: Catchment 2 > Catchment 4 > Catchment 7 |
| Dry & wet weather data (Catchment 2, 4, & 7 sites only) – TSS | Event (dry or wet) Catchment (2, 4, 7) | Two-way ANOVA Event: F=138.4 p<0.001 Catchment: F=1.7, p=0.194 Event x Catchment: F=12.8, p<0.001 | Significant interaction - effect of event depends on catchment Dry weather: Catchments 4 & 7 > Catchment 2 Wet weather: Catchment 2 > Catchments 4 & 7 |




Dry weather sampling




Wet weather sampling

**Figure 23** Total suspended solids (TSS) box and whisker plots from spot sampling during dry weather (N=8) and wet weather (Catchment 2: N=4, Catchment 4 & &: N=3). The dry weather plot shows two guideline values from ANZG (2018); "warm, dry, low elevation" applies to Catchment 7, while "cool, dry, low elevation" applies to all other sampled catchments. These guidelines are not shown on the wet weather graph because of the larger range on the y-axis scale. The dashed blue lines show means.

### 3.2.4 Aluminium & pH

Combining all the catchments, pH had a mean of 7.55, a median of 7.5, and a range of 6.8–8.3 units. With the exception of a few measurements just below 7, pH data for all catchments generally fall within the 7–8.5 range of Schedule E of the One Plan for the relevant water management subzones. This indicates generally circumneutral conditions and the relevant toxicant guideline from ANZG (2018) for dissolved aluminium is for "Aluminium (pH >6.5)". For dissolved aluminium 60 out of the 109 water samples taken had concentrations below the laboratory detection limit of 0.016 $g/m^3$, indicating that much of the time, dissolved aluminium concentrations in the samples catchments are very low (Table 6). However, for all sampled catchments, with the exception of Catchment 3, on at least one occasion dissolved aluminium was above the 95% level of protection limit of 0.055 $g/m^3$ (Table 6). In Catchments 2 and 7, where both dry and wet data is available, this limit was only breached once out of 21 samples (dry and wet combined) in each catchment. In Catchment 4 (which also has dry and wet weather data), this limit was breached at all five sites, but only during wet weather events (Table 6). In Catchment 5, where only dry weather sampling was undertaken, the 0.055 $g/m^3$ limit was breached on one occasion at each the five monitoring sites. The upstream-most Catchment 6 site consistently had dissolved aluminium concentrations greater than this limit (i.e., three of four samples were above the limit) (Table 6).

It is important to note the default guideline values for "Aluminium (pH >6.5)" in ANZG (2018) have been designated as being of "low" reliability, which means they are not considered adequate for assessing water quality (see https://www.waterquality.gov.au/anz-guidelines/guideline-values/default/water-quality-toxicants for a full explanation of reliability criteria and implications). The default guideline value for "Aluminium (pH <6.5)" of 0.0008 $g/m^3$ has "unknown" reliability. Where construction phase monitoring involves measuring dissolved aluminium (i.e., monitoring of sediment retention pond discharge points where aluminium-containing flocculants are used) the 0.055 $g/m^3$ limit is therefore unreliable and likely not ecologically relevant. While the dissolved aluminium data collected is limited, it will be more relevant to derive any instream limits based on this catchment-specific data, rather than rely on an ANZG (2018) default guideline value of low reliability.

Total aluminium tended to be at higher concentrations during wet events in Catchments 2, 4, and 7, and this was more than likely the same in those other catchments which were not sampled during rain events (Table 6). This results from aluminium typically being bound to or contained within the minerals comprising the suspended fine sediments that are more prevalent during and after periods of rainfall. Aluminium is the most abundant metal in the Earth's crust and third most abundant element overall and is found within numerous minerals, hence its presence in the waterways within the project area is unremarkable.

**Table 6** Aluminium (dissolved and total) and pH spot sample data collected from the 19 Te Ahu a Turanga baseline water quality sites between December 2018 and September 2019. Mean, medians, and ranges are presented for pH and total aluminium. Much of the dissolved aluminium results were below the laboratory detection limit, so this data is presented as number of samples above this limit, raw values, and number of values greater than the toxicant 95% level of protection from ANZG (2018) (the relevant level for the relevant water management subzones from the One Plan). Dissolved aluminium values that are higher than that limit are highlighted with red text. Grey shading separates sites and bold lines separate catchments. For Catchments 2, 4, and 7 dry and wet results are shown on separate rows for each site.

| Site | N | pH | | | Aluminium – dissolved | | | Aluminium – total | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Median | Range | Samples above detection limit (0.016 $g/m^3$) | Raw values | Values >95% level of protection (0.055 $g/m^3$) | Mean | Median | Range |
| C2A-US Dry | 4 | 7.9 | 7.9 | 7.5–8.3 | 1 | 0.05 | 0 | 0.129 | 0.109 | 0.06–0.239 |
| C2A-US Wet | 3 | 7.5 | 7.4 | 7.4–7.8 | 2 | 0.027, 0.036 | 0 | 2.7 | 2.6 | 2.13–3.41 |
| C2A-DS1 Dry | 4 | 7.7 | 7.6 | 7.4–8 | 2 | 0.051, 0.016 | 0 | 0.129 | 0.115 | 0.042–0.245 |
| C2A-DS1 Wet | 3 | 7.5 | 7.4 | 7.3–7.9 | 2 | 0.041, 0.049 | 0 | 1.7 | 2.04 | 0.562–2.5 |
| C2A-DS2 Dry | 4 | 7.5 | 7.5 | 7.5 | 2 | 0.051, 0.03 | 0 | 0.1 | 0.1 | 0.041–0.145 |
| C2A-DS2 Wet | 3 | 7.5 | 7.4 | 7.2–8 | 2 | 0.023, 0.058 | 1 | 1.93 | 2.48 | 0.215–2.48 |
| C3A-DS Dry | 4 | 7.5 | 7.5 | 7.4–7.7 | 1 | 0.02 | 0 | 0.107 | 0.126 | 0.037–0.14 |
| C4H-US Dry | 5 | 7.2 | 7.1 | 6.9–7.6 | 1 | 0.031 | 0 | 0.149 | 0.137 | 0.038–0.3 |
| C4H-US Wet | 2 | 7.3 | 7.3 | 7.5–7.3 | 2 | 0.032, 0.062 | 1 | 0.927 | 0.927 | 0.654–1.2 |
| C4A-DS1 Dry | 5 | 7.3 | 7.3 | 7.1–7.6 | 1 | 0.022 | 0 | 0.211 | 0.144 | 0.064–0.548 |
| C4A-DS1 Wet | 2 | 7.25 | 7.25 | 7.2–7.3 | 2 | 0.036, 0.062 | 1 | 0.736 | 0.736 | 0.699–0.773 |
| C4A-DS2 Dry | 5 | 7.34 | 7.3 | 7.1–7.6 | 1 | 0.026 | 0 | 0.131 | 0.14 | 0.058–0.168 |
| C4A-DS2 Wet | 2 | 7.2 | 7.2 | 7.2 | 2 | 0.048, 0.062 | 1 | 0.134 | 0.134 | 0.771–1.91 |
| C4A-DS3 Dry | 5 | 7.36 | 7.3 | 7.2–7.7 | 0 | N/A | 0 | 0.155 | 0.168 | 0.086–0.196 |
| C4A-DS3 Wet | 2 | 7.15 | 7.15 | 7.1–7.2 | 2 | 0.062, 0.093 | 2 | 1.44 | 1.44 | 0.78–2.09 |
| C4A-DS4 Dry | 5 | 7.54 | 7.5 | 7.3–7.9 | 2 | 0.025, 0.031 | 0 | 0.615 | 0.697 | 0.349–0.901 |
| C4A-DS4 Wet | 2 | 7.35 | 7.35 | 7.3–7.4 | 2 | 0.042, 0.061 | 1 | 1.921 | 1.921 | 2.99–0.852 |

Table 6 continued

| Site | N | pH | | | Aluminium – dissolved | | | Aluminium – total | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Median | Range | Samples above detection limit (0.016 g/m$^3$) | Raw values | Values >95% level of protection (0.055 g/m$^3$) | Mean | Median | Range |
| C5A-US Dry | 4 | 7.08 | 7.05 | 6.8–7.4 | 2 | 0.108, 0.045 | 1 | 0.339 | 0.323 | 0.211–0.499 |
| C5A-DS1 Dry | 4 | 7.6 | 7.55 | 7.5–7.8 | 2 | 0.068, 0.038 | 1 | 0.348 | 0.337 | 0.231–0.475 |
| C5B-US Dry | 4 | 7.38 | 7.4 | 7.2–7.4 | 3 | 0.071, 0.035, 0.032 | 1 | 0.419 | 0.451 | 0.2–0.574 |
| C5B-DS Dry | 4 | 7.45 | 7.5 | 7.3–7.5 | 2 | 0.102, 0.04 | 1 | 0.355 | 0.366 | 0.282–0.405 |
| C5A-DS2 Dry | 4 | 7.7 | 7.65 | 7.5–8 | 2 | 0.062, 0.035 | 1 | 0.293 | 0.274 | 0.13–0.493 |
| C6A-DS1 Dry | 4 | 7.48 | 7.4 | 7.4–7.7 | 3 | 0.074, 0.058, 0.06 | 3 | 0.332 | 0.33 | 0.168–0.495 |
| C6A-DS2 Dry | 4 | 7.63 | 7.65 | 7.4–7.8 | 1 | 0.056 | 1 | 0.263 | 0.233 | 0.129–0.457 |
| C7A-DS1 Dry | 5 | 7.84 | 7.8 | 7.7–8 | 3 | 0.06, 0.021, 0.02 | 1 | 0.130 | 0.087 | 0.051–0.28 |
| C7A-DS1 Wet | 2 | 7.9 | 7.9 | 7.9 | 0 | N/A | 0 | 0.078 | 0.078 | 0.051–0.105 |
| C7A-DS2 Dry | 5 | 8.08 | 8.1 | 8–8.2 | 2 | 0.053, 0.016 | 0 | 0.117 | 0.101 | 0.054–0.226 |
| C7A-DS2 Wet | 2 | 8.05 | 8.05 | 8–8.1 | 0 | N/A | 0 | 0.499 | 0.499 | 0.483–0.515 |
| C7A-DS3 Dry | 5 | 8.06 | 8.1 | 8–8.1 | 2 | 0.052, 0.023 | 0 | 0.116 | 0.091 | 0.065–0.205 |
| C7A-DS3 Wet | 2 | 8.05 | 8.05 | 7.9–8.2 | 0 | N/A | 0 | 0.489 | 0.489 | 0.342–0.636 |

## 3.3 Aquatic Macroinvertebrates

### 3.3.1 Overview

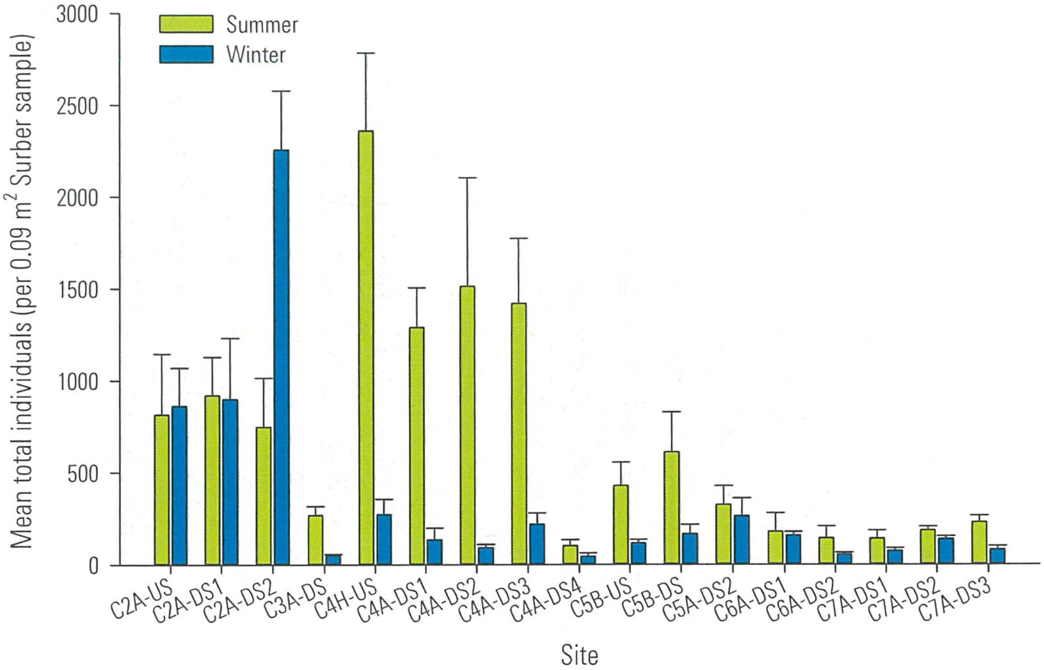
A total of 103 macroinvertebrate taxa were found across the six catchments and 17 sites sampled in summer (February 2019) and winter (May (Catchment 2 only) and June 2019) as part of the TAaT baseline freshwater quality monitoring programme. The most diverse groups were the two-winged flies (Diptera: 29 taxa), caddisflies (Trichoptera: 22 taxa), mayflies (Ephemeroptera: 8 taxa), stoneflies (Plecoptera: 8 taxa), molluscs (Mollusca: 7 taxa), crustaceans (Crustacea: 6 taxa), beetles (Coleoptera: 6 taxa), true bugs (Hemiptera: 5 taxa), and dragonflies/damselflies (Odonata: 3 taxa). Groups represented by one taxon included mites (Acarina), Cnidaria (hydrozoans), springtails (Collembola), leeches (Hirudinea), nematode worms (Nematoda), proboscis worms (Nemertea), worms (Oligochaeta), flatworms (Platyhelminthes), and dobsonflies (Megaloptera).

The overall community was dominated by the freshwater snail *Potamopyrgus antipodarum* (44%). Eleven other taxa had relative abundances greater than 1%: *Deleatidium* mayflies (7%), Elmidae beetles (6%), Talitridae amphipods (4%), oligochaete worms (4%), *Paracalliope fluviatilis* amphipods (3%), Orthocladiinae midge larvae (3%), Tanytarsini midge larvae (3%), *Archichauliodes diversus* dobsonfly larvae (2%), *Hydropsyche* caddisfly larvae (2%), *Physa* snails (2%), and Copepod crustaceans (2%). The other 91 taxa collectively accounted for the remaining 18% of all macroinvertebrates captured.

In summer, macroinvertebrate densities were far greater at four of the five Catchment 4 sites, followed by the three Catchment 2 sites, than at all other sites (Figure 24). With the exception of Catchment 2, densities were lower in winter, likely as a result of a large rain event that induced bed movement at some sites in mid-June (note the Catchment 2 winter sampling occurred prior to this rain event). Likewise, taxa richness tended to be greater in summer than in winter, except for Catchment 2 (Figure 24).

MCI-hb scores were lowest in Catchment 4 and highest in those sites with forest cover in Catchment 3 (C3A-DS), Catchment 5 (C5A-DS2), Catchment 6 (C6A-DS2), and Catchment 7 (C7A-DS1, C7A-DS2) (Figure 25). Catchment 3, 5, 6, and 7 all tend to have MCI-hb scores greater than the One Plan Schedule E target of 100 for the relevant water management zone (Figure 25). Four of the five Catchment 4 sites had particularly low MCI-hb scores (either "poor" or just within the "fair" category). There was some variation in MCI-hb scores within sites between summer and winter sampling, and although these did transcend the interpretative categories of Stark & Maxted (2007b), the same general differences among sites persisted (Figure 25). QMCI-hb scores showed similar trend to those of the MCI-hb, however because QMCI takes into account the number of individuals rather than just presence-absence, there were some quite large differences between summer and winter samples within sites (Figure 25). This results from some taxa being more resistant and/or resilient to the effects of large flow events, with winter samples containing a higher proportion of such taxa.

EPT taxa richness and percentage EPT individuals were clearly least at the Catchment 4 sites (Figure 26). EPT taxa richness was greatest at two Catchment 2 sites (C2A-US, C2A-DS1), one Catchment 5 site (C5A-DS2), and was particularly high at the C7A-DS2 Catchment 7 site during the winter sampling (Figure 26). EPT percentage individuals were generally highest in Catchments 3, 5, 6, and 7, with values typically being greater during the winter sampling (Figure 26).



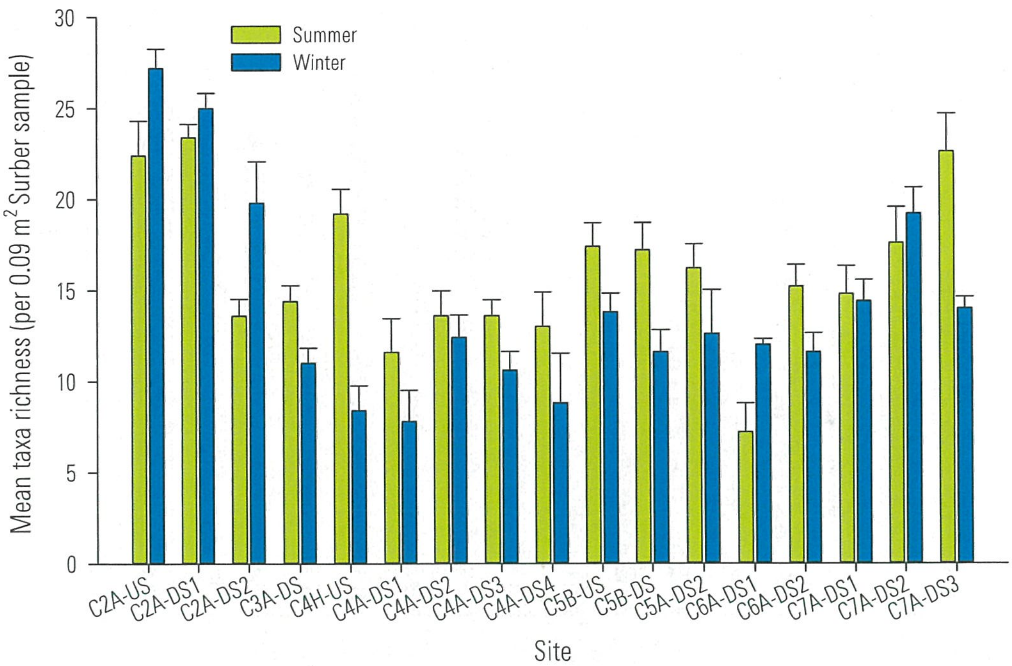
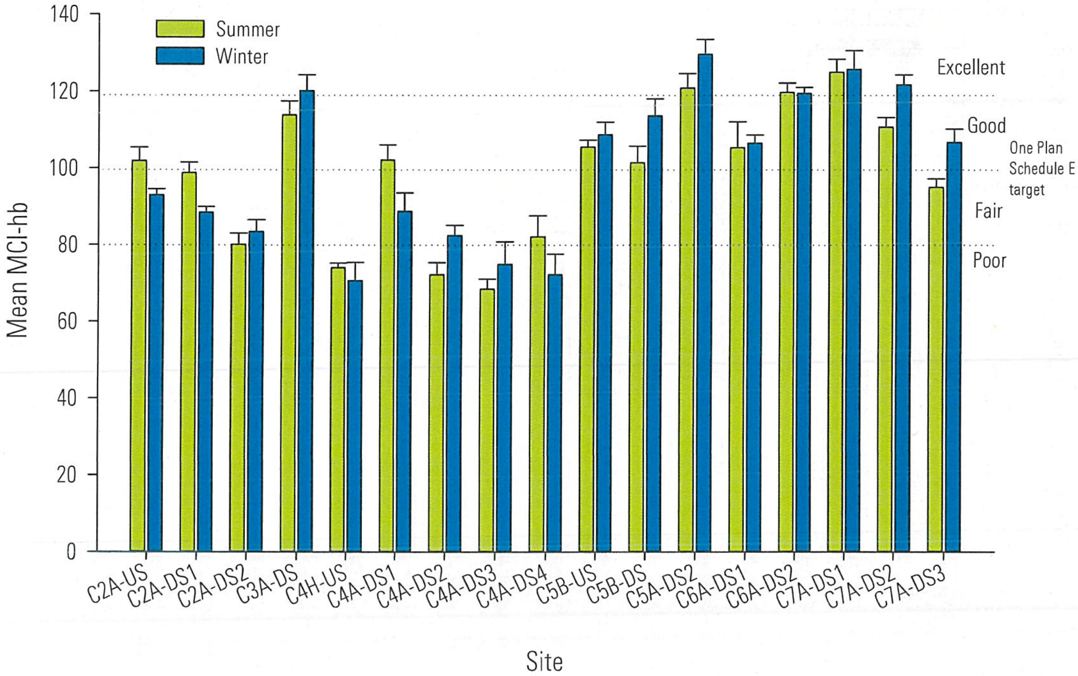




Figure 24 Mean total individual densities and taxa richness for the 17 Te Ahu a Turanga baseline water quality sites where macroinvertebrates were sampled by EOS Ecology in summer (February) and winter (May (Catchment 2 only) and June) 2019. Error bars are one standard error.



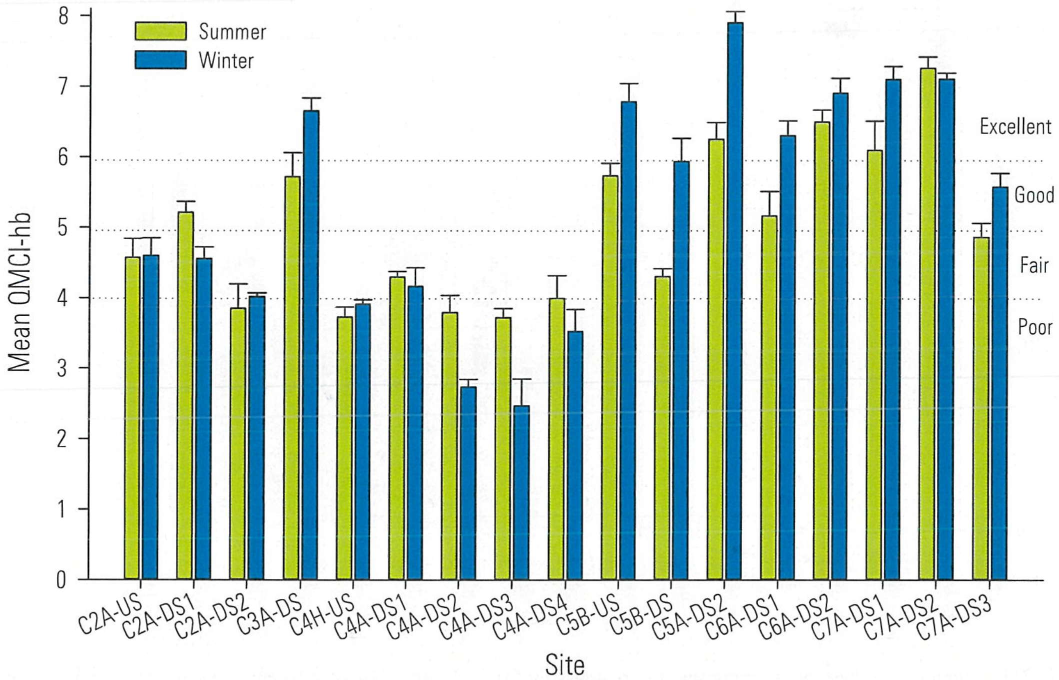
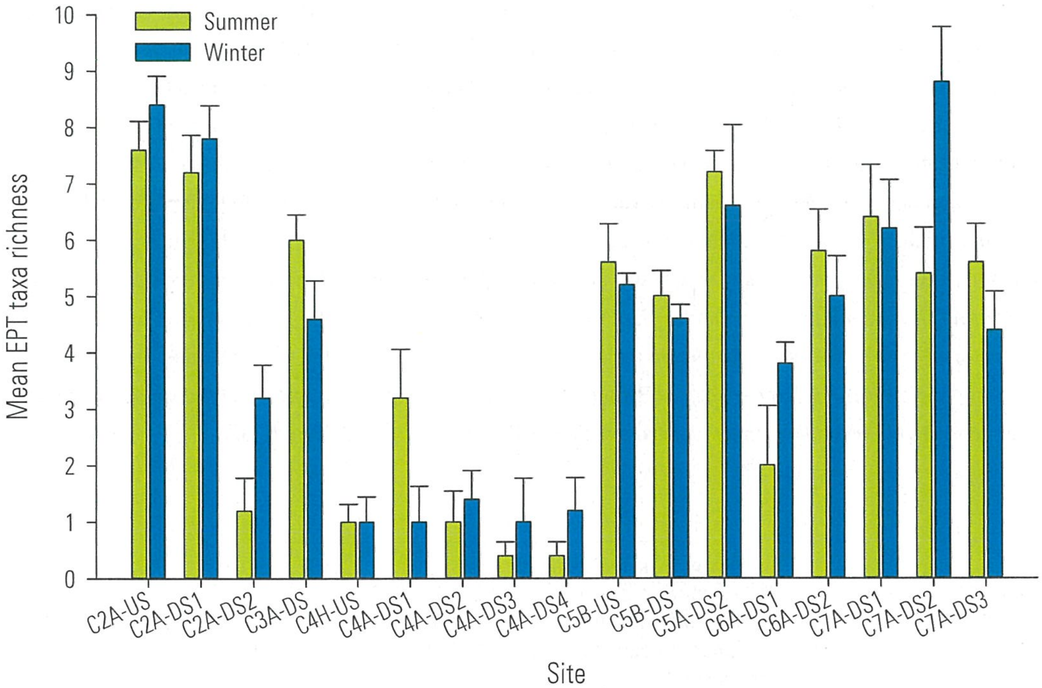




**Figure 25** Mean MCI-hb and QMCI-hb scores for the 17 Te Ahu a Turanga baseline water quality sites where macroinvertebrates were sampled by EOS Ecology in summer (February) and winter (May (Catchment 2 only) and June) 2019. Error bars are one standard error.



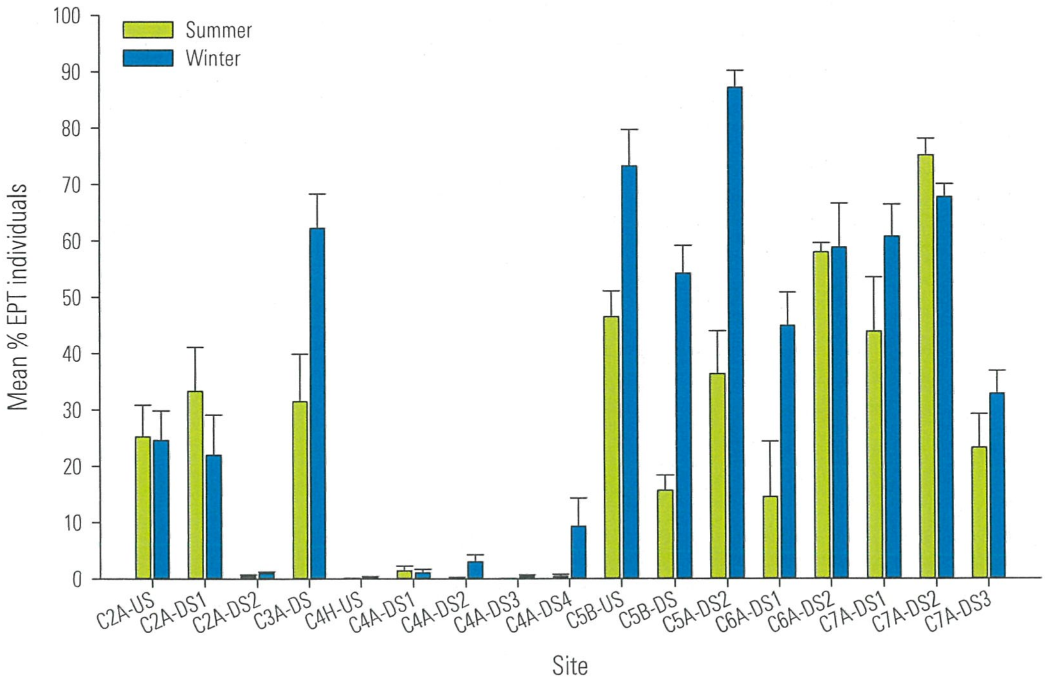




**Figure 26** Mean EPT taxa richness and percentage EPT individuals for the 17 Te Ahu a Turanga baseline water quality sites where macroinvertebrates were sampled by EOS Ecology in summer (February) and winter (May (Catchment 2 only) and June) 2019. Error bars are one standard error.

NMS ordination combining all sites and sampling occasions (summer and winter) effectively split the catchments into three groupings: Catchment 2; Catchment 4; and the other four catchments (Figure 27). Two-way ANOSIM with season and catchment as factors showed a significant difference with relatively high strength for catchment ($R=0.69$, $p=0.001$) but no effect of season ($R=0.018$, $p=0.32$). SIMPER analysis of three community groupings identified by NMS ordination indicated Catchment 2 was separated from Catchment 4 samples predominantly as a result of higher densities of Elmidae and *Berosus* beetle larvae, Tanytarsini and Orthocladiinae midge larvae, *Hydropsyche* (*Aoteapsyche*) caddisfly larvae, *Deleatidium* mayflies, and *Physa* snails in Catchment 2. Catchment 2 was separated from the other four catchments mostly as a result of having higher densities of Elmidae and *Berosus* beetle larvae, Tanytarsini and Orthocladiinae midge larvae, *Hydropsyche* (*Aoteapsyche*) caddisfly larvae, and *Potamopyrgus* and *Physa* snails, and lower densities of *Deleatidium* mayflies. Catchment 4 was separated from the other four catchments predominantly as a result of higher densities of *Potamopyrgus* snails, oligochaete worms, and *Paracalliope* amphipods and lower densities of *Deleatidium* and *Zephlebia* mayflies, and *Archichauliodes* dobsonfly larvae.

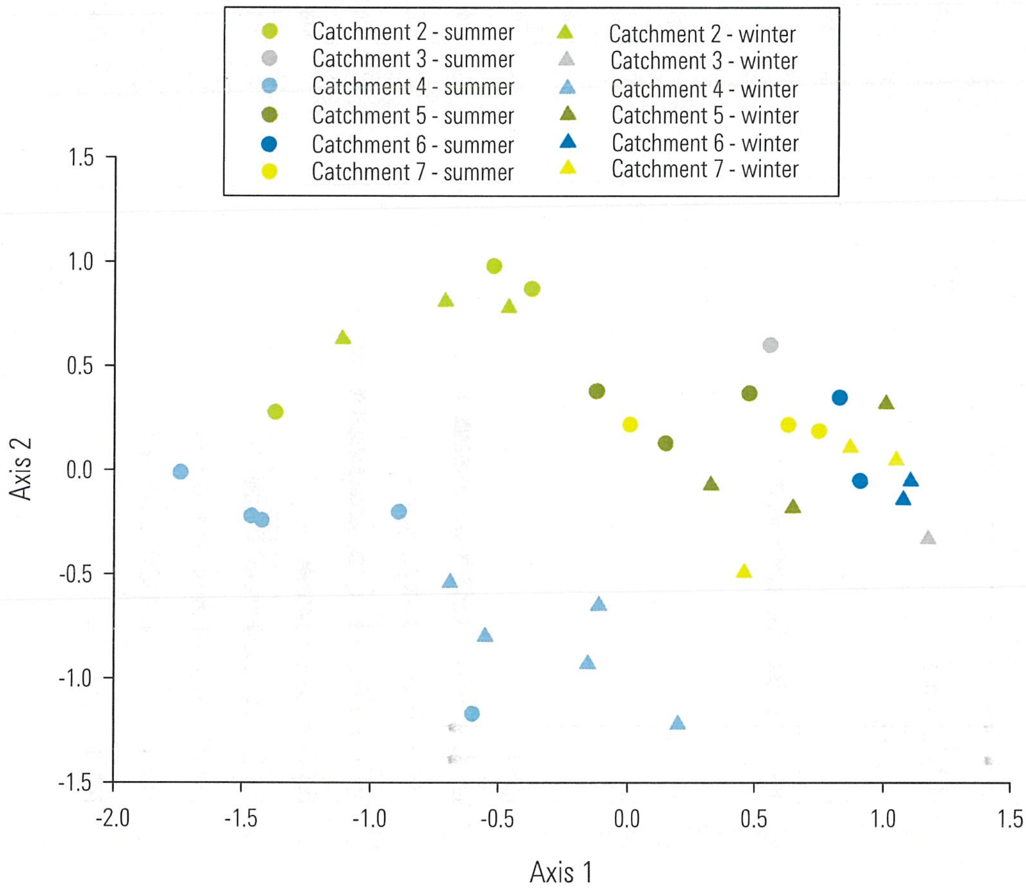



Figure 27 Non-metric multidimensional scaling ordination of macroinvertebrates samples collected from 17 baseline monitoring sites, across six catchments in summer and winter. Each data point represents the pooled community data from five Surber samples (0.45 m²) taken from a single site. The ordination had a stress value of 0.12, which is indicative of a plot that "can still correspond to a usable picture", although "Too much reliance should not be placed on details of the plot" (Clarke, 1993).

### 3.3.2 Catchment 2

Catchment 2 was generally dominated by taxa with some tolerance to deposited fine sediments, although some common taxa such as *Deleatidium* mayflies might be expected to decline if deposition was elevated to a point that even faster flowing riffle habitat became smothered by fine sediments (Figure 28). Elmidae riffle beetle larvae were particularly prevalent at all three sites. During the summer sampling the downstream-most site (C2A-DS2) had ceased flowing such that riffles were dry, and the site consisted of large isolated pools from where the samples were collected. This is likely why oligochaetes and *Sigara* water boatman were so prevalent at this time (Figure 28). While riffles were flowing again by the time of the winter sampling, this period of drying likely had some effect on the macroinvertebrate assemblage present then. The downstream-most C2A-DS2 site also had lower MCI and QMCI scores, and EPT richness and percentage individuals than the other two Catchment 2 sites (Figure 25, Figure 26). The MCI scores of site C2A-DS2 were just into the "fair" category, while QMCI scores were around the "poor" to "fair" boundary. The other two sites were well into the "fair" category with the C2A-US and C2A-DS1 sites in the "good" category during summer (Figure 25).

| C2A-US | | C2A-DS1 | | C2A-DS2 | |
|---|---|---|---|---|---|
| Summer | Winter | Summer | Winter | Summer | Winter |
| <br>Elmidae beetle larvae (576, 14%) | <br>*Potamopyrgus* snails (916, 21%) | <br>Elmidae (1284, 28%) | <br>*Potamopyrgus* (1599, 36%) | <br>*Potamopyrgus* (2286, 61%) | <br>*Potamopyrgus* (7088, 63%) |
| <br>Tanytarsini midge larvae (573, 14%) | <br>Elmidae (745, 17%) | <br>*Hydropsyche* caddis larvae (739, 16%) | <br>Elmidae (1057, 24%) | <br>Elmidae (347, 9%) | <br>Elmidae (1428, 13%) |
| <br>*Hydropsyche* (513, 13)% | <br>Tanytarsini (731, 17%) | <br>Acarina mites (409, 9%) | <br>*Hydropsyche* (288, 6%) | <br>*Berosus* beetle larvae (311, 8%) | <br>Tanytarsini (672, 6%) |
| <br>*Potamopyrgus* (505, 12%) | <br>*Deleatidium* mayfly nymphs (289, 7%) | <br>*Deleatidium* (409, 9%) | <br>*Physa* snails (191, 4%) | <br>Oligochaeta worms (175, 5%) | <br>*Physa* (648, 6%) |
| <br>Orthocladiinae (451, 11%) | <br>*Hydropsyche* (225, 5%) | <br>*Berosus* beetle larvae (322, 7%) | <br>Tanytarsini (163, 4%) | <br>*Sigara* (141, 4%) | <br>Orthocladiinae (304, 3%) |

**Figure 28** The five most abundant macroinvertebrate taxa in Catchment 2 during summer and winter sampling at each site. The values shown are the total densities from five Surber samples (0.45 m2) and the percentage relative abundance. The *Hydropsyche* caddisfly larvae present would have been *Aoteapsyche* prior to the reclassification of New Zealand hydropsychidae genera by Geraci et al. (2010).

### 3.3.3 Catchment 3

The Catchment 3 site was dominated by a mix of taxa tolerant (e.g., Talitridae amiphipods, *Potamopyrgus* snails) and relatively intolerant (e.g., *Hydropsyche* caddisflies and *Deleatidium* mayflies) of elevated fine sediment deposition (Figure 29). Four of the five dominant taxa were common between the summer and winter samplings. MCI and QMCI scores were indicative of "good" conditions in summer, with this raising to "excellent" in winter (Figure 25). Catchment 3, with full forest cover for much of its length, is one of the higher quality waterways affected by the project.

| C3A-US | |
|---|---|
| Summer | Winter |
| <br>Talitridae amphipods (362, 27%) | <br>*Zephlebia* (108, 43%) |
| <br>*Potamopyrgus* snails (220, 16%) | <br>*Archichauliodes* (40, 16%) |
| <br>*Zephlebia* mayflies (187, 14%) | <br>Talitridae (22, 9%) |
| <br>*Archichauliodes* dobsonfly larvae (168, 13%) | <br>*Hydropsyche* (21, 8%) |
| <br>*Hydropsyche* caddisfly larvae (111, 8%) | <br>*Deleatidium* mayfly (11, 4%) |

Figure 29 The five most abundant macroinvertebrate taxa at the sampling site in Catchment 3 during summer and winter. The values shown are the total densities from five Surber samples (0.45 m$^2$) and the percentage relative abundance. The *Hydropsyche* caddisfly larvae present would have been *Orthopsyche* prior to the reclassification of New Zealand hydropsychidae genera by Geraci *et al.* (2010).

### 3.3.4 Catchment 4

Catchment 4 was dominated by taxa that are tolerant of or prefer habitat with high deposited fine sediment cover such as *Potamopyrgus* snails, amphipods, and oligochaete worms (Figure 30). During the summer sampling in late February 2019, riffles had ceased flowing at the upstream site (C4H-US) such that surface water existed as isolated pooled areas. At this time taxa that prefer slow flowing or still waters were prominent (i.e., Copepoda and Cladocera crustaceans, and Culicidae mosquito larvae) (Figure 30). Catchment 4 had some of the highest macroinvertebrate densities of all the sampling sites in summer, with high abundances of *Potamopyrgus* snails accounting for much of this (Figure 24, Figure 30). Overall, Catchment 4 had the lowest taxa richness, among the lowest MCI and QMCI scores (generally indicative of "fair" to "poor" conditions), and the lowest EPT taxa richness and percentage of EPT individuals of all the sampled catchments (Figure 24, Figure 25, Figure 26). Catchment 4 has been degraded by agricultural land use and for much of its length is unfenced and subject to disturbance by sheep and cattle.

| C4H-US | | C4A-DS1 | | C4A-DS2 | |
|---|---|---|---|---|---|
| Summer | Winter | Summer | Winter | Summer | Winter |
| <br>*Potamopyrgus* snails<br>(7284, 62%) | <br>*Potamopyrgus*<br>(1222, 90%) | <br>*Potamopyrgus*<br>(4250, 66%) | <br>*Potamopyrgus*<br>(444, 66%) | <br>*Potamopyrgus*<br>(4555, 60%) | <br>Oligochaeta<br>(132, 29%) |
| <br>Copepoda<br>crustacean<br>(1064, 9%) | <br>Talitridae<br>amphipods<br>(29, 2%) | <br>Talitridae<br>(1829, 28%) | <br>Talitridae<br>(124, 18%) | <br>*Paracalliope*<br>(1476, 20%) | <br>Orthocladiinae<br>midge larvae<br>(95, 21%) |
| <br>Culicidae mosquito<br>larvae (848, 7%) | <br>Oligochaeta<br>(28, 2%) | <br>*Microvelia* water<br>strider<br>(78, 1%) | <br>Oligochaeta<br>(44, 7%) | <br>Physa<br>(328, 4%) | <br>*Potamopyrgus*<br>(89, 19%) |
| <br>Oligochaeta worms<br>(656, 6%) | <br>Copepoda<br>(21, 2%) | <br>*Paracalliope*<br>amphipods<br>(69, 1%) | <br>*Microvelia*<br>(11, 2%) | <br>*Xanthocnemis*<br>damselfly larvae<br>(313, 4%) | <br>*Polypedilum* midge<br>larvae (25, 5%) |
| <br>Cladocera<br>crustaceans<br>(433, 4%) | <br>Ferrissia limpets<br>(17, 1%) | <br>Oligochaeta<br>(37, 1%) | <br>Acarina (9, 1%) | <br>Oligochaeta<br>(202, 3%) | <br>*Austrosimulium*<br>sandfly larvae<br>(17, 4%) |

**Figure 30** The five most abundant macroinvertebrate taxa in Catchment 4 during summer and winter sampling at each site. The values shown are the total densities from five Surber samples (0.45 m²) and the percentage relative abundance.

| C4A-DS3 | | C4A-DS4 | |
|---|---|---|---|
| Summer | Winter | Summer | Winter |
|  *Potamopyrgus* (4326, 61%) |  Oligochaeta (685, 63%) |  *Paracalliope* (197, 39%) |  *Potamopyrgus* (53, 25%) |
|  *Paracalliope* (773, 11%) |  *Potamopyrgus* (295, 27%) |  *Potamopyrgus* (44, 9%) |  *Acroperla* stonefly nymph (28, 13%) |
|  Oligochaeta (600, 8%) |  Hexatomini fly larvae (16, 1%) |  Oligochaeta (40, 8%) |  Oligochaeta (24, 11%) |
|  Nematoda worms (400, 6%) |  *Austrosimulium* (13, 1%) |  *Microvelia* (38, 8%) |  *Paracalliope* (16, 8%) |
|  Ostracoda crustacean (344, 5%) |  Nematoda (12, 1%) |  *Anisops* backswimmers (33, 7%) |  Orthocladiinae (14, 7%) |

**Figure 30 continued**

### 3.3.5 Catchment 5

In Catchment 5 several macroinvertebrate taxa that prefer relatively high quality instream habitat with clean, stony substrates are found among the five most abundant taxa, including *Deleatidium, Coloburiscus*, and *Neozephlebia* mayflies and *Archichauliodes* dobsonfly larvae (Figure 31). Catchment 5 has among the highest MCI and QMCI scores (generally indicative of "good" to "excellent" conditions), EPT taxa richness, and percentage of EPT individuals of the sampled sites (Figure 25, Figure 26). The downstream-most site (C5A-DS2), which was within the forested Manawatū Gorge Scenic Reserve, tended to have higher MCI, QMCI, and EPT taxa richness values than the two other sites, which were within farmland (Figure 25, Figure 26).

| C5B-US | | C5B-DS | | C5A-DS2 | |
|---|---|---|---|---|---|
| Summer | Winter | Summer | Winter | Summer | Winter |
| <br>*Deleatidium* mayfly nymphs (785, 37%) | <br>*Deleatidium* (315, 55%) | <br>*Potamopyrgus* (1325, 43%) | <br>*Deleatidium* (263, 32%) | <br>*Archichauliodes* (563, 35%) | <br>*Deleatidium* (738, 56%) |
| <br>*Potamopyrgus* snails (726, 34%) | <br>*Zephlebia* (84, 15%) | <br>Orthocladiinae (587, 19%) | <br>*Potamopyrgus* (260, 31%) | <br>*Deleatidium* (360, 22%) | <br>*Coloburiscus* (267, 20%) |
| <br>Orthocladiinae midge larvae (111, 5%) | <br>*Potamopyrgus* (63, 11%) | <br>*Archichauliodes* dobsonfly larvae (399, 13%) | <br>*Zephlebia* (77, 9%) | <br>*Potamopyrgus* (322, 20%) | <br>*Zephlebia* (49, 4%) |
| <br>*Zephlebia* mayfly larvae (102, 5%) | <br>Talitridae (23, 4%) | <br>*Deleatidium* (284, 9%) | <br>Oligochaeta worms (76, 9%) | <br>*Polypedilum* (127, 8%) | <br>*Neozephlebia* (48, 4%) |
| <br>Talitridae amphipods (75, 4%) | <br>*Coloburiscus* mayfly larvae (23, 4%) | <br>*Polypedilum* midge larvae (146, 5%) | <br>*Coloburiscus* (42, 5%) | <br>*Coloburiscus* (56, 3%) | <br>*Hydropsyche* caddisfly (47, 4%) |

**Figure 31** **The five most abundant macroinvertebrate taxa in Catchment 5 during summer and winter sampling at each site. The values shown are the total densities from five Surber samples (0.45 m²) and the percentage relative abundance. The *Hydropsyche* caddisfly larvae present would have been *Orthopsyche* prior to the reclassification of New Zealand hydropsychidae genera by Geraci *et al.* (2010).**

### 3.3.6 Catchment 6

Among the five most abundant taxa in Catchment 6 were some that prefer a clean, stony substrate, and good water quality including *Deleatidium* mayflies, *Hydropsyche* (*Orthopsyche*) caddisflies, *Archichauliodes* dobsonfly larvae, and Eriopterini cranefly larvae (Figure 32). Catchment 6 has among the highest MCI and QMCI scores (generally indicative of "good" to "excellent" conditions), EPT taxa richness, and percentage of EPT individuals of the sampled sites (Figure 25, Figure 26). The downstream-most site (C6A-DS2), which was within the forested Manawatū Gorge Scenic Reserve, tended to have higher MCI, QMCI, and EPT taxa richness values than the other site, which was within former farmland that has now been fenced but remains subject to periodic stock access (authors pers. ob.) (Figure 25, Figure 26).

| C6A-DS1 | | C6A-DS2 | |
|---|---|---|---|
| Summer | Winter | Summer | Winter |
|  Talitridae amphipods (462, 52%) |  Talitridae (347, 44%) |  *Deleatidium* (253, 35% |  *Deleatidium* (89, 34%) |
|  *Deleatidium* mayfly nymphs (275, 31%) |  *Deleatidium* (236, 30%) |  *Polypedilum* (85, 12%) |  Eriopterini (32, 12%) |
|  *Polypedilum* midge larvae (42, 5%) |  *Zephlebia* (85, 11%) |  Orthocladiinae (77, 11%) |  *Zephlebia* (30, 11%) |
|  Orthocladiinae midge larvae (24, 3%) |  Eriopterini (32, 4%) |  *Hydropsyche* caddisfly (52, 7%) |  Orthocladiinae (17, 6%) |
|  *Zephlebia* mayfly larvae (24, 3%) |  *Hydropsyche* caddisfly (18, 2%) |  *Archichauliodes* (46, 6%) |  *Archichauliodes* (15, 6%) |

Figure 32 The five most abundant macroinvertebrate taxa in Catchment 6 during summer and winter sampling at each site. The values shown are the total densities from five Surber samples (0.45 m²) and the percentage relative abundance. The *Hydropsyche* caddisfly larvae present would have been *Orthopsyche* prior to the reclassification of New Zealand hydropsychidae genera by Geraci *et al.* (2010).

### 3.3.7 Catchment 7

As with Catchments 5 and 6, among the five most abundant taxa in Catchment 7 were some that require relatively high water quality and a clean, stony substrate. These include *Deleatidium* and *Coloburiscus* mayflies and *Archichauliodes* dobsonfly larvae (Figure 33). Catchment 7, in particular the upstream-most two sites, had among the highest MCI and QMCI scores, EPT taxa richness, and percentage of EPT individuals of the sampled sites (Figure 25, Figure 26). In Catchment 7, the upstream-most site (C7A-DS1) was within a fenced, forested gully within a QEII covenanted area, and was the most pristine site of the 19 baseline sampling sites.

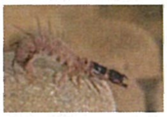
| C7A-DS1 | | C7A-DS2 | | C7A-DS3 | |
|---|---|---|---|---|---|
| Summer | Winter | Summer | Winter | Summer | Winter |
|  *Deleatidium* mayfly nymphs (159, 23%) |  *Hydropsyche* caddisfly (78, 21%) |  *Deleatidium* (592, 64%) |  *Deleatidium* (289, 42%) |  *Potamopyrgus* (440, 38%) |  *Potamopyrgus* (111, 28%) |
|  Talitridae amphipod (110, 16%) |  *Deleatidium* (67, 18%) |  *Coloburiscus* (65, 7%) |  *Archichauliodes* (62, 9% |  *Deleatidium* (224, 20%) |  *Deleatidium* (102, 26%) |
|  *Polypedilum* midge larvae (61, 9%) |  Talitridae (45, 12%) |  *Archichauliodes* (54, 6%) |  *Coloburiscus* (53, 8%) |  Orthocladiinae (108, 9%) |  *Paracalliope* (83, 21%) |
|  *Archichauliodes* dobsonfly larvae (58, 8%) |  *Coloburiscus* mayfly larvae (39, 11%) |  *Potamopyrgus* snails (42, 5%) |  Talitridae (47, 7%) |  *Archichauliodes* (80, 7%) |  *Acroperla* stonefly nymph (12, 3%) |
|  Orthocladiinae midge larvae (51, 7%) |  *Zephlebia* mayfly larvae (35, 9%) |  Elmidae beetle larvae (25, 3%) |  *Zephlebia* (46, 7%) |  *Oxyethira* caddisfly larvae (32, 3%) |  *Austrosimulium* sandfly larvae (12, 3%) |

**Figure 33** **The five most abundant macroinvertebrate taxa in Catchment 7 during summer and winter sampling at each site. The values shown are the total densities from five Surber samples (0.45 m²) and the percentage relative abundance. The *Hydropsyche* caddisfly larvae present would have been *Orthopsyche* prior to the reclassification of New Zealand hydropsychidae genera by Geraci *et al.* (2010).**

# 4 CONSTRUCTION PHASE MONITORING RECOMMENDATIONS

## 4.1 Deposited Fine Sediment

From an ecological perspective, deposited fine sediment is far more likely to have adverse impacts on freshwater ecology than relatively short periods of elevated suspended fine sediment. Hence, we recommend the monitoring of fine deposited sediment during construction. However, as some catchments are already impacted by elevated sediment deposition as a result of agricultural land use (Figure 34), any construction phase monitoring programme will need to carefully consider site location and monitoring methodology. For example, with only Catchment 7 consistently having median values below the One Plan Schedule E target prior to construction (Figure 34), it would not be realistic to use this target as a construction phase limit. The figures in Section 3.1 indicate how deposited fine sediment may vary over time and be particularly impacted by larger flow events. This indicates simple upstream – downstream monitoring of a particular worksite or discharge is very unlikely to be useful as results will be confounded by high rainfall events. For those sites that do not have medians at or very near 100% cover, we recommend the use of site and/or catchment-specific fine sediment criteria based on the data collected by the baseline monitoring programme (e.g. 80th percentile). For those catchments with very high existing fine sediment coverage, such as Catchment 2 and 4, it will not be realistic to use a visual fine sediment percentage cover methodology. If deposited fine sediment monitoring is desirable at such sites then an alternate method such as the resuspendible sediment (Quorer method) or sediment depth methods may be more suitable (SAM-4 and SAM-6 in Clapcott *et al.* (2011), respectively).

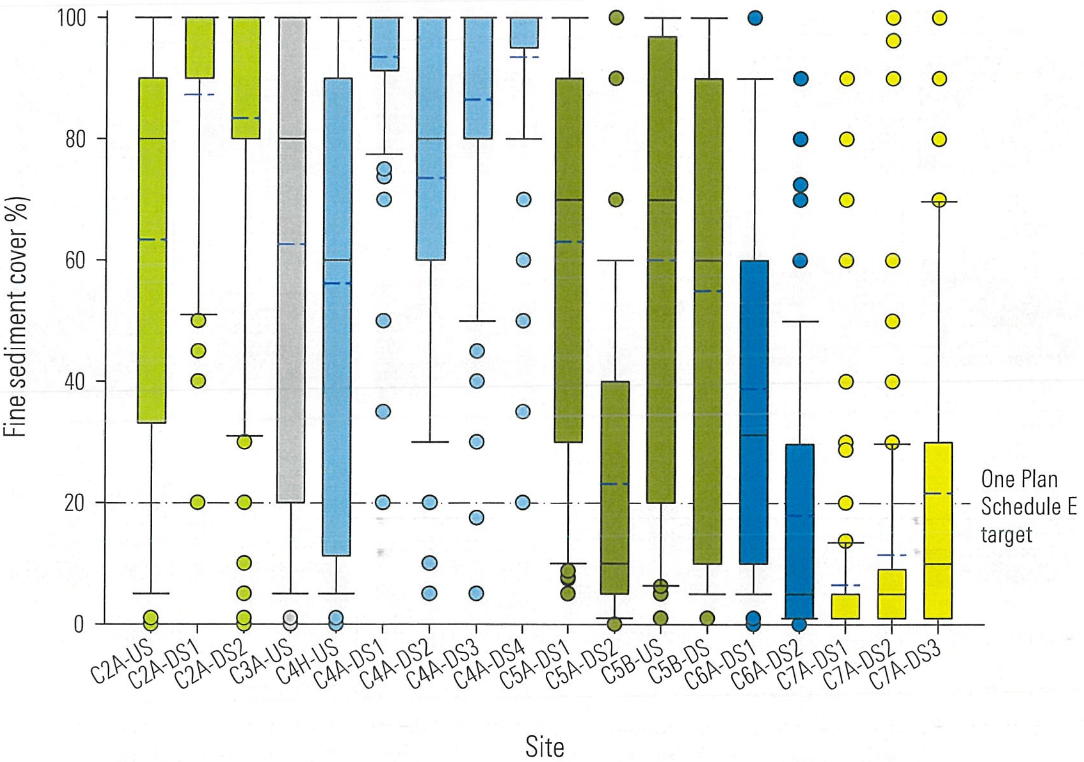



Figure 34 Deposited fine sediment cover from the 18 Te Ahu a Turanga baseline water quality sampling sites measured on six occasions between February and August 2019. All six sampling occasions for each site are combined. Dashed blue lines indicate mean values. The One Plan Schedule E target for deposited fine sediment of 20% cover is shown to give context to the results.

## 4.2 Water Quality

### 4.2.1 Visual Water Clarity

Measurement of visual water clarity is highly recommended during the construction phase wherever monitoring of potentially sediment-laden discharges are required. All the sampled catchments, with the exception of Catchment 2, were generally too shallow to allow consistent use of the black disk-periscope method typically employed for routine water clarity measurement. Hence, we recommend the use of water clarity tubes. These are relatively inexpensive, simple devices that anyone can be trained to use, they require no calibration, and provide instant results. In terms of compliance limits, Schedule E of the One Plan indicates a percentage change of 30%. This may be suitable for any discharges occurring during dry weather conditions, however during wet weather sampling of Catchments 2, 4, and 7 it has been shown that water clarity is greatly reduced. This is especially the case in Catchment 2, where very low readings (i.e., <10 cm) were recorded. Under such turbid water conditions, the effectiveness of clarity tubes is diminished, and the use of a percentage change limit could lead to regular non-compliance during rain events. For example, where background clarity is reduced to a low level, say 10 cm, then even a very minor decrease downstream of any discharge at such a time to say 6 or 7 cm could equate to non-compliance. Such a small difference is within the error of the methodology. To avoid this outcome, we would suggest the 30% change water clarity limit only applies when the background or upstream visual water clarity is equal or greater than 20 cm. Below 20 cm visibility so other measure of suspended fines should be used. water clarity tube

### 4.2.2 Fine Sediments

The measurement of suspended fine sediments (as TSS and turbidity) will be a key aspect of construction phase monitoring, wherever construction-derived fine sediment may enter waterways. Spot sampling may be appropriate in some locations, while automatic samplers linked to rainfall or pond discharge may be useful to monitor the performance of sediment control infrastructure such as detention ponds. During dry weather conditions, the ANZG (2018) default guideline values may be appropriate for Catchment 7 (turbidity and TSS) and Catchment 2 (TSS only) but baseline monitoring sites in the other catchments generally had baseline median values greater than the relevant guideline value (Figure 22, Figure 23). Any catchment specific limits for TSS and turbidity should take baseline data into account. Additionally, the turbidity loggers in Catchment 2 and 7 are currently generating a continuous baseline record from which realistic dry weather and wet weather turbidity limits could be generated. Due to a limited dataset (turbidity loggers have only been installed in August and September 2019) this data set has not been analysed in this report.

### 4.2.3 Aluminium & pH

The monitoring of aluminium during the construction phase should be undertaken only where sediment detention ponds that utilise aluminium-containing flocculants discharge to waterways. Dissolved aluminium concentrations and pH should be measured. Spot sampling may be appropriate in some instances, but ideally automatic samplers linked to rainfall or pond discharge will be used to provide more detailed information on sediment pond discharge water quality. Any catchment-specific limits for dissolved aluminium should take baseline data into account. Note that such limits will not be based on toxic effects (as in ANZG (2018)) but rather on the existing concentrations of dissolved aluminium found in the streams affected by the project. Reasoning behind not using the ANZG (2018) default guideline value is fully described in Section 3.2.4.

## 4.3 Aquatic Macroinvertebrates

The main risk to aquatic macroinvertebrates during the construction phase will be from elevated levels of fine sediment entering and being deposited on stream beds and uncontrolled discharge of toxicants (e.g., fuel spills). Commonly used macroinvertebrate community indices applied to the baseline sampling sites show trends of significant declines with increasing levels of deposited fine sediment, although there is a lot of variation among the sites (Figure 35). The monitoring of macroinvertebrates during and after construction is arguably more relevant than any other freshwater variable as they effectively integrate everything that is happening in the catchment, such that the macroinvertebrate assemblage of a site provides much information on prevailing catchment habitat condition and water quality. Hence, we recommend general surveillance monitoring of macroinvertebrates on a regular basis through the construction period. Additionally, it could be worthwhile having triggers that may initiate extra macroinvertebrate sampling (e.g., a large increase in deposited fine sediment cover at a particular site).

Once the final round of baseline macroinvertebrate sampling is completed (spring 2019), we will have a relatively good appreciation of the macroinvertebrate assemblage from 17 sites in six catchments, and if there is much seasonal variation. We recommend all construction phase monitoring follow the methods used for the baseline surveys (i.e., quantitative Surber sampling with a minimum of five samples from each site per sampling occasion).

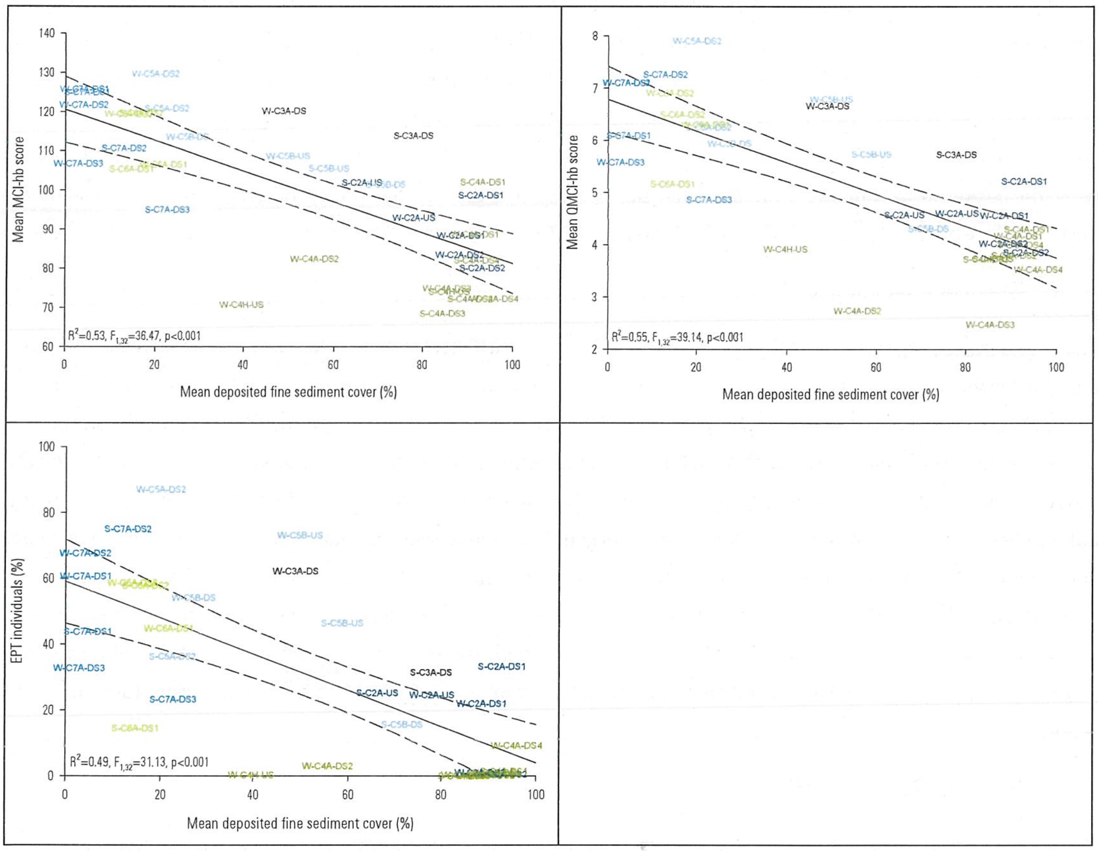



**Figure 35** **The relationship between common aquatic macroinvertebrate community indices and deposited fine sediment cover from the 17 baseline sites where macroinvertebrates were sampled in summer and winter 2019. Deposited fine sediment cover data from the day of macroinvertebrate sampling was used in the analysis. Linear regression results are shown. Dashed lines are 95% confidence levels.**

There are various ways of analysing and interpreting aquatic macroinvertebrate data to determine if there has been a change over time that can be attributed to the activity of interest or at least trigger further investigation. This is often not straightforward as various other factors may be at play (e.g., seasonal variation, flood effects, drought impacts, land use effects, random variation). Potential methods include:

» Comparison of QMCI values between sites and over time. One Plan Schedule E Table E.1 includes a 20% change limit for QMCI "*between appropriately matched habitat upstream and downstream of activities, such as discharges to water, for the purposes of measuring the effect of discharges on aquatic macroinvertebrate communities.*" The equivalence testing method described by Stark (2013) could be used to measure this in a robust manner. Such a 20% change approach would be possible in all the baseline survey catchments, with the exception of Catchment 4 where QMCI scores are generally low ("poor") such that they do not have much ability to be reduced further, bar some major environmental disaster. However, an upstream-downstream comparison would only by possible in Catchment 2 as no suitable upstream sites exist in Catchments 3, 5, 6, and 7 meaning any 20% change threshold would need to apply to temporal data only in those catchments. Alternate QMCI methods exist, such as the one used for the Peka Peka to Otaki (PP2O) compliance monitoring, where an assessment of the cause of the effect is triggered when "*A decline in the QMCI score of 1.5 or greater from the corresponding upstream monitoring site or baseline monitoring scores*" was detected (NZTA, 2019).

» Comparison of the densities and taxa richness of invertebrate taxa known to be relatively sensitive to the impacts of elevated fine sediment deposition (e.g., most mayflies and stoneflies, some caddisflies). Such taxa were relatively common in Catchments 3, 5, 6, and 7. A similar method was also used for the Peka Peka to Otaki (PP2O) compliance monitoring, where an assessment of the cause of the effect is triggered when "*A decline of greater than 20% in sensitive invertebrate taxa (in this case taxa with a QMCI score of ≥ 5) compared to the upstream monitoring site or baseline monitoring scores*" was detected (NZTA, 2019). As with QMCI, this method is not particularly suited to those sites or catchments where sensitive taxa are already rare or absent.

» Analyses of macroinvertebrate assemblage changes over time and space using ordination techniques such as non-metric multidimensional scaling (NMS) and associated tests (e.g., ANOSIM (using factors such as site and time) and SIMPER to identify those taxa most responsible for any changes over time and space). NMS ordination plots are very useful for plotting how macroinvertebrate communities change over time. This method of assessing community changes over time and space has the advantage of being useful in all catchments irrespective of the existing macroinvertebrate assemblage.

## 4.4 Construction Phase Monitoring Summary

### 4.4.1 Sediments and Aluminium

Catchment specific monitoring recommendations and guidance around developing realistic construction phase limits/trigger values for deposited fine sediment, visual water clarity, dissolved aluminium, and suspended fine sediments are outlined in Table 7. For deposited fine sediment, baseline monitoring has shown the SAM-2 (visual fine sediment cover estimation) method not to be particularly useful in Catchments 2 and 4 due to their existing high fine sediment cover and thus alternative methods are suggested (Table 7). Baseline monitoring has shown even modest rainfall can result in very low water clarity in some catchments (e.g., Catchment 2) and as such any visual water clarity limits (such as the One Plan Schedule E 30% change) should not apply when background/upstream clarity is below 20 cm. For dissolved aluminium, the ANZG (2018) 95% toxicant guideline for "Aluminium >6.5" should not be used as it is acknowledged as being of "low" reliability. Instead, any limit/trigger values should take into account existing baselines, which are often below laboratory detection levels. Suspended sediment limits/trigger values should take into account catchment-specific baseline data, as there were clear differences among catchments and sites. For Catchments 2 and 7, turbidity loggers have now been installed and once sufficient data has been collected, this data should be used to generate any turbidity limits/trigger values. We have purposely not tried to calculate any specific limits or trigger values as derivation of realistic numbers will depend on the locations of any construction period discharge points and the expected treatment efficiency and discharge water quality of any sediment control features (e.g., detention ponds).

Table 7 Recommended monitoring methodologies and guidance around limits/triggers to be used during the Te Ahu a Turanga construction phase for deposited fine sediment and water quality (visual water clarity, dissolved aluminium, and suspended fine sediment). Actual values should be derived once the main locations of potential sediment runoff in the project area are known (i.e., outlets of sediment control infrastructure). For the limit suggestions, "TBC" is where alternate monitoring methodologies are recommended for that catchment during the construction phase, such that there is currently no baseline data.

| Catchment | | Deposited fine sediment | Visual water clarity | Dissolved aluminium and pH | Suspended fine sediments (TSS & turbidity) |
|---|---|---|---|---|---|
| 2 | Method | SAM-4 and/or SAM-6 | Clarity tube or black disk (where water depth allows) | Water samples | Water samples |
| | Limit or trigger | TBC | 30% change (only applicable when background/upstream clarity >20 cm) | Takes baseline data into account | Takes baseline data into account. Use continuous logged data for turbidity. |
| 3 | Method | SAM-2 | Clarity tube | Water samples | Water samples |
| | Limit or trigger | Baseline data 80th percentile | 30% change (only applicable when background/upstream clarity >20 cm) | Takes baseline data into account | Takes baseline data into account |
| 4 | Method | SAM-4 and/or SAM-6 | Clarity tube | Water samples | Water samples |
| | Limit or trigger | TBC | 30% change (only applicable when background/upstream clarity >20 cm) | Takes baseline data into account | Takes baseline data into account |
| 5 | Method | SAM-2 | Clarity tube | Water samples | Water samples |
| | Limit or trigger | Baseline data 80th percentile | 30% change (only applicable when background/upstream clarity >20 cm) | Takes baseline data into account | Takes baseline data into account |
| 6 | Method | SAM-2 | Clarity tube | Water samples | Water samples |
| | Limit or trigger | Baseline data 80th percentile | 30% change (only applicable when background/upstream clarity >20 cm) | Takes baseline data into account | Takes baseline data into account |
| 7 | Method | SAM-2 | Clarity tube | Water samples | Water samples |
| | Limit or trigger | Baseline data 80th percentile | 30% change (only applicable when background/upstream clarity >20 cm) | Takes baseline data into account | Takes baseline data into account. Use continuous logged data for turbidity. |

### 4.4.2 Aquatic Macroinvertebrates

Any aquatic macroinvertebrate monitoring during (and after) the construction phase should use the same quantitative Surber sampling methodology as the baseline surveys. Site selection will depend on the locations of likely discharge points, but several of the baseline survey sites should still be suitable. It is highly recommended that the Catchment 5 and 6 sites within the Manawatū Gorge Scenic Reserve (C5A-DS2 and C6A-DS2 respectively) are included in any construction monitoring as these had among the highest MCI/QMCI and EPT metrics of the 17 baseline survey sites. Catchment-specific trigger guidance is provided in Table 8. From a consenting point of view, a QMCI percentage change and some metrics based on sensitive taxa would allow for relatively simple resource consent conditions. However, we would suggest these be supported by multivariate analysis which is a powerful tool for identifying which taxa are responsible for any community changes in time and space.

**Table 8 Potential triggers or limits and monitoring methodologies to be used during the Te Ahu a Turanga construction phase for aquatic macroinvertebrates.**

| Catchment | | Aquatic macroinvertebrates |
|---|---|---|
| 2 | Method | Quantitative Surber sampling |
| | Triggers | QMCI: 20% change (catchment has appropriate upstream and downstream sites)<br>Sensitive taxa: densities and taxa richness<br>Multivariate analysis: NMS, ANOSIM, SIMPER |
| 3 | Method | Quantitative Surber sampling |
| | Triggers | QMCI: 20% change (no upstream site, any change would need to be measured over time)<br>Sensitive taxa: densities and taxa richness<br>Multivariate analysis: NMS, ANOSIM, SIMPER |
| 4 | Method | Quantitative Surber sampling |
| | Triggers | Multivariate analysis: NMS, ANOSIM, SIMPER |
| 5 | Method | Quantitative Surber sampling |
| | Triggers | QMCI: 20% change (no upstream site, any change would need to be measured over time)<br>Sensitive taxa: densities and taxa richness<br>Multivariate analysis: NMS, ANOSIM, SIMPER |
| 6 | Method | Quantitative Surber sampling |
| | Triggers | QMCI: 20% change (no upstream site, any change would need to be measured over time)<br>Sensitive taxa: densities and taxa richness<br>Multivariate analysis: NMS, ANOSIM, SIMPER |
| 7 | Method | Quantitative Surber sampling |
| | Triggers | QMCI: 20% change (no upstream site, any change would need to be measured over time)<br>Sensitive taxa: densities and taxa richness<br>Multivariate analysis: NMS, ANOSIM, SIMPER |

# 5 REFERENCES

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SCIENCE + ENGAGEMENT

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# 1 SSESCP-001 - CONSTRUCTION NOTES

## 1.1 Scope

This Site-Specific Erosion and Sediment Control Plan (SSESCP) covers the construction activities associated with the construction of three stabilised all-weather access tracks and three staging units for the construction of the Eco Bridge (Bridge 3) located across the watercourse (being an un-named tributary of the Manawatū River).

The proposed erosion and sediment control measures have been designed in accordance with the Auckland Council's Guideline Documents 2016/005 *'Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region, June 2016'* (GD05).

Activities associated with this SSESCP:

- Construction of three all-weather access areas; and
- Construction of three staging units.

Reference drawings:

- TAT-3-DG-E-3831-A

## 1.2 Methodology

- Prior to the commencement of any earthworks the Construction Manager will inspect the site to confirm the suitability of the proposed controls and methodologies.
- Prior to any works commencing in or adjacent to areas of native vegetation the Exclusion Zone protocols as detailed in section 1.4 must be completed and signed off.
- The works will commence from the end of the current access track, constructed as part of the Access Track No. 1 work (see ESCP-002-02 for details). A short section of additional track will be constructed to provide access to Staging Unit 1. This will be completed as a "box cut" operation, where all cut material will be cut to waste (via Access Track 1). The new section of track will be covered with geogrid and stabilised with metal. Any batters adjacent the track will be covered with geotextile. This section of works is expected to take two days to complete.
- Staging Unit 1 will then be constructed in accordance with the 'Temporary Bridge Staging Construction Methodology' detailed below.
- Once Staging Unit 1 has been installed the All-Weather Access Area 1 will be constructed. Refer to the typical cross-sections on SSESCP-001-01 for more detail. Each of the three All Weather Access Areas will be constructed using a cut and cover methodology ensuring that at the end of each day, or prior to rain (whichever is first), any exposed area is fully stabilised with aggregate or geotextile. The construction of the All-Weather Access Areas will be undertaken by laying geotextile over the existing ground surface. The geotextile will then be covered with a 300mm layer of aggregate. A high strength geogrid will be then placed on top of the aggregate, followed by an additional layer of aggregate.
- Once the All-Weather Access Area 1 has been completed then the staging piling rigs will return and commence the installation of Staging Unit 2, in accordance with the Temporary Bridge Staging Construction Methodology.
- Upon completion of Staging Unit 2 the All-Weather Access Area 2 will be constructed following the same methodology for the construction of All-Weather Access Area 1.
- These methodologies will then be repeated for Staging Unit 3 and All-Weather Access 3

### Temporary Bridge Staging Construction Methodology

Each temporary staging unit will be constructed utilising the same construction methodology in a staged manner as follows:

- The crane will be setup on the all-weather access area.
- Setout staging pile (steel casing) locations working from the end of the all-weather access area.
- Pitch steel casing and drive to refusal using vibro-hammer.
- Pitch adjacent steel casings and repeat drive to refusal using vibro hammer.
- Switch vibro-hammer to drop-hammer and strike each of the casings to the design set depth.
- Cut casings to correct height to accommodate the temporary staging crosshead.
- Place temporary staging crosshead onto cut casings and install fixings to secure in place.
- Repeat steps 1 – 7 to install the second crosshead for the first staging span.
- Lift and place longitudinal beams onto the two crossheads and secure in position.
- Place timber decking mat units (9m x 9m) into position on the longitudinal beams and secure in place. Handrail stanchions are to be pre-fixed to the timber deck units prior to installation.
- Complete handrail and toe-board installation.
- Complete required temporary works design checks and confirm approval to load the span.
- Walk crane forward on to completed staging span
- Repeat steps 8-13 for the remaining staging spans

### Construction Timetable

Insert details of construction timetable - **TBC**

## 1.3 Operation and Maintenance

Upon completion of the all-weather access areas, silt fences will be installed immediately below the areas and encompassing the permanent pile locations. The silt fences will provide a delineation barrier for all staff as well as a contingency measure during operating and use if the area temporarily becomes dirty and will capture rubble from the working spaces.

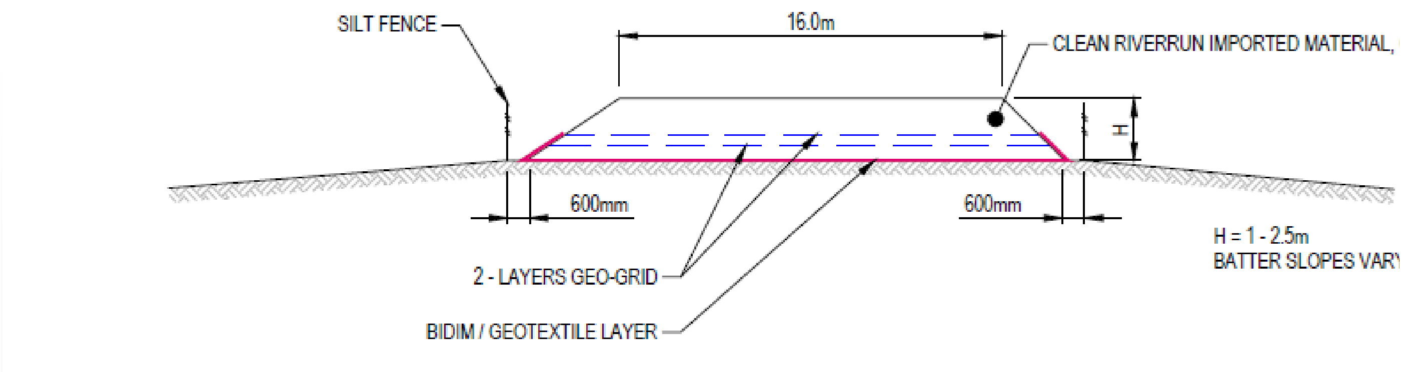
- The environmental and erosion and sediment control measures and ongoing quality of the all-weather access areas will be inspected and signed off by the Environmental Advisor prior to commencement of works.
- All erosion and sediment controls and quality of the all-weather access areas and staging structures will be inspected on a weekly basis and within 24 hours of each rainstorm event that is likely to impair the function of performance of the controls.
- A record will be maintained of the date and time of inspections undertaken, any maintenance requirements identified, and any maintenance undertaken.
- All erosion and sediment measures are to be monitored and maintained throughout the works until the site is stabilised.
- The key maintenance requirement will be maintaining a stabilised and clean access area. This requires maintaining a minimum aggregate depth of 150mm and free of any clay material.

## 1.4 Exclusion Zones

Highly sensitive native vegetation and wetland areas are associated with this SSESCP.

- Prior to works commencing in areas of native vegetation and wetlands they are to be fenced so the extent of vegetation clearance will be clearly physically delineated. The fencing alignments are to be confirmed onsite by an ecologist being overseen by the Lead Project Ecologist. Areas of native vegetation are highlighted on the attached drawing TAT-3-DG-E-3831-A.
- No construction materials or waste will be deposited into vegetation within the fenced off areas.
- Prior to vegetation clearance written approval must be obtained from the Project Ecologist that native fauna and flora relocations have been completed.
- Vegetation clearance can only be undertaken between 1 January to 31 March.

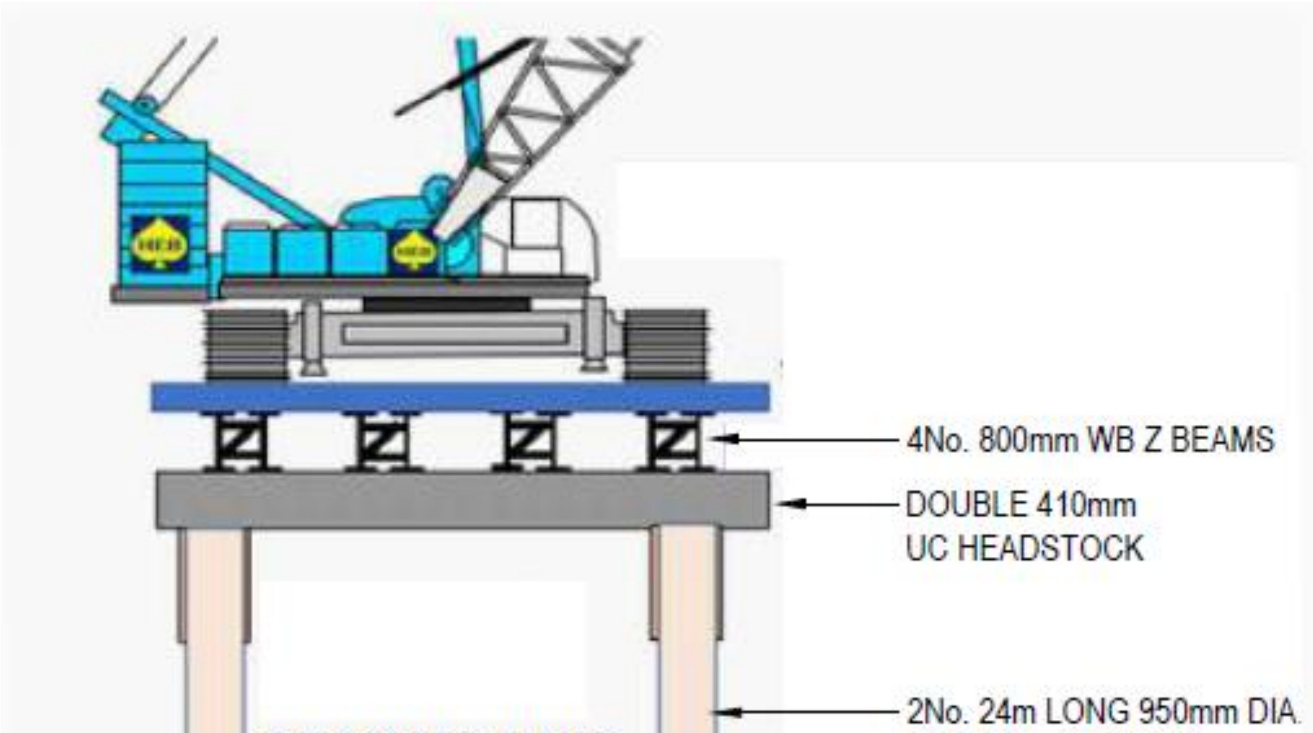
## 1.5 Typical All-Weather Access Track Details




TYPICAL CROSS SECTION: ECO CAUSEWAY

NOT TO SCALE

## 1.6 Typical Staging Details




STAGING UNIT

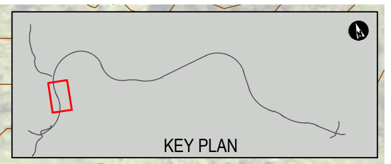
NOT TO SCALE

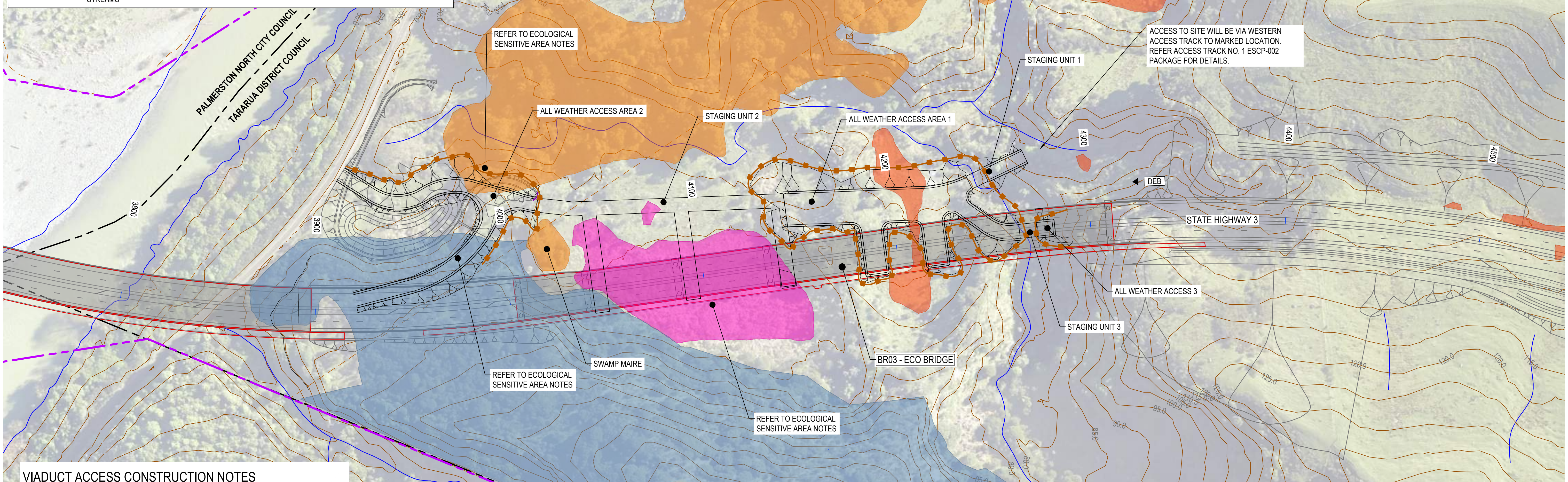
## LEGEND

| | | | |
|---|---|---|---|
| | PROPOSED DESIGNATION BOUNDARY | | TEMPORARY CULVERT |
| | COUNCIL BOUNDARY | | DIRECTION OF FLOW |
| | EXISTING PROPERTY BOUNDARY | | TEMPORARY PIPE IN SWALE DRAIN |
| SRP | SEDIMENT RETENTION POND | | HIGH VALUE SEEPAGE WETLANDS |
| DEB | PROPOSED DECANTING EARTH BUND | | KANUKA FORESTS |
| B | PERIMETER DIVERSION BUND / DRAIN | | OLD GROWTH FOREST ALLUVIAL |
| | SILT FENCE | | EXOTIC OR NATIVE DOMINATED WETLAND |
| | STREAMS | | PROPOSED CULVERT |

## NOTES

1. ALL EROSION AND SEDIMENT CONTROLS TO BE INSTALLED AND MAINTAINED IN ACCORDANCE WITH AUCKLAND COUNCIL GUIDELINE DOCUMENT 2016/005 'EROSION AND SEDIMENT CONTROL GUIDE FOR LAND DISTURBING ACTIVITIES IN THE AUCKLAND REGION' (GD05).
2. EARTHWORKS ARE TO BE PROGRAMMED TO ENSURE RAPID STABILISATION IN ACCORDANCE WITH GD05.
3. ALL EROSION AND SEDIMENT CONTROL MEASURES OR METHODOLOGY (CUT AND COVER OPERATIONS MUST BE STABILISED AT THE END OF EACH DAY) WILL BE INSPECTED ON A DAILY BASIS BY THE SITE FOREMAN.
4. SITE MONITORING WILL BE UNDERTAKEN BEFORE AND IMMEDIATELY AFTER RAIN AS WELL AS DURING HEAVY RAINFALL EVENTS. ANY REQUIRED MAINTENANCE OR IMPROVEMENTS TO CONTROL MEASURES WILL BE UNDERTAKEN IMMEDIATELY.
5. ALL PERIMETER BUNDS TO BE A MINIMUM OF 0.55 m HIGH UNLESS OTHERWISE SPECIFIED.




## VIADUCT ACCESS CONSTRUCTION NOTES

1. SMALL SECTION OF ADDITIONAL TRACK TO BE CONSTRUCTED FROM THE END OF EXISTING ACCESS TRACK 1 (REFER ESCP-002-02), TO ALLOW ACCESS TO STAGING UNIT 1. TO BE COMPLETED AS A BOX CUT. ALL CUT MATERIAL WILL BE CUT TO WASTE (VIA ACCESS TRACK 1). NEW SECTION OF TRACK TO BE COVERED WITH GEOGRID AND COVERED WITH METAL. BATTERS TO BE COVERED WITH GEOTEXTILE. SECTION OF WORKS IS EXPECTED TO TAKE 2 DAYS TO COMPLETE.
2. STAGING UNIT 1 WILL THEN BE CONSTRUCTED IN ACCORDANCE WITH TEMPORARY BRIDGE STAGING CONSTRUCTION METHODOLOGY.
3. ONCE STAGING UNIT 1 HAS BEEN INSTALLED, ALL-WEATHER ACCESS AREA 1 TO BE CONSTRUCTED. REFER TYPICAL CROSS SECTION OF ALL-WEATHER ACCESS TRACK.
4. GEOTEXTILE CLOTH TO BE LAID OVER EXISTING GROUND WHICH WILL BE COVERED BY 300mm LAYER OF AGGREGATE. HIGH-STRENGTH GEOGRID TO BE PLACED FOLLOWED BY 1m (APPROX.) OF AGGREGATE.
5. ONCE ALL-WEATHER ACCESS AREA 1 IS COMPLETED, STAGING PILING RIGS WILL RETURN AND COMMENCE INSTALLATION OF STAGING UNIT 2. STAGING UNIT TO BE CONSTRUCTED IN ACCORDANCE WITH TEMPORARY BRIDGE STAGING CONSTRUCTION METHODOLOGY.
6. UPON COMPLETION OF STAGING UNIT 2, ALL-WEATHER ACCESS AREA 2 WILL BE CONSTRUCTED. FOLLOW SAME METHODOLOGY AS PER CONSTRUCTION OF ALL-WEATHER ACCESS AREA 1.
7. METHODOLOGY TO BE REPEATED FOR STAGING UNIT 3 AND ALL-WEATHER ACCESS AREA 3.

## TEMPORARY BRIDGE STAGING CONSTRUCTION METHODOLOGY

TEMPORARY STAGING UNITS TO BE CONSTRUCTED USING THE SAME CONSTRUCTION METHODOLOGY IN A STAGED MANNER AS FOLLOWS:

1. PILING RIG TO BE SET UP ON THE ACCESS AREAS AND WORK IN A NORTH TO SOUTH DIRECTION.

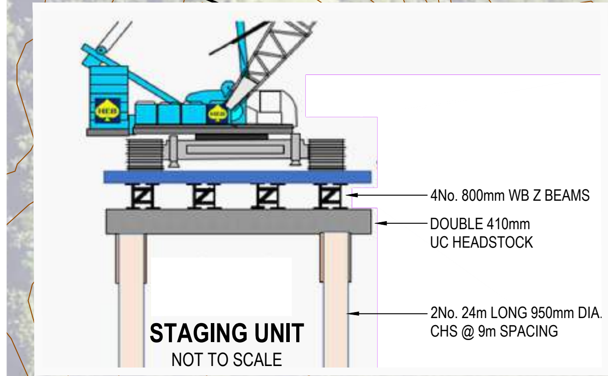
INSTALLATION OF TEMPORARY STAGING TO BE UNDERTAKEN IN STAGED MANNER AS FOLLOWS:

1. SETOUT STAGING PILE (STEEL CASING) LOCATIONS WORKING FROM THE END OF THE ALL-WEATHER ACCESS AREA.
2. PITCH STEEL CASING AND DRIVE TO REFUSAL USING VIBRO-HAMMER.
3. PITCH ADJACENT STEEL CASING AND REPEAT DRIVE TO REFUSAL USING HYDRAULIC HAMMER.
4. SWITCH VIBRO-HAMMER TO DROP-HAMMER AND STRIKE EACH CASING TO DESIGN SET/DEPTH.
5. CUT CASINGS TO CORRECT HEIGHT TO ACCOMMODATE TEMPORARY STAGING CROSSHEAD.
6. PLACE TEMPORARY STAGING CROSSHEAD ONTO CUT CASINGS AND INSTALL FIXINGS TO SECURE IN PLACE.
7. REPEAT STEPS 1 - 7 TO INSTALL THE SECOND CROSSHEAD FOR THE FIRST STAGING SPAN.
8. LIFT AND PLACE LONGITUDINAL BEAMS ONTO TWO CROSSHEADS AND SECURE IN POSITION.
9. PLACE TIMBER DECKING MAT UNITS (9m x 9m) INTO POSITION ON LONGITUDINAL BEAMS AND SECURE IN PLACE. HANDRAIL STANCHIONS ARE TO BE PRE-FIXED TO TIMBER DECK UNITS PRIOR TO INSTALLATION.
10. COMPLETE HANDRAIL AND TOE-BOARD INSTALLATION.
11. COMPLETE REQUIRED TEMPORARY WORKS DESIGN CHECKS AND CONFIRM APPROVAL TO LOAD THE SPAN.
12. REPEAT STEPS 7-11 FOR REMAINING STAGING SPANS.

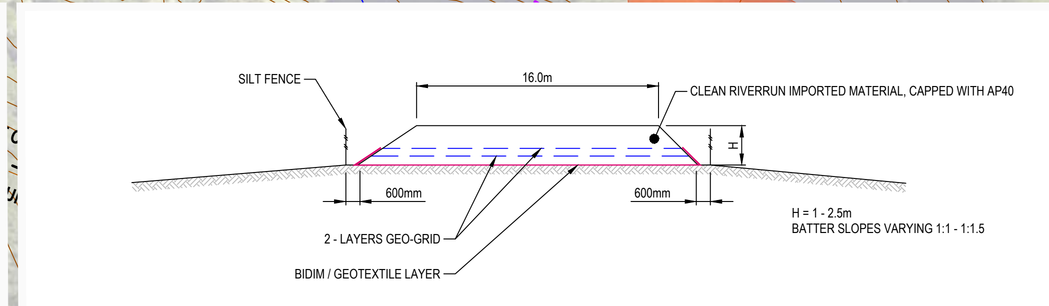
## ECOLOGICAL SENSITIVE AREA NOTES

1. PRIOR TO WORKS COMMENCING AREAS OF NATIVE VEGETATION AND WETLANDS ARE TO BE FENCED AND VIEWED ON SITE BY IWI CULTURAL MONITORS SO EXTENT OF VEGETATION CLEARANCE WILL BE CLEARLY AND PHYSICALLY DELINEATED.
2. NO CONSTRUCTION MATERIALS OR WASTE TO BE DEPOSITED INTO VEGETATION OUTSIDE OF FENCING.
3. PRIOR TO VEGETATION CLEARANCE APPROVAL MUST BE OBTAINED FROM THE PROJECT ECOLOGIST THAT NATIVE FAUNA AND FLORA RELOCATIONS HAVE BEEN COMPLETED.

   HOLD POINT
4. VEGETATION CLEARANCE CAN ONLY BE UNDERTAKEN BETWEEN 1 OCTOBER TO 31 MARCH.




**STAGING UNIT**
NOT TO SCALE




**TYPICAL CROSS SECTION: ECO CAUSEWAY**
NOT TO SCALE

10 0 20 40m
SCALE 1:1000

| REV | DATE | REVISION DETAILS | APPROVED |
|---|---|---|---|
| A | 24/02/2020 | ISSUED FOR REGIONAL CONSENT | D. McGAHAN |

CLIENT: WAKA KOTAHI NZ TRANSPORT AGENCY — Te Ahu a Turanga Manawatū Tararua Highway

| SCALE | SIZE |
|---|---|
| 1:1000 | A1 |

DRAWN: L. STEINER
DESIGNED: C. STEWART
REVIEWED: D. MACKINTOSH

CONSENT
NOT FOR CONSTRUCTION

APPROVED: T. WATTERSON DATE

PROJECT: TE AHU A TURANGA: MANAWATŪ TARARUA HIGHWAY

TITLE: SITE SPECIFIC EROSION AND SEDIMENT CONTROL ECO BRIDGE

DRAWING No.

| PROJECT No. | PHASE | TYPE | DISC | NUMBER | REV |
|---|---|---|---|---|---|
| TAT | 3 | DG | E | 3831 | A |

OPT340 23/01/20

Plot Date: 2020-02-18 11:14:32 Office: AUDC1 Filename: Z:\MANAWATU TARARUA HIGHWAY\PAA PHASE\05 TECHNICAL – DESIGN WORKING AREA\DRAFTING\DELIVER DESIGN\2 DRAWING_DRAWINGS\3_CONCEPT AND CONSENTING\TAT-3-DG-E-3831-3836.DWG

# 1 SSESCP-002 - CONSTRUCTION NOTES

## 1.1 Scope

This Site-Specific Erosion and Sediment Control Plan (SSESCP) covers the construction activities associated with the triple culvert, culvert 8 (CU-8) located at Chainage 7840.

The concept design details of the culvert are as follows:

- Culvert 8 (CU-08) - triple 2x2m box culvert at chainage 7850.
- CU-08 catchment area is 320ha.
- Length 71m.
- Gradient 2%.
- Embedment of 500mm (for fish passage).
- Upstream invert level of 280.95m RL (with embedment).
- Downstream invert level of 279.60m RL (with embedment).

The proposed erosion and sediment control measures and stream works activities have been designed in accordance with the Auckland Council's Guideline Documents 2016/005 *'Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region, June 2016'* (GD05).

Activities associated with this SSESCP:

- Construction of erosion and sediment controls;
- General earthworks;
- Stream works; and
- Culvert construction and installation.

Reference drawing:

- ESCP-002-01

## 1.2 Methodology

- Prior to the commencement of any earthworks the Construction Manager will inspect the site to confirm the suitability of the proposed controls and methodologies.
- At the approximate locations, as detailed in the attached drawing, the erosion and sediment controls will be installed. Erosion and sediment control (ESC) will be managed using silt fences and one sediment retention pond (SRP). The SRP 7900WB has been sized for a future earthwork's catchment. It will be constructed early to cater for the culvert construction works. Refer to the ESC design details and schedule in Appendix A.
- Any overland flow runoff will be captured and treated by the silt fences. Although, it is expected that due to the nature of the works, majority of runoff will be contained within the excavations. All dirty water will be pumped to SRP 7900WB for treatment prior to being discharged from the site.
- An as-built will be completed immediately following construction of each to confirm that they have been constructed in accordance with the ESCPs and GD05. The as-built will be submitted to Horizons prior to the earthworks and streamworks commencing.
- The site will be accessed via the existing stabilised Meridian Energy access track.

### Culvert Construction

Currently, three 750mm diameter pipes lie beneath the Meridian Energy access track. These pipes will be removed and CU-8 will be constructed in their place and extended to allow for the future main alignment.

<u>Stage 1</u>

- The construction of the temporary stream diversion will be constructed offline to the existing watercourse. At the upstream and downstream extent of the temporary diversion a dam, or plug of existing earth, will remain in place during the construction.
- The dimensions of the temporary stream diversion are outlined in Appendix A.
- As part of Stage 1, a permanent section of the stream diversion (located to the south-west of the temporary stream diversion channel) will be constructed and stabilised off-line as per the design details.
- The temporary stream diversion, including the temporary culverts will be constructed and installed off-line. The temporary stream diversion will be stabilised with geotextile.
- Three 900mm diameter temporary culverts will be installed within the temporary stream diversion to provide continued access for Meridian Energy along their access track. The flow capacity of these three 900mm diameter culverts will not have sufficient capacity to convey to 5% AEP storm, as required by GD05. In this case, if the culverts are exceeded then flow will overtop the culverts, flow over the stabilised access track and then into the temporary stream diversion (which has been sized in accordance with GD05).
- Any dirty water within the excavations during construction will be pumped to SRP 7900WB. During the construction of the temporary stream diversion, the outlet of the SRP will need to be piped beyond the works area.
- All dewatering will be undertaken in accordance with the Pumping Management Procedure (Appendix D of the ESCP).
- All excavated material will be temporarily stockpiled in the identified location or removed from site.

<u>Stage 2</u>

- The stream will be diverted into the temporary stream diversion. The downstream dam will be removed first, followed by the upstream dam using a temporary pump system to bypass the isolated areas of work.
- A stabilised dam (sheet metal plate or sandbags) will be installed across the existing stream channel at the upstream end to divert stream flows into the temporary stream diversion. This will be followed by a stabilised dam installed at the downstream location once the existing stream has drained.
- The now off-line section of existing stream will be "de-fished" by the projects Freshwater Ecologist. Once the all clear is given excavation of the triple culvert alignment will commence.
- All excavated material will be temporary stockpiled in the identified location or removed from site.
- Any dirty water within the excavations during construction will be pumped to SRP7900WB.
- Following the completion of the culvert, including rock riprap the upstream and downstream dams will be removed to allow the stream to flow through the permanent culverts.
- Stabilised dams will then be reinstated at the upstream and downstream location of the temporary stream diversion to take it offline again. It will then be de-fished by the projects Freshwater Ecologist and filled in.

### As-Builts

- An as-built for the erosion and sediment controls (including temporary diversion) will be completed and submitted to the Horizons immediately following their installation.

### Construction Timetable

- Insert details of construction timetable **- TBC**

## 1.3 Operation and Maintenance

- The environmental and erosion and sediment control measures will be inspected and signed off by the Environmental Manager or ESC Technical Specialist prior to commencement of works.
- All erosion and sediment control structures will be inspected on a weekly basis and within 24 hours of each rainstorm event that is likely to impair the function of performance of the controls.
- A record will be maintained of the date and time of inspections undertaken, any maintenance requirements identified, and any maintenance undertaken.
- All erosion and sediment measures are to be monitored and maintained throughout the works until the site is stabilised.

## 1.4 Chemical Treatment

- Chemical Treatment will be undertaken in accordance the site's Chemical Treatment Management Plan (CTMP).
- SRP 7900WB will be constructed for the sole purpose of dewatering the areas during the Culvert 8 installation. No overland flow will enter this pond. Therefore, chemical treatment will likely be undertaken by

batch dosing. SRP 7900WB will be used of bulk earthworks at a later stage. At this time a rainfall activated floc shed will be installed. This will be detailed in a future SSESCP.

- Ongoing monitoring and maintenance will be undertaken in accordance with the CTMP. Any change to the dose rate of delivery mechanism will be confirmed in writing to Horizons.

# Appendix A – Erosion and Sediment Control Details

### Sediment Control Schedule

| Device | Catchment (maximum) | Volume (minimum) | Dimensions (L x W x D) |
|---|---|---|---|
| SRP 7900WB | 1.1ha | 330m$^3$ | 32.35m x 13m x 1.6m |

| Temporary Stream Diversion | | | | | | |
|---|---|---|---|---|---|---|
| 5% AEP (24 hr) rainfall | Maximum Catchment Area | Peak Flow (m3/s) | Base Width | Slope | Minimum Design Flow Depth | Including Minimum 300mm Freeboard |
| 98mm | 320ha | 26.133 | 1.3m | 5% | 1.3m | 1.6m |

In accordance with the Auckland Council's GD05 the temporary stream diversion has been sized to have sufficient capacity to safely carry the flow from a 5% AEP storm, plus a freeboard of 300mm.

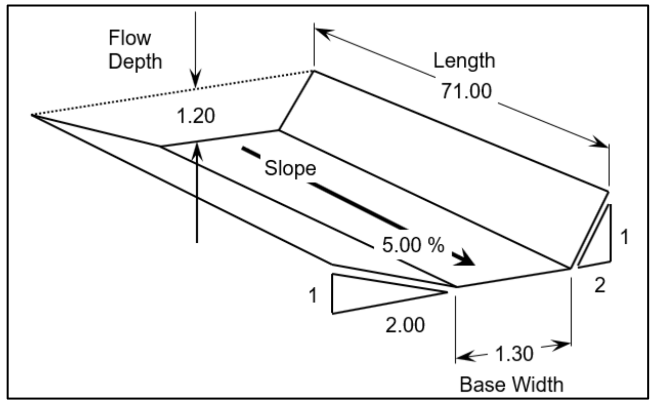



**Figure 1: Temporary stream diversion channel design.**

| Temporary Stream Diversion Culverts | | | | | |
|---|---|---|---|---|---|
| 5% AEP (24 hr) rainfall | Maximum Catchment Area | Peak Flow (m$^3$/s) | Culvert diameter | Slope | Flow capacity (m$^3$/s) |
| 98mm | 320ha | 26.133 | 3x 900mm | 5% | 14.1 |

The three culverts will not have sufficient capacity to convey the flow from a 5% AEP storm, as required by GD05. In this case, if the capacity of the culverts is exceeded then flow will continue down the temporary stream diversion.

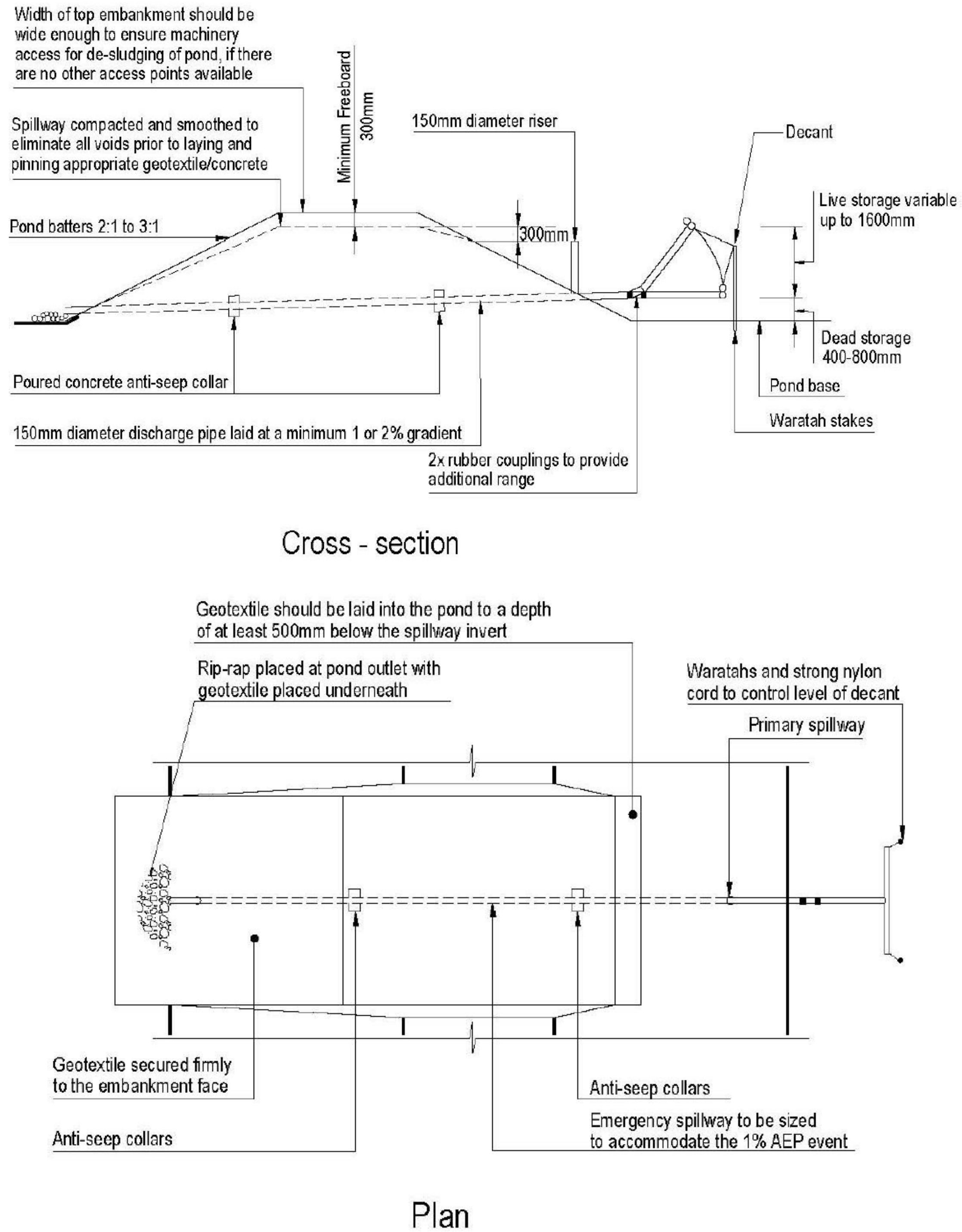


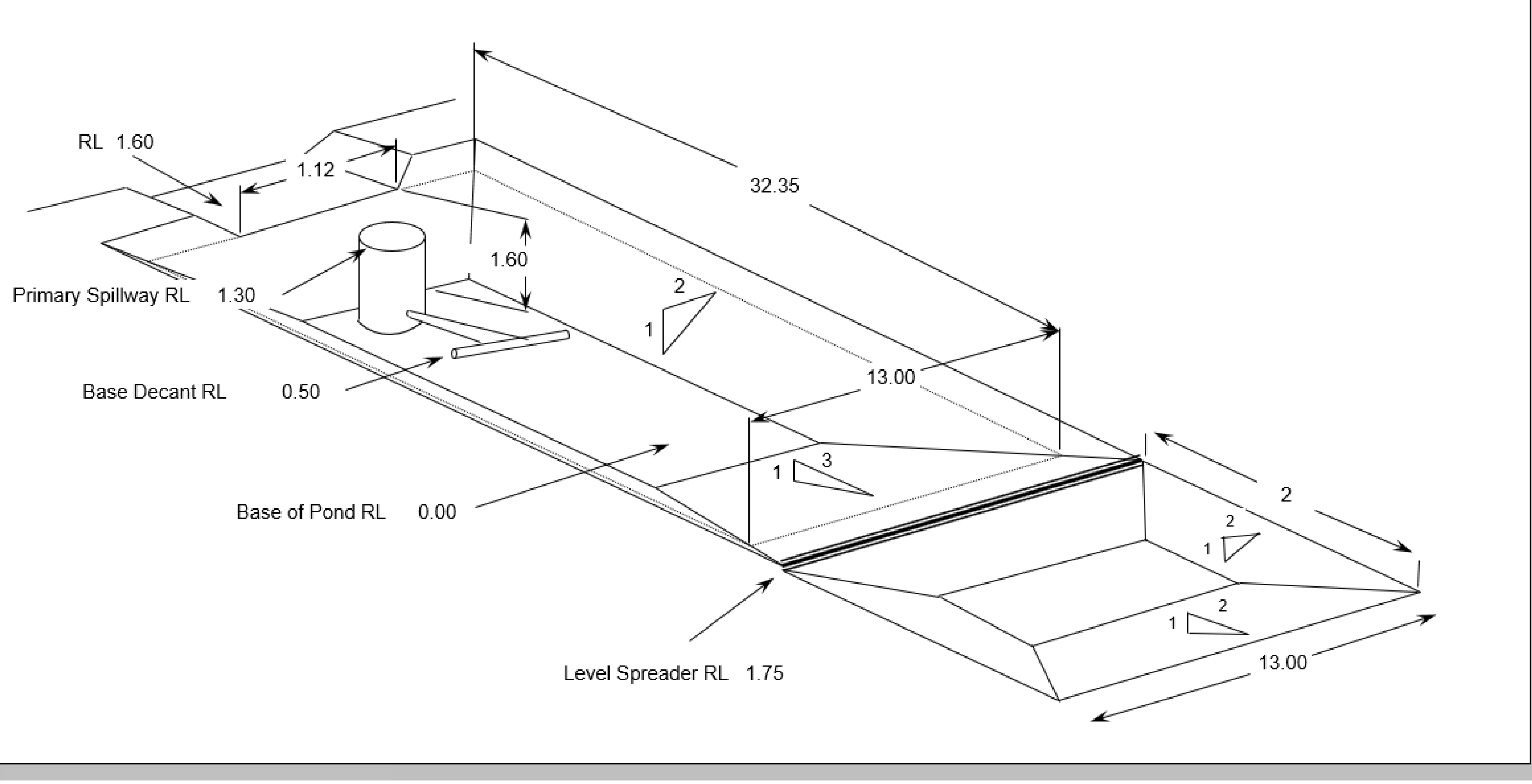

**Figure 2: Sediment retention pond for <1.5ha catchments.**

**Sediment Retention Pond Sizing**

| Size criteria | Length Ratio | Side slopes | Depth from Emergency Spillway | R.L. of Pond Base |
|---|---|---|---|---|
| Auto | 3:1 | 2:1 | 1.60 | 0.00 |

# SRP 7900WB

| | |
|---|---|
| Storage Volume Criteria | 3% |
| Contributing Catchment (ha) | 1.10 |
| Minimum Storage Volume (m3) | 330 |
| Length at Spillway Level | 32.35 |
| Width at Spillway Level | 13.00 |
| Spillway base width (300mm deep) | 1.12 |
| Primary Spillway diameter (min) | 150mm |
| Number of decants | 1 |
| Number of holes per decant | 146 |
| Minimum outlet diameter | 150mm |
| RL Emergency Spillway | 1.60 |
| RL Primary Spillway | 1.30 |
| RL Level Spreader (min) | 1.75 |
| RL Base Decant | 0.50 |




**Forebay**

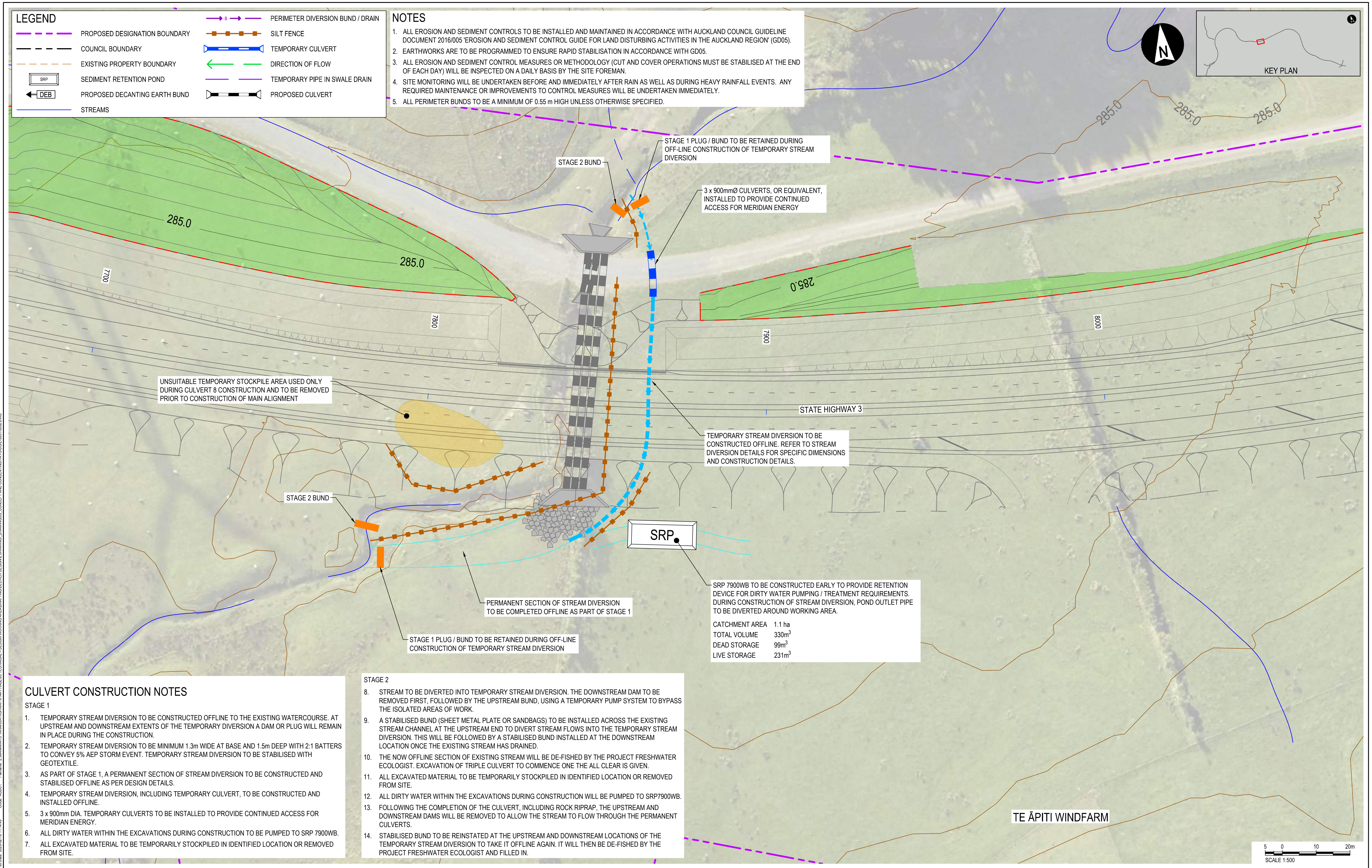
| | | |
|---|---|---|
| Depth | 1 m | min. depth |
| Width | 13.00 m | full width of pond |
| Length | 2 m | min. length |

## LEGEND

- PROPOSED DESIGNATION BOUNDARY
- COUNCIL BOUNDARY
- EXISTING PROPERTY BOUNDARY
- SRP — SEDIMENT RETENTION POND
- DEB — PROPOSED DECANTING EARTH BUND
- STREAMS
- PERIMETER DIVERSION BUND / DRAIN
- SILT FENCE
- TEMPORARY CULVERT
- DIRECTION OF FLOW
- TEMPORARY PIPE IN SWALE DRAIN
- PROPOSED CULVERT

## NOTES

1. ALL EROSION AND SEDIMENT CONTROLS TO BE INSTALLED AND MAINTAINED IN ACCORDANCE WITH AUCKLAND COUNCIL GUIDELINE DOCUMENT 2016/005 'EROSION AND SEDIMENT CONTROL GUIDE FOR LAND DISTURBING ACTIVITIES IN THE AUCKLAND REGION' (GD05).
2. EARTHWORKS ARE TO BE PROGRAMMED TO ENSURE RAPID STABILISATION IN ACCORDANCE WITH GD05.
3. ALL EROSION AND SEDIMENT CONTROL MEASURES OR METHODOLOGY (CUT AND COVER OPERATIONS MUST BE STABILISED AT THE END OF EACH DAY) WILL BE INSPECTED ON A DAILY BASIS BY THE SITE FOREMAN.
4. SITE MONITORING WILL BE UNDERTAKEN BEFORE AND IMMEDIATELY AFTER RAIN AS WELL AS DURING HEAVY RAINFALL EVENTS. ANY REQUIRED MAINTENANCE OR IMPROVEMENTS TO CONTROL MEASURES WILL BE UNDERTAKEN IMMEDIATELY.
5. ALL PERIMETER BUNDS TO BE A MINIMUM OF 0.55 m HIGH UNLESS OTHERWISE SPECIFIED.




## CULVERT CONSTRUCTION NOTES

STAGE 1

1. TEMPORARY STREAM DIVERSION TO BE CONSTRUCTED OFFLINE TO THE EXISTING WATERCOURSE. AT UPSTREAM AND DOWNSTREAM EXTENTS OF THE TEMPORARY DIVERSION A DAM OR PLUG WILL REMAIN IN PLACE DURING THE CONSTRUCTION.
2. TEMPORARY STREAM DIVERSION TO BE MINIMUM 1.3m WIDE AT BASE AND 1.5m DEEP WITH 2:1 BATTERS TO CONVEY 5% AEP STORM EVENT. TEMPORARY STREAM DIVERSION TO BE STABILISED WITH GEOTEXTILE.
3. AS PART OF STAGE 1, A PERMANENT SECTION OF STREAM DIVERSION TO BE CONSTRUCTED AND STABILISED OFFLINE AS PER DESIGN DETAILS.
4. TEMPORARY STREAM DIVERSION, INCLUDING TEMPORARY CULVERT, TO BE CONSTRUCTED AND INSTALLED OFFLINE.
5. 3 x 900mm DIA. TEMPORARY CULVERTS TO BE INSTALLED TO PROVIDE CONTINUED ACCESS FOR MERIDIAN ENERGY.
6. ALL DIRTY WATER WITHIN THE EXCAVATIONS DURING CONSTRUCTION TO BE PUMPED TO SRP 7900WB.
7. ALL EXCAVATED MATERIAL TO BE TEMPORARILY STOCKPILED IN IDENTIFIED LOCATION OR REMOVED FROM SITE.

STAGE 2

8. STREAM TO BE DIVERTED INTO TEMPORARY STREAM DIVERSION. THE DOWNSTREAM DAM TO BE REMOVED FIRST, FOLLOWED BY THE UPSTREAM BUND, USING A TEMPORARY PUMP SYSTEM TO BYPASS THE ISOLATED AREAS OF WORK.
9. A STABILISED BUND (SHEET METAL PLATE OR SANDBAGS) TO BE INSTALLED ACROSS THE EXISTING STREAM CHANNEL AT THE UPSTREAM END TO DIVERT STREAM FLOWS INTO THE TEMPORARY STREAM DIVERSION. THIS WILL BE FOLLOWED BY A STABILISED BUND INSTALLED AT THE DOWNSTREAM LOCATION ONCE THE EXISTING STREAM HAS DRAINED.
10. THE NOW OFFLINE SECTION OF EXISTING STREAM WILL BE DE-FISHED BY THE PROJECT FRESHWATER ECOLOGIST. EXCAVATION OF TRIPLE CULVERT TO COMMENCE ONE THE ALL CLEAR IS GIVEN.
11. ALL EXCAVATED MATERIAL TO BE TEMPORARILY STOCKPILED IN IDENTIFIED LOCATION OR REMOVED FROM SITE.
12. ALL DIRTY WATER WITHIN THE EXCAVATIONS DURING CONSTRUCTION WILL BE PUMPED TO SRP7900WB.
13. FOLLOWING THE COMPLETION OF THE CULVERT, INCLUDING ROCK RIPRAP, THE UPSTREAM AND DOWNSTREAM DAMS WILL BE REMOVED TO ALLOW THE STREAM TO FLOW THROUGH THE PERMANENT CULVERTS.
14. STABILISED BUND TO BE REINSTATED AT THE UPSTREAM AND DOWNSTREAM LOCATIONS OF THE TEMPORARY STREAM DIVERSION TO TAKE IT OFFLINE AGAIN. IT WILL THEN BE DE-FISHED BY THE PROJECT FRESHWATER ECOLOGIST AND FILLED IN.

| REV | DATE | REVISION DETAILS | APPROVED |
|---|---|---|---|
| A | 24/02/2020 | ISSUED FOR REGIONAL CONSENT | D. McGAHAN |

CLIENT: WAKA KOTAHI NZ TRANSPORT AGENCY — Te Ahu a Turanga Manawatū Tararua Highway

| | |
|---|---|
| SCALE | 1:500 |
| SIZE | A1 |
| DRAWN | L. STEINER |
| DESIGNED | C. STEWART |
| REVIEWED | D. MACKINTOSH |
| APPROVED | T. WATTERSON |
| STATUS | CONSENT — NOT FOR CONSTRUCTION |
| PROJECT | TE AHU A TURANGA: MANAWATŪ TARARUA HIGHWAY |
| TITLE | SITE SPECIFIC EROSION AND SEDIMENT CONTROL CULVERT 8 (CH 7850) |
| DRAWING No. | TAT - 3 - DG - E - 3832 - A |

OPT340 23/01/20

# 1 SSESCP-003 - CONSTRUCTION NOTES

## 1.1 Scope

This Site-Specific Erosion and Sediment Control Plan (SSESCP) covers the construction activities associated with the construction of the main alignment from Chainage 12100 to Chainage 12900.

The proposed erosion and sediment control measures have been designed in accordance with the Auckland Council's Guideline Documents 2016/005 *'Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region, June 2016'* (GD05).

Earthworks associated with this SSESCP:

- Construction of erosion and sediment controls;
- General earthworks; and
- Disposal areas and Stockpiling;

Reference drawings:

- TAT-3-DG-E-3833-A
- TAT-3-DG-E-3834-A
- TAT-3-DG-E-3835-A

## 1.2 Methodology

- Prior to the commencement of any earthworks the Construction Manager will inspect the site to confirm the suitability of the proposed controls and methodologies.
- At the approximate location, as detailed in the attached drawings, the erosion and sediment controls will be constructed.
- Erosion and sediment control will be managed primarily using sediment retention ponds (SRP's), as well as decanting earth bunds (DEB's) in small isolated areas that cannot drain to the sites SRP's. Please refer to the erosion and sediment control (ESC) design details and schedule in Appendix A.
- Perimeter bunds will be constructed to divert runoff from the earth worked areas to their respective sediment control measures. The perimeter bunds have been designed to convey the 5% Annual Exceedance Probability (AEP) rain event. Supporting calculations can be found in Appendix A.
- The perimeter bunds will be stabilised.
- The site will be accessed via the eastern access track off Hope Road.
- Once the erosion and sediment controls have been installed and as-builted the earthworks will commence.

### Bulk Earthworks

- SRP's and DEB's are to be constructed at the approximate locations shown on the attached drawings and have been sized to provide treatment for each section of works.
- The bulk earthworks will be conducted as a standard cut to fill operation where cut material from Chainage 12100 to Chainage 12525 will be cut and used as fill from Chainage 12525 to Chainage 12900.
- The earthworks from Chainage 12100 to 12300 will be undertaken in a way that ensures that runoff will fall into site, towards SRP 12550.
- Staged perimeter bunds will be constructed along the alignment to ensure that runoff is directed to the SRP.
- Topsoil will be stockpiled in the location shown on the attached drawings. Topsoil on the flats between Chainage 12600 to Chainage 12900 will be formed into the perimeter bunds, enlarging the minimum size of the perimeter bunds.

### As-Builts

- An as-built will be completed immediately following construction of to confirm that they have been constructed in accordance with the SSESCPs and GD05. These as-builts will be submitted to Horizons Regional Council (Horizons) prior to the commencement of earthworks in the respective catchment of the device.
- The as-built documentation will include the SRP and DEB dose rates, catchment tray size and header tank specification for each chemical treatment system.

### Construction Timetable

Construction timetable - TBC

## 1.3 Operation and Maintenance

- The environmental and erosion and sediment control measures will be inspected and signed off by the Environmental Manager or Advisor prior to commencement of works.
- All erosion and sediment control structures will be inspected on a weekly basis and within 24 hours of each rainstorm event that is likely to impair the function of performance of the controls.
- A record will be maintained of the date and time of inspections undertaken, any maintenance requirements identified, and any maintenance undertaken.
- All erosion and sediment measures are to be monitored and maintained throughout the works until the site is stabilised.

## 1.4 Exclusion Zones

No works are to be undertaken within the Mangamanaia Stream or any of its tributaries.

No sensitive native vegetation or wetland areas are associated with this SSESCP.

## 1.5 Chemical Treatment

- Chemical Treatment will be undertaken in accordance the site's Chemical Treatment Management Plan (CTMP).
- The SRP's and DEB's will be chemically treated by way of a rainfall activated floc shed.
- Ongoing monitoring and maintenance will be undertaken in accordance with the CTMP. Any change to the dose rate of delivery mechanism will be confirmed in writing to Horizons.

## 1.6 Dust Management

- The emphasis of the site dust strategy will be one of prevention and will be covered in more detail in the Dust Management Procedure (refer to Appendix C of the ESCP).
- The topsoil stockpiles and bunds will be stabilised progressively.
- Vehicle movements on site will be governed by speed restrictions (30km through most of the site, 20KM around sensitive residential receivers) which will, among other things, assist in preventing dust generation.
- A water cart will be made available if required. The Site Engineer will obtain daily forecasts and circulate to all appropriate staff to ensure that during dry weather everyone knows the probability of dust creation. Dust control measures will be put on standby if dry, windy conditions are forecast.

# Appendix A – Erosion and Sediment Control Details

## Perimeter Bund Sizing Summary

| Perimeter Bunding | | | | | | |
|---|---|---|---|---|---|---|
| 5% AEP (24 hr) rainfall | Maximum Catchment Area | Peak Flow (m3/s) | Base Width | Slope | Minimum Design Flow Depth | Including Minimum 300mm Freeboard |
| 98mm | 4ha | 0.459 | 0.5m | 2% | 250mm | 550mm |

In accordance with the Auckland Council's GD05 the perimeter bunds are sized to have sufficient capacity to safely carry the flow from a 5% AEP storm, plus a freeboard of 300mm. A minimum bund height of 550mm (200mm plus 300mm freeboard), will be installed across the project for catchment areas up to 4ha.

The site's perimeter bunds will be constructed as per one of the following cross-sections depending on their main purpose to be confirmed onsite by the ESC Management Team:

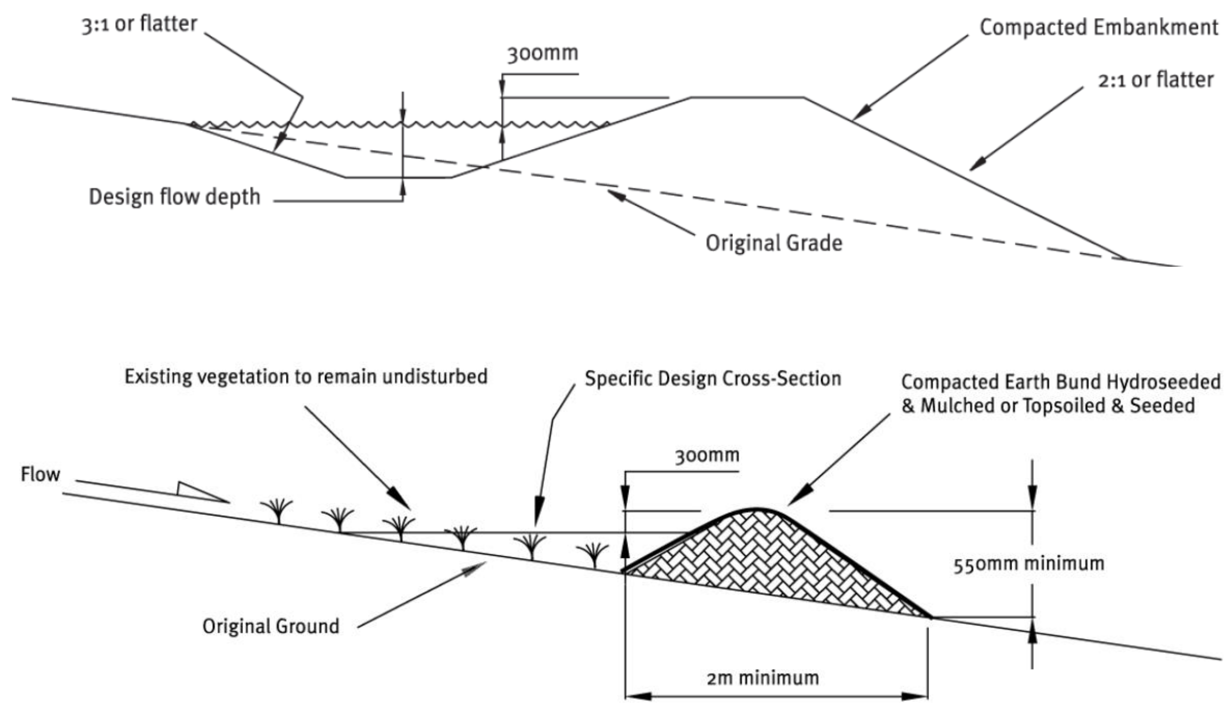



**Figure 1: Perimeter bund cross-sections.**

## Decanting Earth Bund Design Details

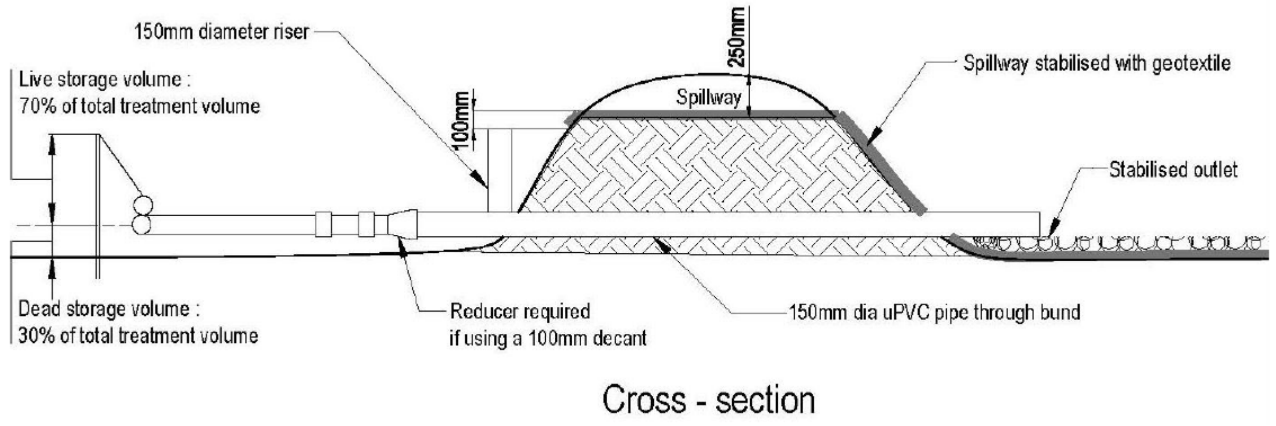



**Figure 2: Decanting earth bund cross-section.**

## Sediment Control Schedule

| Device | Catchment (maximum) | Volume (minimum) | Dimensions (L x W x D) |
|---|---|---|---|
| SRP 12550 | 4ha | 1200m$^3$ | 51.77m x 19.94m x 2m |
| SRP 12800 | 2.5ha | 750m$^3$ | 42.13m x 16.73m x 2m |
| SRP 12850 | 3.5ha | 1050m$^3$ | 48.8m x 18.95m x 2m |
| DEB 12200 | 2,000m$^2$ | 40m$^3$ | 12m x 3.5m x 1m |
| DEB 12330 | 2,000m$^2$ | 40m$^3$ | 12m x 3.5m x 1m |

NZ TRANSPORT AGENCY WAKA KOTAHI | Te Ahu a Turanga Manawatū Tararua Highway

**Sediment Retention Pond Sizing**

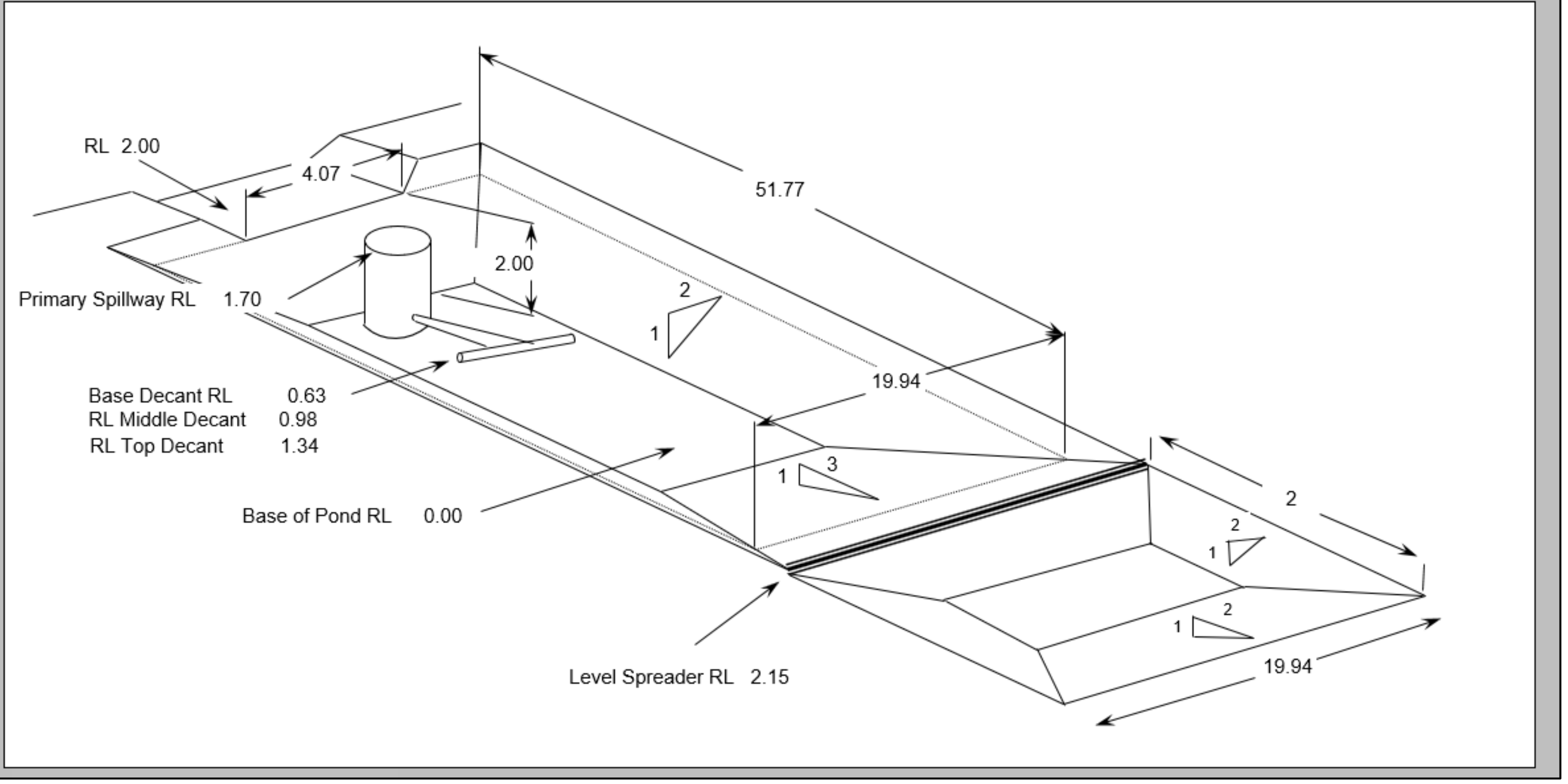
## SRP 12550

| Size criteria | Length Ratio | Side slopes | Depth from Emergency Spillway | R.L. of Pond Base |
|---|---|---|---|---|
| Auto | 3:1 | 2:1 | 2.00 | 0.00 |

| | |
|---|---|
| Storage Volume Criteria | 3% |
| Contributing Catchment (ha) | 4.00 |
| Minimum Storage Volume (m3) | 1200 |
| Length at Spillway Level | 51.77 |
| Width at Spillway Level | 19.94 |
| Spillway base width (300mm deep) | 4.07 |
| Primary Spillway diameter (min) | Manhole Required |
| Number of decants | 3 |
| Number of holes per decant | 177 |
| Minimum outlet diameter | 300mm |
| RL Emergency Spillway | 2.00 |
| RL Primary Spillway | 1.70 |
| RL Level Spreader (min) | 2.15 |
| RL Base Decant | 0.63 |
| RL Middle Decant | 0.98 |
| RL Top Decant | 1.34 |

**Forebay**

| | | |
|---|---|---|
| Depth | 1 m | min. depth |
| Width | 19.94 m | full width of pond |
| Length | 2 m | min. length |




**Sediment Retention Pond Sizing**

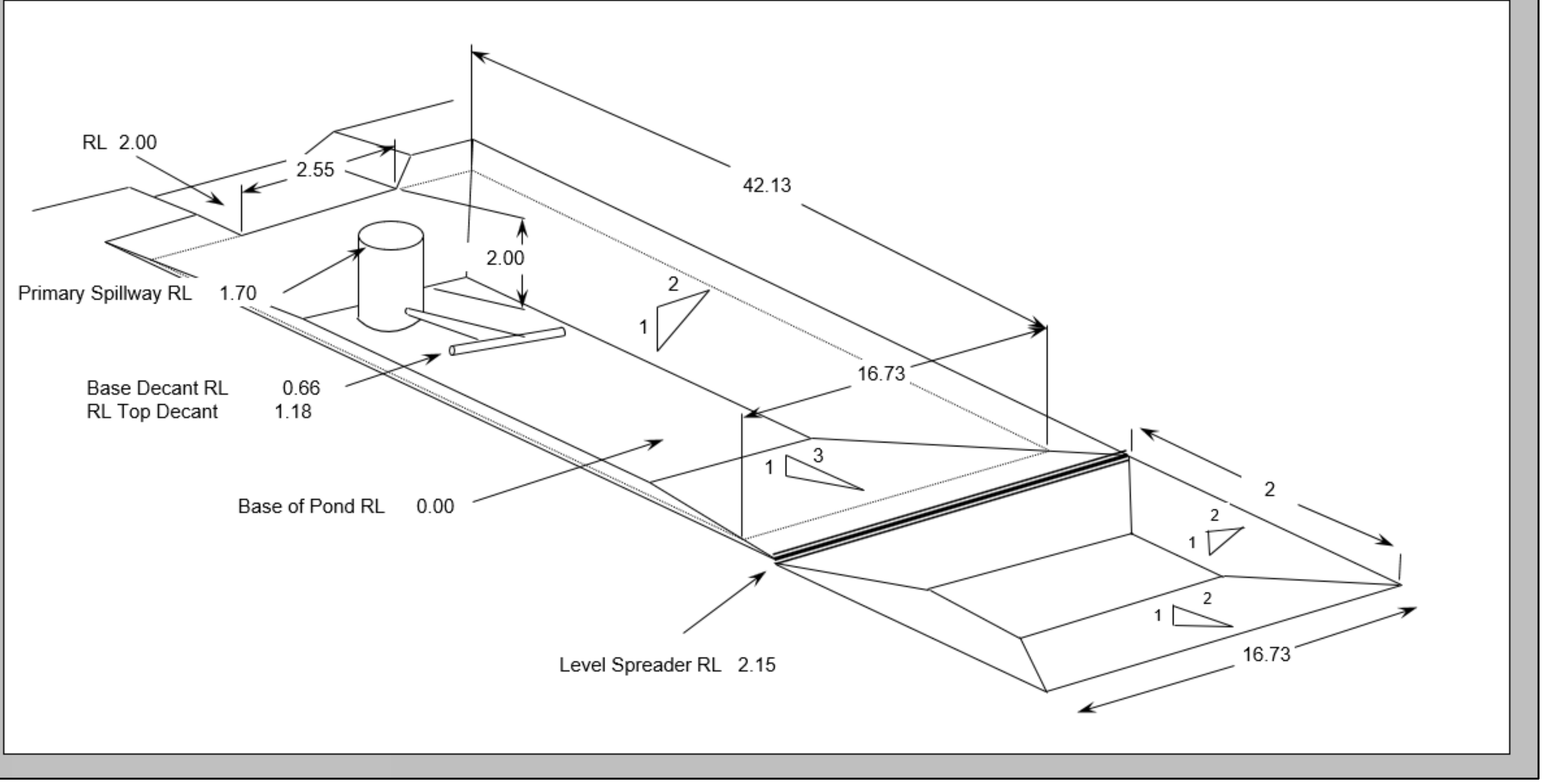
## SRP 12800

| Size criteria | Length Ratio | Side slopes | Depth from Emergency Spillway | R.L. of Pond Base |
|---|---|---|---|---|
| Auto | 3:1 | 2:1 | 2.00 | 0.00 |

| | |
|---|---|
| Storage Volume Criteria | 3% |
| Contributing Catchment (ha) | 2.50 |
| Minimum Storage Volume (m3) | 750 |
| Length at Spillway Level | 42.13 |
| Width at Spillway Level | 16.73 |
| Spillway base width (300mm deep) | 2.55 |
| Primary Spillway diameter (min) | 150mm |
| Number of decants | 2 |
| Number of holes per decant | 166 |
| Minimum outlet diameter | 150mm |
| RL Emergency Spillway | 2.00 |
| RL Primary Spillway | 1.70 |
| RL Level Spreader (min) | 2.15 |
| RL Base Decant | 0.66 |
| RL Top Decant | 1.18 |

**Forebay**

| | | |
|---|---|---|
| Depth | 1 m | min. depth |
| Width | 16.73 m | full width of pond |
| Length | 2 m | min. length |



**Sediment Retention Pond Sizing**

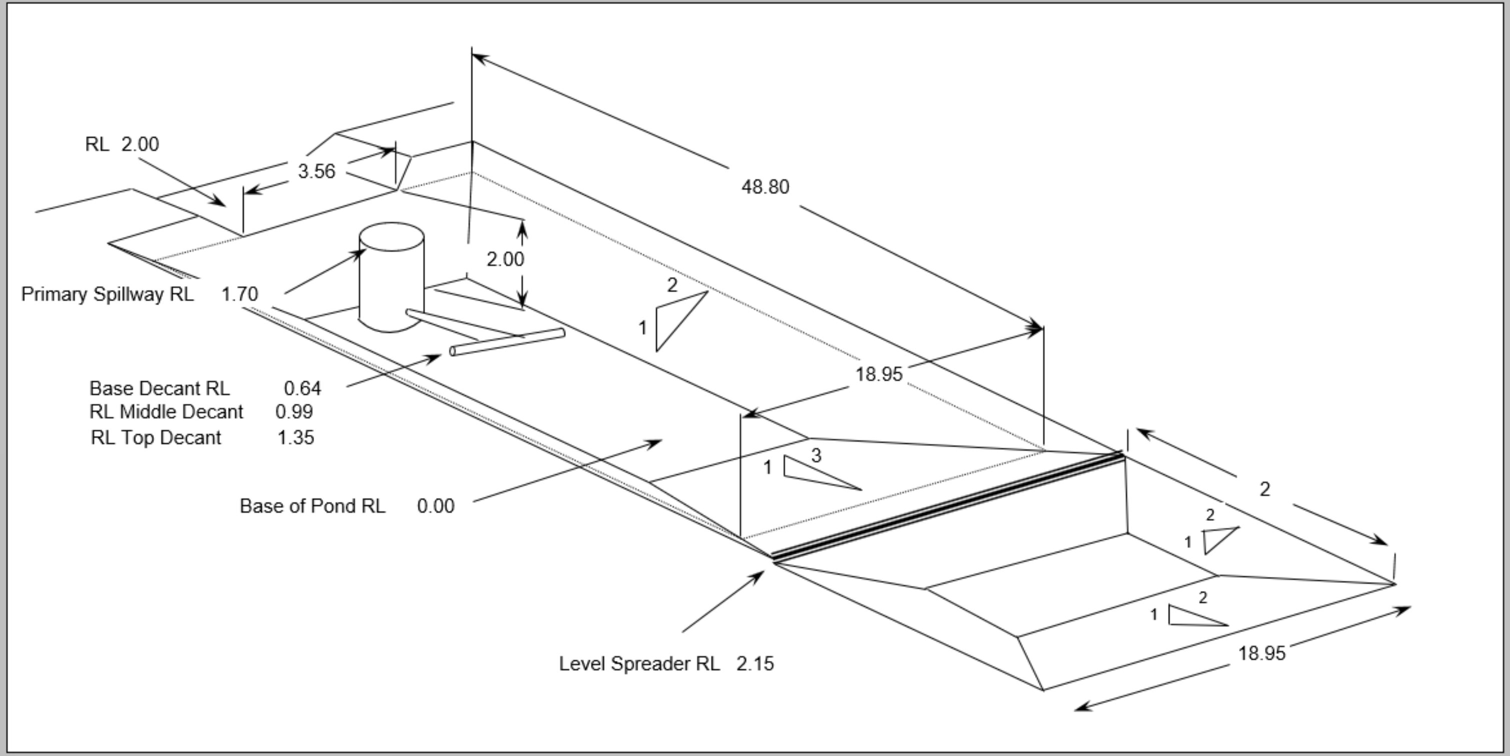
| Size criteria | Length Ratio | Side slopes | Depth from Emergency Spillway | R.L. of Pond Base |
|---|---|---|---|---|
| Auto | 3:1 | 2:1 | 2.00 | 0.00 |

# SRP 12850

| | |
|---|---|
| Storage Volume Criteria | 3% |
| Contributing Catchment (ha) | 3.50 |
| Minimum Storage Volume (m3) | 1050 |
| Length at Spillway Level | 48.80 |
| Width at Spillway Level | 18.95 |
| Spillway base width (300mm deep) | 3.56 |
| Primary Spillway diameter (min) | Manhole Required |
| Number of decants | 3 |
| Number of holes per decant | 155 |
| Minimum outlet diameter | 300mm |
| RL Emergency Spillway | 2.00 |
| RL Primary Spillway | 1.70 |
| RL Level Spreader (min) | 2.15 |
| RL Base Decant | 0.64 |
| RL Middle Decant | 0.99 |
| RL Top Decant | 1.35 |

**Forebay**

| | | |
|---|---|---|
| Depth | 1 m | min. depth |
| Width | 18.95 m | full width of pond |
| Length | 2 m | min. length |



## LEGEND

- PROPOSED DESIGNATION BOUNDARY
- COUNCIL BOUNDARY
- EXISTING PROPERTY BOUNDARY
- SRP — SEDIMENT RETENTION POND
- DEB — PROPOSED DECANTING EARTH BUND
- STREAMS
- PERIMETER DIVERSION BUND / DRAIN
- SILT FENCE
- TEMPORARY CULVERT
- DIRECTION OF FLOW
- TEMPORARY PIPE IN SWALE DRAIN
- PROPOSED CULVERT

## NOTES

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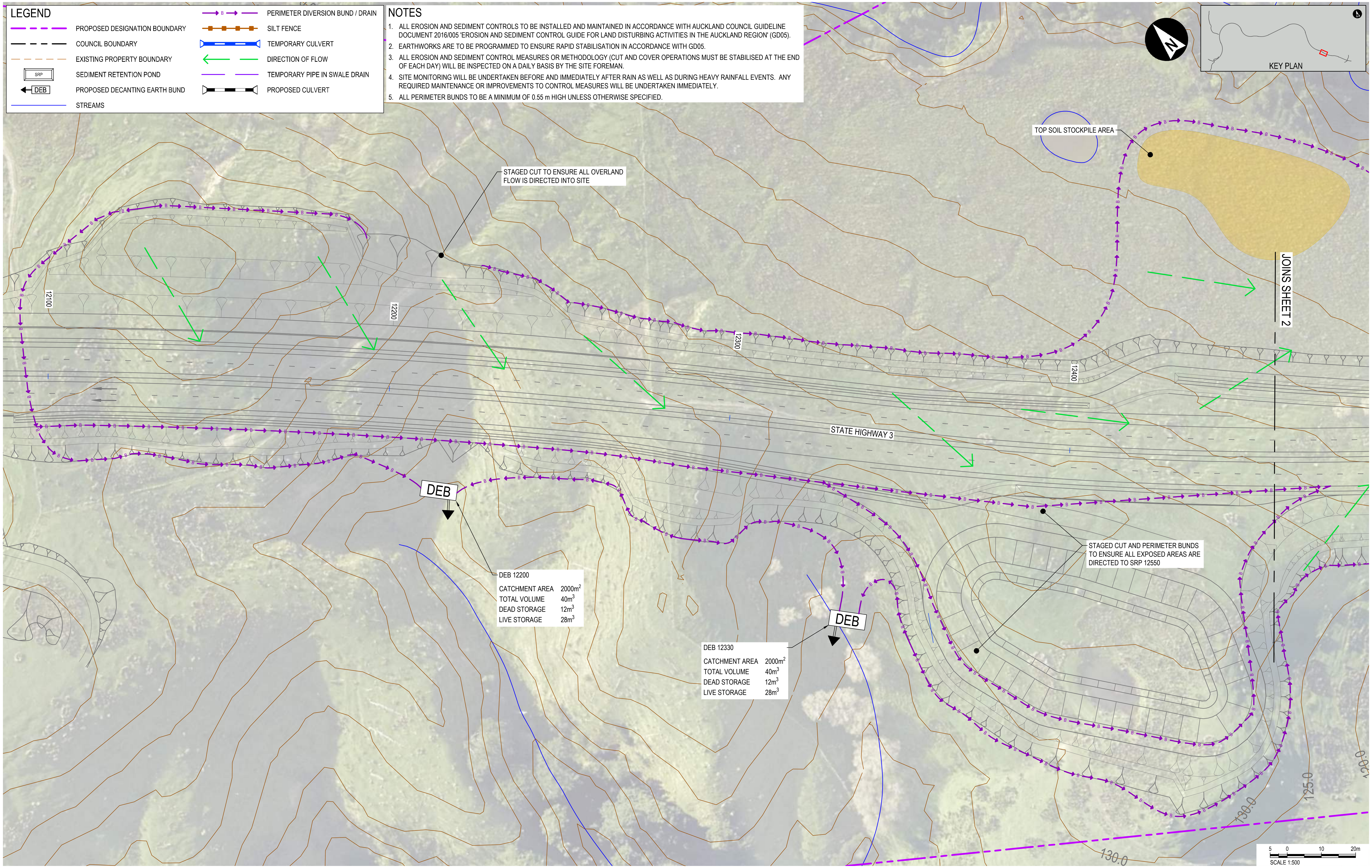


CLIENT: WAKA KOTAHI NZ TRANSPORT AGENCY — Te Ahu a Turanga Manawatū Tararua Highway

| REV | DATE | REVISION DETAILS | APPROVED |
|---|---|---|---|
| A | 24/02/2020 | ISSUED FOR REGIONAL CONSENT | D. McGAHAN |

SCALE: 1:500 | SIZE: A1

DRAWN: L. STEINER
DESIGNED: C. STEWART
REVIEWED: D. MACKINTOSH

CONSENT
NOT FOR CONSTRUCTION

APPROVED: T. WATTERSON | DATE

PROJECT: TE AHU A TURANGA: MANAWATŪ TARARUA HIGHWAY

TITLE: SITE SPECIFIC EROSION AND SEDIMENT CONTROL
CH 12100 - 12900
SHEET 1

| DRAWING No. | PROJECT No. | PHASE | TYPE | DISC | NUMBER | REV |
|---|---|---|---|---|---|---|
| | TAT | 3 | DG | E | 3833 | A |

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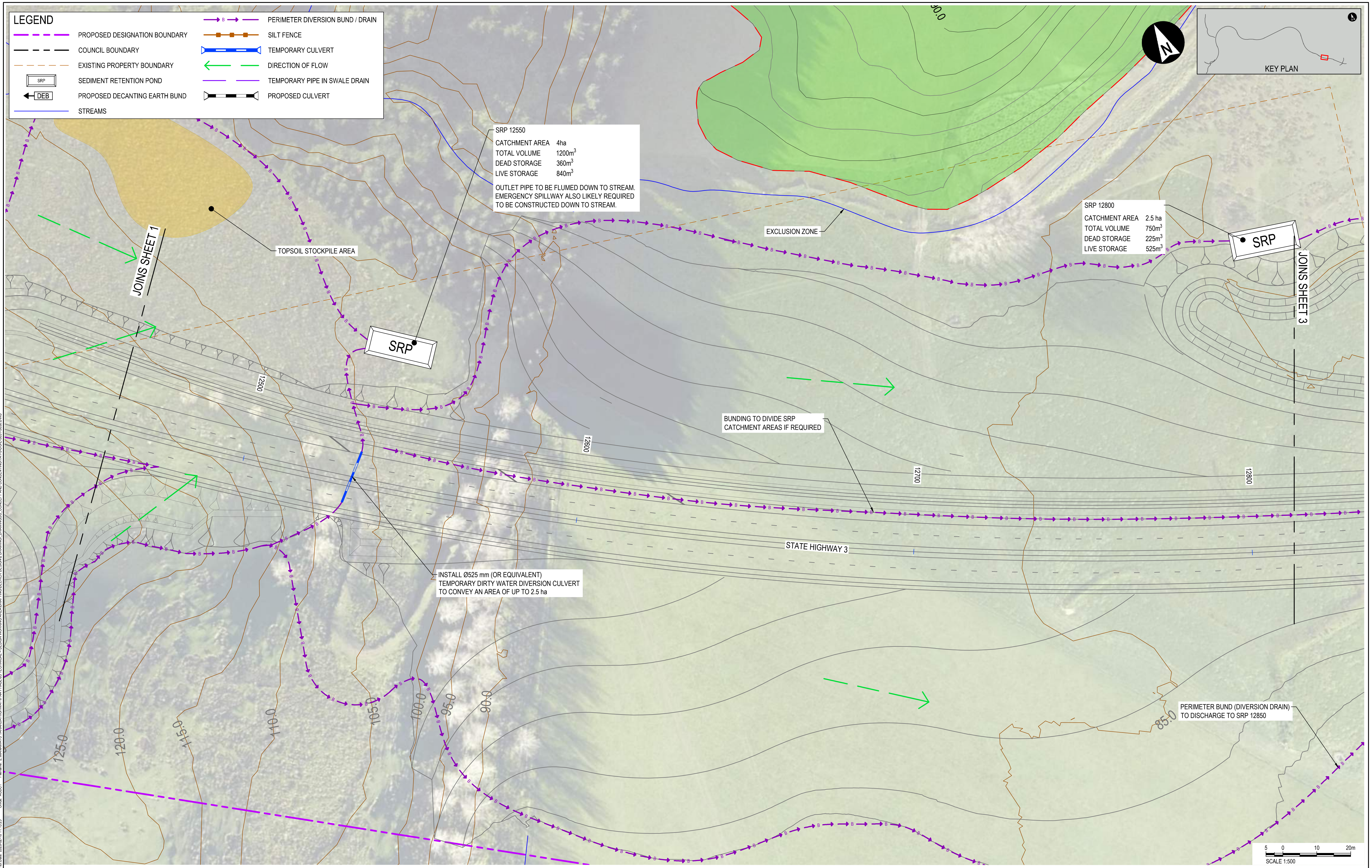


| CLIENT | REV | DATE | REVISION DETAILS | APPROVED |
|---|---|---|---|---|
| WAKA KOTAHI NZ TRANSPORT AGENCY — Te Ahu a Turanga Manawatū Tararua Highway | A | 24/02/2020 | ISSUED FOR REGIONAL CONSENT | D. McGAHAN |

SCALE: 1:500 | SIZE: A1

CONSENT
NOT FOR CONSTRUCTION

DRAWN: L. STEINER
DESIGNED: C. STEWART
REVIEWED: D. MACKINTOSH
APPROVED: T. WATTERSON DATE

PROJECT: TE AHU A TURANGA: MANAWATŪ TARARUA HIGHWAY

TITLE: SITE SPECIFIC EROSION AND SEDIMENT CONTROL
CH 12100 - 12900
SHEET 2

| DRAWING No. | PROJECT No. | PHASE | TYPE | DISC | NUMBER | REV |
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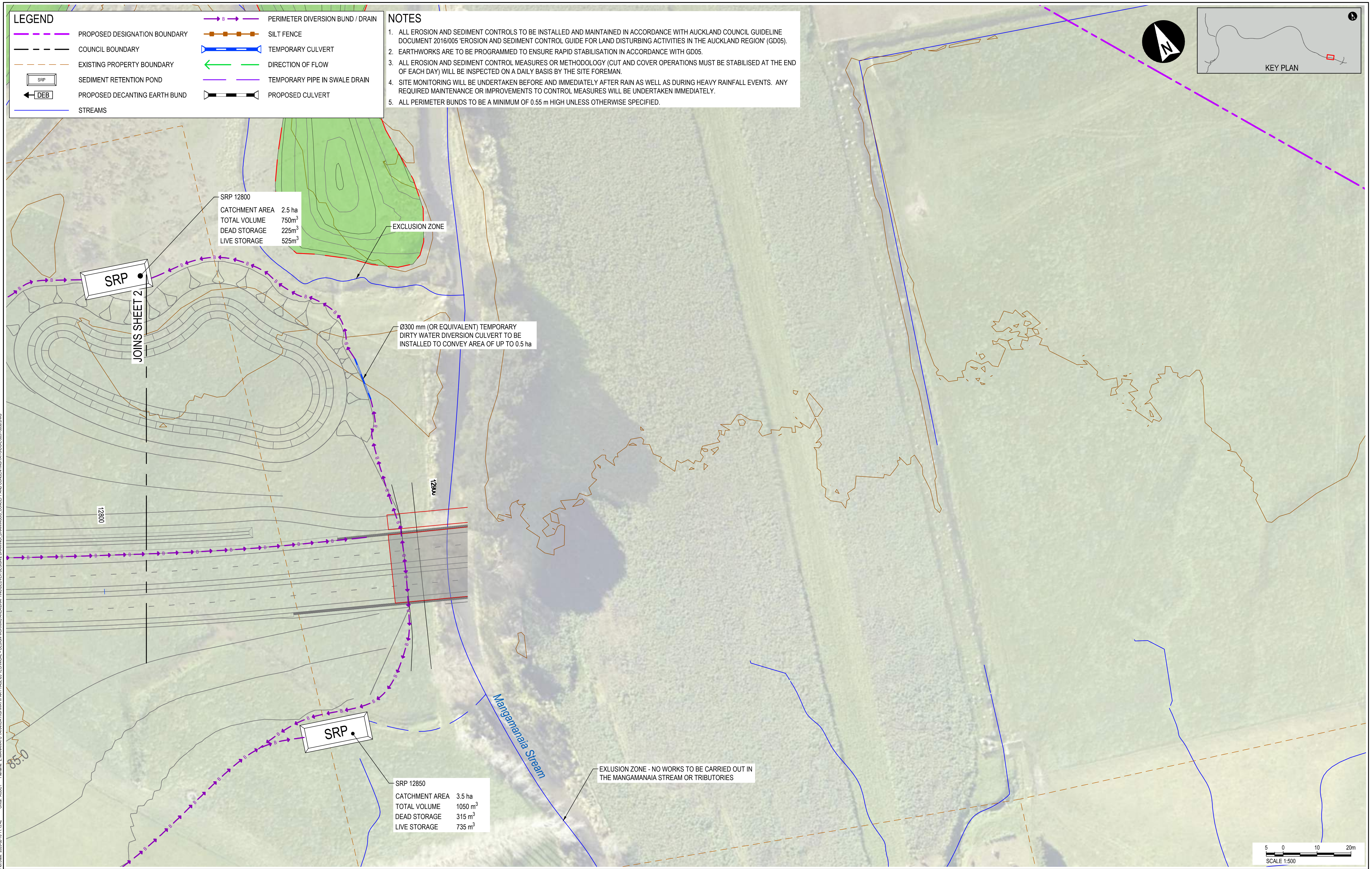
OPT340 23/01/20




| CLIENT | REV | DATE | REVISION DETAILS | APPROVED |
|---|---|---|---|---|
| WAKA KOTAHI NZ TRANSPORT AGENCY — Te Ahu a Turanga Manawatū Tararua Highway | A | 24/02/2020 | ISSUED FOR REGIONAL CONSENT | D. McGAHAN |

| | |
|---|---|
| SCALE | 1:500 |
| SIZE | A1 |
| DRAWN | L. STEINER |
| DESIGNED | C. STEWART |
| REVIEWED | D. MACKINTOSH |
| CONSENT | NOT FOR CONSTRUCTION |
| APPROVED | T. WATTERSON |
| DATE | |
| PROJECT | TE AHU A TURANGA: MANAWATŪ TARARUA HIGHWAY |
| TITLE | SITE SPECIFIC EROSION AND SEDIMENT CONTROL CH 12100 - 12900 SHEET 3 |

| DRAWING No. | PROJECT No. | PHASE | TYPE | DISC | NUMBER | REV |
|---|---|---|---|---|---|---|
| | TAT | 3 | DG | E | 3835 | A |

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# Attachment 7

## Updates to Table 2 to address inconsistencies

Corrections to the Tables are shown in **underlined red** for new text, and ~~strikethrough~~ for deleted text.

**Table 2: 'Ecological Values' assessment (as per EcIA guidelines) for each notable habitat present in the Project footprint**

| Ecosystem types | Value of Vegetation/habitats (as per EIANZ guidelines) | 'Ecological Value' (EcIAG) |
|---|---|---|
| Old growth forest (alluvial) | Representativeness: **High**<br>• Dominated by indigenous species.<br>• Generally a typical structure and composition with the exception of the lower tiers which have be grazed by stock.<br>• However, the impacts of grazing on the lower tiers and the absence of mammalian pest control suggest that the area may not support a full fauna assemblage, but will be more representative than many habitats given that old growth forest is now rare across the Region.<br>Rarity/distinctiveness: **High**<br>• Old growth hardwood forest is threatened in the Manawatū Region (Maseyk, 2007).<br>• The alluvial old growth forest occurs within a land environment where only 10 - 20% of indigenous cover remains (LENZ Level IV - Walker et al., 2015).<br>• Includes a stand of Threatened - Nationally Critical swamp maire.<br>• At Risk - Declining whitehead birds have been confirmed in this forest type.<br>• Likely to support At Risk and Not Threatened gecko species including:<br>– Barking gecko, Ngahere gecko, Raukawa gecko, Pacific gecko, glossy brown skink, ornate skink, northern grass skink.<br>– Note, this habitat is less likely to support ground-dwelling skinks due to stock access.<br>Diversity and Pattern: **High**<br>• A diverse indigenous vegetation assemblage but browsing pressure has resulted in decreased diversity the lower tiers.<br>• Unlikely to support sensitive ground-dwelling invertebrates due to stock degradation. | **Very High**: High for 3 or all of the four assessment matters |

| Ecosystem types | Value of Vegetation/habitats (as per EIANZ guidelines) | 'Ecological Value' (EcIAG) |
|---|---|---|
| | Ecological context: **High**<br>• Relatively large tract of forest with connectivity to the Manawatū Scenic Reserve.<br>• Part of a mosaic of alluvial habitats including raupō wetlands and swamp maire forest.<br>• The diverse, old-growth canopy suggests the area could be effectively restored via stock exclusion and targeted weed control/suppression. | |
| Old-growth forest (hill country) | Generally as above but noting:<br>• The hill country forest is located within a QEII covenant, grazing pressure is still evident in the lower tiers but notably less degradation compared to the alluvial forest described above.<br>• Swamp maire not present but Threatened - Nationally Critical *Lophomyrtus* species observed as well as Threatened - Nationally Vulnerable rata species.<br>• Historically hill country forest has not been under as much clearance pressure for agricultural purposes, however, it is old-growth tawa forest and still considered threatened in the region.<br>• This forest patch is not part of the alluvial mosaic but directly buffers a high value watercourse. | **Very High:** High for 3 of the assessment matters |
| Secondary broadleaved forests with old-growth signatures | Representativeness: **High**<br>• Dominated by indigenous species.<br>• Secondary forest subject to prior modification, but with old-growth characteristics demonstrating an advanced successional stage on a trajectory towards representative old-growth forest.<br>Rarity/distinctiveness: **High**<br>• These remnants occur across land environments where either, <10%, or 10 - 20% of indigenous cover remains (LENZ Level IV - Walker et al., 2015).<br>• Given advanced successional stage, I have assessed this habitat type as old-growth and is thus considered threatened under the One Plan.<br>• Threatened - Nationally Vulnerable rata species recorded in this habitat.<br>Diversity and Pattern: **High**<br>• Generally high flora diversity but does not contain the full range of old growth species present in the habitat types above. | **Very High**: High for 3 of the assessment matters, 'Moderate' for the remainder |

| Ecosystem types | Value of Vegetation/habitats (as per EIANZ guidelines) | 'Ecological Value' (EcIAG) |
|---|---|---|
| | • All of the fauna species described in the 'old-growth forest alluvial' habitat type above could potentially inhabit the patches of this forest type also.<br>• With the exception of the larger remnant (CH 10400 - CH 10500), the size of the patches and their isolation from the Manawatū Gorge Scenic Reserve suggest that the areas are less likely to support less mobile species such as lizards and ground-dwelling invertebrates. Although remnant populations could exist.<br><br>Ecological context: **'Moderate'**<br>• The patches of this habitat vary in size but three of the four patches are less than 0.5 ha.<br>• The sensitivity to edge effects of these small patches is somewhat mitigated because they are located within a mosaic of habitat types.<br>• The fourth remnant (CH 10400 - CH 10550) is part of an assemblage covering approximately 8.5 ha.<br>• The old growth trees are likely an important seed source for the less advanced habitat types within the mosaics.<br>• Only one small patch (CH 7300 - CH 7400) has direct connectivity to the Manawatū Gorge Scenic Reserve.<br>• These patches sit with an agricultural matrix and likely provide stepping stone habitat for mobile species when dispersing between the Scenic Reserve and forest patches to the north. | |
| Old-growth treelands | Representativeness: **'Moderate'**<br>• Canopy dominated by indigenous species<br>• Understory and ground tiers essentially absent thus structure and composition is not representative of pre-human old-growth forest.<br>• The limited structural and flora diversity suggests that these areas are unlikely to support the typical fauna assemblage expected of old-growth vegetation.<br>• The likelihood of the treeland patches supporting a representative fauna assemblage if further limited by the small size of the patches.<br>• The areas are not subject to pest control.<br>Rarity/distinctiveness: **High** | **'Moderate':** High for one matter, 'Moderate' and 'Low' for the remainder |

| Ecosystem types | Value of Vegetation/habitats (as per EIANZ guidelines) | 'Ecological Value' (EcIAG) |
|---|---|---|
| | • Although the treelands are not representative of pre-human old-growth forest, old-growth treeland is still considered threatened under the One Plan.<br>• The treeland remnants all occur across land environments where 10 - 20% of indigenous cover remains (LENZ Level IV - Walker et al., 2015).<br>• Threatened - Nationally Critical ramarama recorded in the habitat patch between Chainage 5700 - 5800. The threat status of ramarama was elevated from Not Threatened due the risk imposed by myrtle rust. There is evidence to suggest the *Lophomyrtus* species are particularly susceptible to myrtle rust.<br>• Threatened - Nationally Vulnerable rata species recorded in this habitat.<br>• The treeland areas are likely to be used, at least occasionally by mobile At Risk species such as whitehead but the limited flora diversity indicates that these areas are unlikely to support a diverse invertebrate assemblage and thus, are unlikely to be core habitat insectivorous species such as whitehead.<br>• Remnant populations of arboreal lizards such as Barking gecko, Ngahere gecko, Raukawa gecko and Pacific gecko could occur in this habitat. This is more likely in the patch between CH 4050 - CH 4150 because of its connectivity to the more intact old-growth forest.<br>• The heavily grazed ground tier suggests it is unlikely to support populations of Threatened or At Risk ground dwelling lizards or invertebrates.<br>Diversity and Pattern: **Low**<br>• The absence of all structural tiers except the canopy limits the diversity of these areas.<br>• The generally small size of the patches suggests the areas are subject to limited underlying abiotic diversity.<br>Ecological context: **'Moderate'**<br>• The individual patches (all smaller than 0.2 ha) are small and have limited structural and flora diversity to represent key source habitats in the landscape.<br>• However, the old-growth trees provide habitat characteristics such as cavities which are rare, and often a limiting resource for native species such as cavity-nesting birds and bats.<br>• These the mature trees will also provide a seed source to more intact habitat types in the surrounding landscape as well as a fruit source for birds. | |

| Ecosystem types | Value of Vegetation/habitats (as per EIANZ guidelines) | 'Ecological Value' (EcIAG) |
|---|---|---|
| Kānuka Forests | Representativeness: **Low**<br>• Dominated by indigenous species.<br>• Limited diversity of native broadleaved species in the canopy and in lower tiers.<br>• The understory and ground tiers are modified by ungulate grazing, the extent of stock damage varies between areas.<br>• kānuka forest occurring across the Project is an artefact of stock degradation suppressing broadleaved species from establishing. Kānuka forest would not have occurred in the area naturally.<br>• The limited structural and flora diversity suggests that these areas are unlikely to support the typical fauna assemblage expected of forest at this successional stage in the absence of ungulate browsing pressure.<br>• Only the area between CH 5100 - CH 5200 is subject to pest control.<br>Rarity/distinctiveness: **High**<br>• Kānuka is Threatened - Nationally Vulnerable.<br>• Given the direct connectivity to the Manawatū Gorge Scenic Reserve it is likely that the At Risk whitehead use the habitat at least occasionally. However, it is unlikely to be preferred habitat when compared to the old-growth forest types in close proximity.<br>• It is likely that At Risk lizards occur in this habitat given its direct connectivity to the Manawatū Gorge Scenic Reserve. This is particularly the case for arboreal lizards such as: Barking gecko, Ngahere gecko, Raukawa gecko, and Pacific gecko.<br>• Mature kānuka forest has been demonstrated to support a similar invertebrate assemblage to old-growth forest (but this is not case for less mature grazed stands). This forest type has the potential to support At Risk invertebrates such as *Meterana* species.<br>• Kānuka forest is considered threatened in the Horizons One Plan, but as above, kānuka forest would not have occurred in the area naturally.<br>• The Kānuka Forest patches all occur across land environments where 10 - 20% of indigenous cover remains (LENZ Level IV - Walker et al., 2015).<br>Diversity and Pattern: **Low**<br>• The diversity in this habitat type is limited. | '**Moderate**': high for one matter, 'Moderate' and 'Low'for the remainder |

| Ecosystem types | Value of Vegetation/habitats (as per EIANZ guidelines) | 'Ecological Value' (EcIAG) |
|---|---|---|
| | • As discussed above, the vegetation assemblage does not reflect underlying abiotic patterns, instead it is likely a result of heavy ungulate browse suppressing broadleaved species.<br>Ecological context: **'Moderate'**<br>• All kānuka forest patches are either contiguous with, or in close vicinity, to the Manawatū Gorge Scenic Reserve or the Western QEII covenant.<br>• The patch between CH 3900 - CH 4300, is large (approximately 3 ha) and forms part of the much large forest assemblage of the Scenic Reserve.<br>• The patch between CH 3900 - CH 4300 buffers to the raupō wetland immediately to the west.<br>• The other patches are smaller and limited in width but provide buffering to stream corridors. The sensitivity to edge effects is somewhat mitigated by the fact that these patches sit within a mosaic of habitat types.<br>• If protected from browsers these areas could be effectively restored. Succession towards broadleaf forest was observed in the patch between CH 5400 - CH 5600 which is fenced. | |
| Advanced Secondary Broadleaved Forest | Representativeness: **High**<br>• Dominated by indigenous species<br>• Diversity generally representative of the successional stage of the habitat type but lacking the diversity of the old-growth forest.<br>• The flora diversity indicative that the area will support a typical fauna assemblage for the successional stage of the vegetation.<br>• The area is fenced and subject to pest control which indicates a higher likelihood of more sensitive fauna occurring in these areas.<br>Rarity/distinctiveness: **High**<br>• Although generally comprised of mid-successional species, the vegetation is not characteristic of old-growth forest types classified as threatened in the Horizons One Plan.<br>• These remnants occur across land environments where either, <10%, or 10 - 20% of indigenous cover remains (LENZ Level IV - Walker et al., 2015). | **Very High**: high for 3 or all of the four assessment matters |

| Ecosystem types | Value of Vegetation/habitats (as per EIANZ guidelines) | 'Ecological Value' (EcIAG) |
|---|---|---|
| | • Although not recorded during site investigations, Threatened kānuka and rata species may be present.<br>• Given the direct connectivity to the Manawatū Gorge Scenic Reserve it is likely that the At Risk whitehead use the habitat.<br>• It is highly likely that At Risk lizards (both arboreal and ground-dwelling) occur in this habitat given its connectivity to the Manawatū Gorge Scenic Reserve, stock exclusion and predator control.<br>• Potential to support Threatened or At Risk invertebrate species, both aerial and ground dwelling.<br>Diversity and Pattern: **'Moderate'**<br>• Diversity generally representative of the successional stage of the habitat type but lacking the diversity of the old-growth forest.<br><br>Ecological context: **High**<br>• Both advanced broadleaved areas are part of a larger vegetation mosaic that is contiguous with the Manawatū Scenic Reserve.<br>• These patches all occur along the edges of these mosaics, providing buffer functionality but are subject to increase edge effects.<br>• The area sit within the Western QEII covenant which is legally protected and is less impacted by stock access. | |

| Ecosystem types | Value of Vegetation/habitats (as per EIANZ guidelines) | 'Ecological Value' (EcIAG) |
|---|---|---|
| Secondary Broadleaved Forests and Scrublands | Generally as assessed for 'Advanced Secondary Broadleaved Forest' except that Ecological Context Diversity and Representative are assessed as 'Moderate' because:<br>• Areas of this habitat type are scattered across the Project footprint and have various patch sizes and levels of connectivity to old-growth habitats.<br>• Represent an earlier successional stage and thus have a less diverse flora assemblage and structure.<br>• Many of these patches sit with an agricultural matrix and have been more modified by stock degradation and likely subject to higher pest pressure. | **'Moderate':** High for 1 of the assessment matters, 'Moderate' or 'Low' for the remainder |
| Mānuka, Kānuka Shrublands | Representativeness: '**Low**'<br>• Generally dominated by indigenous species (kānuka) but exotic broom is a notable canopy component in some areas.<br>• All mānuka, kānuka shrubland patches are highly modified by stock access. Consequently the understorey and groundcover tiers do not have a representative species assemblage and are often absent except for pasture grass.<br>• The low flora diversity and lack of habitat complexity suggests that the remnants are unlikely to support the full species assemblage that would be expected in a less modified early successional habitat type.<br>Rarity/distinctiveness: '**Moderate**'<br>• Mānuka and kānuka are both Threatened - Naturally Vulnerable however this status has been applied as a precautionary measure due to the currently unquantified risk myrtle rust poses to species in the Myrtaceae family. This conservation status does not reflect actual declines in either mānuka or kānuka.<br>• Manuka, kānuka shrublands occur across land environments where either, <10%, or 10 - 20% of indigenous cover remains (LENZ Level IV - Walker et al., 2015).<br>• Scrub and shrubland, not identified has being in the Manawatu-Wanganui Region historically. Mānuka, kānuka shrublands are a common early successional habitat types and not considered rare or threatened in the Region.<br>• It is unlikely that Threatened or At Risk birds, lizards or terrestrial invertebrates occupy the patches given their small size, fragmentation, low flora diversity, and lack of understorey habitat for ground dwelling species. | '**Moderate**' (High for one assessment matter and low for the other three) |

| Ecosystem types | Value of Vegetation/habitats (as per EIANZ guidelines) | 'Ecological Value' (EcIAG) |
| --- | --- | --- |
| | • Notwithstanding the above, remnant populations of immobile species such as geckos are can sometimes occur such habitat. I consider this likelihood very low because of the evidence of herbicide application in these areas to prevent the encroachment of regenerating scrub across productive land.<br>• The habitat patches may be used as stepping stone habitat for mobile species but are unlikely to provide important breeding or foraging habitat for threatened or At Risk birds.<br>Diversity and Pattern: '**Low'**<br>• Low native diversity, limited to early successional species.<br>• Grazing regimes preventing advancement to a more diverse, later-successional assemblage.<br>Ecological context: '**Low'**<br>• A number of small vegetation patches, primarily occurring within grazed pasture, subject to stock modification and edge effects.<br>• The spread of the shrubland across the landscape suggest that that the patches contribute to landscape linkages for mobile species. | |
| Divaricating Shrublands | Representativeness: **'Low'**<br>• Canopy generally dominated by indigenous species but canopy cover is low and the areas are interspersed with exotic pasture.<br>• The divaricating shrubland patches appear to be induced through human modification, namely grazing pressure and aerial herbicide application to suppress mānuka/kānuka regeneration.<br>• The low flora diversity and lack of habitat complexity suggests that the remnants are unlikely to support the full assemblage of fauna that would be expected in a less modified early successional habitat type.<br>Rarity/distinctiveness: '**High'**<br>• The occasional mānuka and kānuka (both Threatened - Naturally Vulnerable) were recorded in these areas. However, this status has been applied as a precautionary measure due to the unquantified risk Myrtle rust currently poses to species in the Myrtaceae family. This conservation status does not reflect actual declines in either mānuka or kānuka. | **'Moderate'** (high for one assessment matter and 'Low' for the remaining 3) |

| Ecosystem types | Value of Vegetation/habitats (as per EIANZ guidelines) | 'Ecological Value' (EcIAG) |
|---|---|---|
| | • No other Threatened, At Risk, or locally uncommon plant species have been identified in the shrublands.<br>• All of the divaricating shrubland patches occur within land environments where only 10 - 20% of indigenous cover remains (LENZ Level IV - Walker et al., 2015).<br>• Scrub and shrubland, has not been identified as being in the Manawatū-Wanganui Region historically (Maseyk, 2007). Thus, divaricating shrubland is not considered rare or threatened in this Region.<br>• Divaricating shrubs are known to support a diversity of invertebrates often with specific host plant associations.<br>• Literature reviews undertaken during the NoR process identified two At Risk moths (*Meterana exquisita* and *M. grandiosa*) could inhabit the Project footprint and the divaricating shrublands could support these species.<br>• The lack of understorey refugia suggests limited habitat for ground-dwelling invertebrates and lizards but remnant populations of At Risk arboreal geckos, including barking gecko and Ngahere gecko, could be present.<br>• As described above, the application of herbicide suggests the persistence of any remnant populations of immobile species is unlikely.<br>• The limited structural integrity of the shrublands suggests that they are unlikely to provide important breeding or foraging habitat for Threatened or At Risk birds with the exception of NZ pipit (At Risk - Declining).<br>Diversity and Pattern: '**Low'**<br>• Low native diversity, limited to early successional species.<br>• Grazing regimes and herbicide application are preventing advancement to a more diverse, later-successional assemblage.<br>Ecological context: '**Low'**<br>• A number of small vegetation patches, primarily occurring within grazed pasture, subject to stock modification and edge effects.<br>• Unlike the mānuka, kānuka shrubland described above, the distribution of the divaricating shrubland patches is largely limited to a single sub-catchment and, therefore, the contribution to connective linkages on a landscape scale is limited. | |

| Ecosystem types | Value of Vegetation/habitats (as per EIANZ guidelines) | 'Ecological Value' (EcIAG) |
|---|---|---|
| Indigenous Dominated Seepage Wetland (raupō wetland) | Representativeness: **'Moderate'**<br>• Canopy dominated by indigenous species.<br>• The remnant swamp maire is representative of the swamp forest that would have likely occurred in the area prior to human modification but the remainder of the wetland is less representative of a pre-human assemblage.<br>• The limited structural diversity compared to the pre-human swamp forest suggests that the area is unlikely to support the typical fauna assemblage expected of intact wetland habitat.<br>• The area is not subject to pest control.<br>Rarity/distinctiveness: '**High'**<br>• Swamp maire is classified as Threatened - Nationally Critical (the threat status of Swamp maire was elevated from Not Threatened due the risk imposed by myrtle rust).<br>• The raupō seepage occurs within a land environment where only 10 - 20% of indigenous cover remains (LENZ Level IV - Walker et al., 2015).<br>• Native-dominated seepage wetlands are classified as rare under the One Plan.<br>• Intact wetlands generally are considered threatened with less than 5% remaining from pre-human extent (Maseyk, 2007).<br>• Several threatened wetland bird species potentially present though no wetland birds have been recorded during the acoustic monitoring and wetlands lack open water which lowers the value of this habitat for some wetland bird species<br>• New Zealand pipit which inhabit open habitats including rough grassland and may nest under amongst rushes or rank grass.<br>Diversity and Pattern: **'Moderate'**<br>• Low native diversity compared to the swamp forest that would have occurred on the alluvial soils originally. However, 'Moderate' diversity of native flora and fauna known or likely to be present<br>Ecological context: '**High'**<br>• Forms part of a mosaic of habitats with connectivity to old-growth forest and the Manawatū Gorge Scenic Reserve. | **'High'** ('High' for two matters and 'Moderate' or 'Low' for other matters) |

| Ecosystem types | Value of Vegetation/habitats (as per EIANZ guidelines) | 'Ecological Value' (EcIAG) |
| --- | --- | --- |
| | • Given the threat status of wetlands generally due to specific hydrological requirements, the protection and restoration of wetlands is a priority under the RMA (Section 6) and the Draft National Policy Statement for Indigenous Biodiversity (Policy 12).<br>• The intact hydrology and its proximity to alluvial forest suggests that the area could be effectively restored if retired from grazing. | |
| Indigenous Dominated Seepage Wetland -<br>(*Carex* dominated wetlands) | Representativeness: **'Moderate'**<br>• Canopy dominated by indigenous species and known or likely to include flora and fauna typical of Carex dominated wetlands.<br>• The size of these seepage wetlands suggests that prior to forest clearance and stock degradation these seepage areas would likely have been characterised by lowland forest surrounding watercourses.<br>• The limited structural diversity compared to the pre-human swamp forest suggests that the area is unlikely to support the typical fauna assemblage expected of intact wetland habitat.<br>• The area are not subject to pest control<br>Rarity/distinctiveness: '**High'**<br>• The 'Moderate' value seepage wetlands occur within a land environment where only 10 - 20% of indigenous cover remains (LENZ Level IV - Walker et al., 2015).<br>• Native-dominated seepage wetlands are classified as rare under the One Plan.<br>• Intact wetlands generally are considered threatened with less than 5% remaining from pre-human extent (Maseyk, 2007).<br>• Several threatened wetland bird species potentially present though no wetland birds have been recorded during the acoustic monitoring and wetlands lack open water which lowers the value of this habitat for some wetland bird species<br>• New Zealand pipit which inhabit open habitats including rough grassland and may nest within or adjacent to the wetland.<br>Diversity and Pattern: '**Low'**<br>• Native component largely limited to *Carex geminata*, likely induced by prolonged stock access. Low native diversity compared to forest habitat that would have occurred in these areas originally.<br>Ecological context: ~~'**High'**~~ **Moderate** | **'~~High~~ Moderate'** ('High' for ~~2~~ **1** matter~~s~~ and **'Moderate' or** 'Low' ~~or 'Moderate'~~ for the remainder) |

| Ecosystem types | Value of Vegetation/habitats (as per EIANZ guidelines) | 'Ecological Value' (EcIAG) |
|---|---|---|
| | • Given the threat status of wetlands generally due to specific hydrological requirements, the protection and restoration of wetlands is a priority under the RMA (Section 6) and the Draft National Policy Statement for Indigenous Biodiversity (Policy 12).<br>• The intact hydrology of these wetland areas suggests that the area could be effectively restored if retired from grazing **but ecological connectance to native forest is low**. | |
| Exotic Wetland (including pasture wetlands dominated by *Juncus edgariae*) | Representativeness: **'Low'**<br>• Dominated by exotic pasture species, or occasionally the common native rush *Juncus edgariae* which often invades rough pasture.<br>• The size of these seepage wetlands suggests that prior to forest clearance and stock degradation these seepage areas would likely have been characterised by lowland forest surrounding small tributaries.<br>• The extent of modification to these areas resulting in a very limited structural diversity and a degraded hydrological system suggests that these areas are highly unlikely to support the typical fauna assemblage expected of intact wetland habitat.<br>• The areas are not subject to pest control.<br>Rarity/distinctiveness: '**High'**<br>• Wetlands, irrespective of condition are a threatened habitat type and the protection and restoration of wetlands is a priority under the RMA (Section 6) and the Draft National Policy Statement for Indigenous Biodiversity (Policy 12).<br>• The pasture wetlands occur within a land environment where only 10 - 20% of indigenous cover remains (LENZ Level IV - Walker et al., 2015).<br>• Native-dominated seepage wetlands are classified as rare under the One Plan but exotic dominated wetlands are not considered threatened under the One Plan.<br>• Although pasture wetlands score highly as an ecosystem type, the extensive modification of these areas suggests are very low likelihood of supporting Threatened or At Risk fauna.<br>Diversity and Pattern: '**Low'**<br>• Native component largely limited to a low cover of common rushes but generally characterised by pasture species.<br>• Heavily degraded by stock resulting in minimal habitat complexity. | **'Moderate' (**High for one matter, 'Moderate' and 'Low' for the remainder), |

| Ecosystem types | Value of Vegetation/habitats (as per EIANZ guidelines) | 'Ecological Value' (EcIAG) |
|---|---|---|
| | Ecological context: **'Moderate'**<br>These wetlands are likely to constitute important stepping stones and provide habitat for mobile species such as pied stilt or pukeko and aquatic invertebrates that are dependent on wetlands with ephemeral or intermittent hyperiods to complete their life cycle. | |

## Updates to Table 6 to address inconsistencies

**Table 6: 'Magnitude of Effect' for each habitat type in the Project footprint assessed using EcIAG methodology**

| Vegetation/ habitat type | Direct impact (extent of vegetation removal) | Indirect impacts (the quality of remaining habitat may be degraded due to changes in edge microclimate as a result of increased exposure to light and wind, increased incursions of pest plants, and from dust deposition)[1] | Minimisation measures | Magnitude of effect |
|---|---|---|---|---|
| Old-growth forest (alluvial) | 0.10 ha, which equates to 2.4% of what is available within the designation corridor and noting that this habitat type is down to 2.5% of its original extent in the Region.<br>This habitat lies within the construction footprint and will be replaced in the long-term | Potential edge effects resulting from the proposed design have been assessed as **"Negligible"** for the following reasons:<br>- A very small area proposed for removal along an existing edge, minimising changes in exposure to the biotic and abiotic factors listed above;<br>- The proposed alignment is located downwind of the prevailing winds hence dust deposition during construction will be limited.<br>- Further fragmentation avoided as an existing edge is being removed. | - Physical delineation to ensure no over clearance of vegetation.<br>- Clearance extent minimised through pruning as opposed to felling of old-growth trees where possible.<br>- Clearance extent along habitat edges, avoiding fragmentation.<br>- Seasonal restrictions and/or pre-clearance protocols will be put in place to minimise harm to native fauna including native snails, lizards, and birds (Refer to the EMP in Volume VII).<br>- Epiphyte and coarse woody debris relocation will reduce harm to invertebrates and provide habitat enhancement in adjacent forest (Refer to the EMP in Volume VII).<br>- Dust suppression is proposed across the Project footprint during construction and monitoring will | **'Moderate'** |
| Old-growth forest (hill country) | Permanent loss of 0.85 ha. This equates to 48% of what is available in the designation corridor and < | Potential edge effects resulting from the proposed design have been assessed as **'Low'** for the following reasons:<br>- Shifting the impact area to the head of the Western QEII gully avoids fragmentation and results in the shifting of an existing edge | | **'Moderate'** |

| Vegetation/ habitat type | Direct impact (extent of vegetation removal) | Indirect impacts (the quality of remaining habitat may be degraded due to changes in edge microclimate as a result of increased exposure to light and wind, increased incursions of pest plants, and from dust deposition)[1] | Minimisation measures | Magnitude of effect |
|---|---|---|---|---|
| | 1% of what is available on the local landscape (i.e., the adjacent Manawatū Scenic Reserve but noting that it is threatened ecosystem type in the region with 19% of its former extent remaining. | rather than the creation of two new edges in addition to the existing edge.<br>- The vegetation adjacent to the new edge is currently less than 100 m in width and therefore is likely already exposed to edge effects, albeit at a lesser extent.<br>- The existing alignment is located upwind of the prevailing wind and therefore dust deposition is more likely to occur during construction. | be undertaken at old-growth forest adjacent to Project footprint (refer to Technical Assessment E).<br>- Weed control and enrichment planting to be undertaken in newly created edges (Refer to the EMP in Volume VII).<br>- Replacement planting at a scale of 1:100 for any swamp maire pruned, or 1:200 for swamp maire felled.<br>- Replacement planting at a scale of 1:100 for any ramarama felled. | |
| Secondary broadleaved forests with old-growth signatures | Long-term loss of ~~0.04~~ **0.25** ha, which equates to ~~1.3~~ **10.5**% of availability within the designation corridor and noting that this habitat type is uncommon in the wider landscape | Potential edge effects resulting from the proposed design have been assessed as **"Negligible" - 'Low'** for the following reasons:<br>- The impact areas are either already fragmented and exposed to edge effects (CH 7300 - CH 7400) or a very small area proposed for removal along an existing edge. Hence both areas are already exposed to edge effects, albeit at a lesser extent.<br>- The existing alignment is located upwind of the prevailing wind at both impact areas and therefore dust deposition is likely to occur | - Physical delineation to ensure no over clearance of vegetation.<br>- Clearance extent along habitat edges, avoiding fragmentation.<br>- Areas of the forest remnant between CH 10400 - CH 10600 that actually contain old-growth trees are avoided.<br>- Seasonal restrictions and/or pre-clearance protocols will be implemented to minimise harm to native fauna including native | ~~'Low'~~ **'Moderate'** |

| Vegetation/ habitat type | Direct impact (extent of vegetation removal) | Indirect impacts (the quality of remaining habitat may be degraded due to changes in edge microclimate as a result of increased exposure to light and wind, increased incursions of pest plants, and from dust deposition)[1] | Minimisation measures | Magnitude of effect |
|---|---|---|---|---|
| | | during construction. It is noted that the area located at CH 7300 - CH 7400 is already exposed to some dust deposition effects from an unsealed farm track that exists along this edge. | snails, lizards, and birds (Refer to draft EMP in Volume VII).<br>- Dust suppression proposed across the footprint during construction (refer to Technical Assessment E)<br>- Weed control and enrichment planting to be undertaken in newly created edges (Refer to the EMP in Volume VII). | |
| Old-growth treelands | Permanent loss of 0.13 ha, which equates to 32% of availability within the designation corridor and noting that this habitat type is **un**common in the wider landscape | Potential edge effects resulting from the proposed design have been assessed as **"Negligible"** for the following reasons:<br>- The treeland remnants are very small and open (< 30 m at the widest point) and hence will already be exposed to high levels of edge effects; and<br>- The understory is already dominated by exotic plants. | - Physical delineation to ensure no over clearance of vegetation.<br>- Clearance extent minimised through pruning as opposed to felling of old-growth trees where possible.<br>- The stormwater wetland proposed for the area has been modified to almost completely avoid the ramarama area.<br>- Seasonal restrictions and/or pre-clearance protocols will be put in place to minimise harm to native fauna including: lizards and birds (Refer to the EMP in Volume VII). | ~~**'Low'**~~ **Moderate** |

| Vegetation/ habitat type | Direct impact (extent of vegetation removal) | Indirect impacts (the quality of remaining habitat may be degraded due to changes in edge microclimate as a result of increased exposure to light and wind, increased incursions of pest plants, and from dust deposition)[1] | Minimisation measures | Magnitude of effect |
|---|---|---|---|---|
| | | | - Dust suppression is proposed across the Project footprint during construction (refer to Technical Assessment E) | |
| Kānuka forests | 1.3 ha, which equates to 29% of availability within the designation corridor. Although kānuka forest is considered threatened regionally, the kānuka forest available in the designation corridor appears to be created as a product of sustained grazing pressure, and is likely to be common in the surrounding | Potential edge effects resulting from the proposed design have been assessed as **'Negligible' - 'Low'** for both impact areas for the following reasons:<br>- The areas impacted are along existing edges. However in the case of CH 3900 - CH 4300, vegetation clearance will shift this edge considerably (>50 m), exposing an area of canopy that has previously been relatively protected from the abiotic effects. Notwithstanding this the area is grazed underneath and the understory is dominated by exotic plants. Hence the impacts of light-demanding pest plants colonising the new edge will be minimal; and<br>- The proposed alignment is located upwind of the prevailing wind but the construction of the viaduct will not create a large area of exposed earth, limiting dust deposition potential.<br>- At CH 5400 - CH 5600, a small area is proposed for removal and the proposed alignment is located downwind of the | - Physical delineation to ensure no over clearance of vegetation.<br>- Seasonal restrictions and/or pre-clearance protocols will be put in place to minimise harm to native fauna including: lizards, birds and bats (Refer to the EMP in Volume VII).<br>- Dust suppression is proposed across the Project footprint during construction (refer to Technical Assessment E)<br>- Weed control and enrichment planting to be undertaken in newly created edges (Refer to the EMP in Volume VII). | **'Moderate'** |

| Vegetation/ habitat type | Direct impact (extent of vegetation removal) | Indirect impacts (the quality of remaining habitat may be degraded due to changes in edge microclimate as a result of increased exposure to light and wind, increased incursions of pest plants, and from dust deposition)[1] | Minimisation measures | Magnitude of effect |
|---|---|---|---|---|
| | rural landscape. | prevailing winds hence dust deposition during construction will be limited. | | |
| Advanced secondary broadleaved forest | Long-term loss of 0.04 ha, which equates to 1.4 % of availability within the designation corridor.<br>Regenerating broadleaved forest at various stages of succession are common in the surrounding landscape and are not listed as threatened in the region. | Potential edge effects resulting from the proposed design have been assessed as **'Low'** for the following reasons:<br>- A small area is proposed for removal and this habitat type is located along an existing gully edge, limiting changes in exposure to the biotic and abiotic factors listed above; and<br>- The proposed alignment is located upwind of the prevailing wind and therefore dust deposition is likely to occur during construction. | - Physical delineation to ensure no over clearance of vegetation.<br>- Seasonal restrictions and/or pre-clearance protocols will be put in place to minimise harm to native fauna including: lizards, birds and bats (Refer to the EMP in Volume VII).<br>- Dust suppression is proposed across the Project footprint during construction (refer to Technical Assessment E)<br>- Weed control and enrichment planting to be undertaken in newly created edges, including temporary edges (Refer to the EMP in Volume VII) | **'Low'** |
| Secondary broadleaved forests and scrublands | 6.44 ha which equates to 39% of availability within the designation corridor. As above, | Potential edge effects resulting from the proposed design have been assessed as **Negligible' - 'Low'** all of the impact locations with the exception of two (details below). The reasoning is below: | - Seasonal restrictions and/or pre-clearance protocols will be put in place to minimise harm to native fauna including: lizards and birds (Refer to the EMP in Volume VII). | **'Moderate'** |

| Vegetation/ habitat type | Direct impact (extent of vegetation removal) | Indirect impacts (the quality of remaining habitat may be degraded due to changes in edge microclimate as a result of increased exposure to light and wind, increased incursions of pest plants, and from dust deposition)[1] | Minimisation measures | Magnitude of effect |
|---|---|---|---|---|
| | regenerating broadleaved forest at various stages of succession are common in the surrounding landscape and are not listed as threatened in the region. | - the secondary broadleaved forests and scrublands are comprised relatively early successional species that are robust to increased exposure abiotic factors listed above;<br>- Many of these areas are already small, fragmented by the existing land use, and interspersed with pest plants, namely broom.<br>- In most cases further fragmentation avoided as existing edges is being removed.<br>- These patches occur at different positions relative to the proposed alignment and thus will be impacted by dust deposition differently. However dust is unlikely to cause more than a 'Low'level effect in any instance.<br>The potential edge effects have been assessed as **'Moderate'** for the secondary broadleaved forest patches at CH 9800 - CH 10000 and CH 10800 - CH 11400. The following reasons apply:<br>- At CH 9800 - CH 10000 a large proportion of this patch is proposed to be removed. Moreover the proposed alignment bisects the patch, resulting in the creation of a large amount of new edge and further fragmentation. However, the patch is less than 100 m in width and so is likely to be | - Dust suppression is proposed across the Project footprint during construction (refer to Technical Assessment E)<br>- Weed control and enrichment planting to be undertaken in newly created edges (Refer to the EMP in Volume VII).<br>- Translocation of *Adiantum formosum* located at CH 3800 - CH 4000 and additional planting of 1:15 for each relocated plant. | |

| Vegetation/ habitat type | Direct impact (extent of vegetation removal) | Indirect impacts (the quality of remaining habitat may be degraded due to changes in edge microclimate as a result of increased exposure to light and wind, increased incursions of pest plants, and from dust deposition)[1] | Minimisation measures | Magnitude of effect |
|---|---|---|---|---|
| | | exposed to some level of edge effects already;<br>- A large proportion of the patches at CH 10800 - 11400 is proposed to be removed creating a large amount of new edge. However all of the areas removed occur along existing edges, avoiding fragmentation and shifting existing edges as opposed the creation of additional edges.At:<br>- The mitigating factors listed above e.g. the high proportion of early-successional species applies to these areas, hence why they have been assessed as 'Moderate' as opposed to high. | | |
| Mānuka, kānuka shrublands | 2.11 ha, which equates to > 50 % of the availability within the designation corridor.<br>This shrubland type is common in the surrounding landscape and appears to readily | Potential edge effects resulting from the proposed design have been assessed as **''Negligible''** for the following reasons:<br>- All mānuka, kānuka shrubland patches are small, isolated and regularly impacted by stock. Consequently, the areas are already exposed to edge effects and are currently comprised of early successional species that are robust to increased exposure abiotic factors listed above. | - Physical delineation to ensure no over clearance of vegetation.<br>- Seasonal restrictions and/or pre-clearance protocols will be put in place to minimise harm to native fauna including: lizards and birds (Refer to the EMP in Volume VII).<br>- Dust suppression is proposed across the Project footprint during construction (refer to Technical Assessment E) | **'Moderate'** |

| Vegetation/ habitat type | Direct impact (extent of vegetation removal) | Indirect impacts (the quality of remaining habitat may be degraded due to changes in edge microclimate as a result of increased exposure to light and wind, increased incursions of pest plants, and from dust deposition)[1] | Minimisation measures | Magnitude of effect |
|---|---|---|---|---|
| | establish in pasture. It is not threatened in the region. | | - Weed control and enrichment planting to be undertaken in newly created edges (Refer to the EMP in Volume VII). | |
| Divaricating shrublands | 0.33 ha, which equates to > 50 % of the availability within the designation corridor. The divaricating shrublands within the designation corridor appear to be closely associated with the manuka, kanuka shrubland. It appears to be **moderately** common in the landscape. It is not threatened in the region. | Potential edge effects resulting from the proposed design have been assessed as **"Negligible"** for the following reasons:<br>- All divaricating shrubland patches are small, isolated and regularly impacted by stock. Consequently, the areas are already exposed to edge effects and are currently comprised of early successional species that are robust to increased exposure abiotic factors listed above. | - Physical delineation to ensure no over clearance of vegetation.<br>- Seasonal restrictions and/or pre-clearance protocols will be put in place to minimise harm to native fauna including: lizards, birds and terrestrial invertebrates (Refer to the EMP in Volume VII).<br>- Dust suppression is proposed across the Project footprint during construction (refer to Technical Assessment E)<br>- If *Meterana* spp. Recorded in the area - a grazing or mowing regime will be continued across the remaining divaricating shrubland patches within the designation to promote the areas remaining in a stalled successional trajectory dominated by divaricating shrubs (Refer to the EMP in Volume VII). | ~~Low~~ **Moderate** |

| Vegetation/ habitat type | Direct impact (extent of vegetation removal) | Indirect impacts (the quality of remaining habitat may be degraded due to changes in edge microclimate as a result of increased exposure to light and wind, increased incursions of pest plants, and from dust deposition)[1] | Minimisation measures | Magnitude of effect |
|---|---|---|---|---|
| Raupō-dominated seepage wetlands (high value) | 0.11, which equates to 20 % of the availability within the designation corridor.<br><br>Raupō wetlands appear to be rare in the wider landscape and in the region noting that only 3% of wetlands remain in the region. | **High**<br>- The raupō wetland occurs within a matrix of forest, scrub and grassland and is generally quite open. The dominant wetland component, raupō, is adapted to open environments and are robust to increased exposure abiotic factors associated with the creation of new edge.<br>- Wetlands are naturally fragmented across the landscape due to the specific landforms they occur within. Hence the species that inhabit wetlands are generally mobile and fragmentation resulting from the Project is unlikely to impact the movement of fauna or dispersal of seed more than the existing agricultural matrix.<br>- Notwithstanding the above, fragmentation of the high value raupō wetland has been avoided by the extension of BR03 to limit impacts in the area.<br>An indirect impact specific to wetland habitat types is changes in hydrology impacting species assemblages.<br>- The hydrology of the raupō appears to be somewhat impacted by stock access but is generally intact. Geotechnical investigations have found that the raupō wetland is located above an artesian | - Physical delineation to ensure no over clearance of vegetation.<br>- The staging piles will be capped to ensure artesian aquifer is not ruptured, thus maintaining the current hydrology.<br>- Seasonal restrictions and/or pre-clearance protocols will be put in place to minimise harm to native wetland birds potentially nesting in the area (Refer to the EMP in Volume VII). | **'Moderate'** |

| Vegetation/ habitat type | Direct impact (extent of vegetation removal) | Indirect impacts (the quality of remaining habitat may be degraded due to changes in edge microclimate as a result of increased exposure to light and wind, increased incursions of pest plants, and from dust deposition)[1] | Minimisation measures | Magnitude of effect |
|---|---|---|---|---|
| | | aquifer. Construction of the Project has the potential to rupture this aquifer which would change the hydrology of the raupō wetland considerably. | | |
| Indigenous-dominated seepage wetlands ('Moderate' value) | 0.44 (which equates to 66.7 % of this type of wetland available in the designation corridor)<br><br>Indigenous dominated seepage wetlands appear to be rare in the surrounding landscape and in the region. | **''Negligible''**<br>- All of the 'Moderate' and 'Low' value wetlands on the site occur in open areas and the species inhabiting the different wetland types are adapted to open environments and are robust to increased exposure abiotic factors associated with the creation of new edge.<br>- Wetlands are naturally fragmented across the landscape due to the specific landforms they occur within. Hence the species that inhabit wetlands are generally mobile and fragmentation resulting from the Project is unlikely to impact the movement of fauna or dispersal of seed more than the existing agricultural matrix.<br>An indirect impact specific to wetland habitat types is changes in hydrology as well as sedimentation and pollution impacting species assemblages.<br>- The hydrology of the 'Moderate' and 'Low'value wetlands appear to be impacted by stock pugging and the native species | - Physical delineation to ensure no over clearance of vegetation.<br>- Seasonal restrictions and/or pre-clearance protocols will be put in place to minimise harm to native lizards, and birds potentially nesting in the area (Refer to the EMP in Volume VII). | **'High'** |
| Pasture wetlands, dominated by exotic species or the common | 4.23 ha, which constitutes an unknown but likely high proportion of wetlands in the | | - Physical delineation to ensure no over clearance of vegetation.<br>- Seasonal restrictions and/or pre-clearance protocols will be put in place to minimise harm to pipit | **'Moderate'** |

| Vegetation/ habitat type | Direct impact (extent of vegetation removal) | Indirect impacts (the quality of remaining habitat may be degraded due to changes in edge microclimate as a result of increased exposure to light and wind, increased incursions of pest plants, and from dust deposition)[1] | Minimisation measures | Magnitude of effect |
|---|---|---|---|---|
| native rush *Juncus edgariae* (low value)<br><br>Numerous locations across the Footprint | designation corridor.<br>Wetlands in improved pasture are common in the surrounding landscape, but noting that freshwater wetlands are down to 3% of their formal extent in the region. | dominating these wetlands (*Juncus edgariae* and *Carex geminata*) are not limited to strict hydrological conditions. Consequently it is unlikely that any hydrological changes caused by the Project will have a discernible impact on these wetland assemblages. | eggs and unfledged chicks (Refer to the EMP in Volume VII). | |

## Updates to Table 8 to address inconsistencies

**Table 8. Level of residual effects for terrestrial and wetland habitats and associated species after effects avoidance and minimisation measures (as per EcIAG step 3)**

| Biodiversity value within the Project footprint (ha) | 'Ecological Value' | 'Magnitude of Effect' after avoidance and minimisation | 'Level of Effect' after avoidance and minimisation |
|---|---|---|---|
| **Vegetation/ habitat type** | | | |
| Old-growth forest (alluvial) | 'Very High' | 'Moderate' | 'High' |
| Old-growth forest (hill country) | 'Very High' | 'Moderate' | 'High' |
| Secondary broadleaved forests with old-growth signatures | ~~'High'~~ **Very High** | 'Moderate' | 'High' |
| Old-growth treelands (+ ramarama) | ~~'High'~~ **Moderate** | 'Low' | 'Moderate'* |
| Kānuka Forests | 'Moderate' | 'Moderate' | 'Moderate' |
| Advanced Secondary Broadleaved Forest | ~~'High'~~ **Very High** | 'Low' | 'Moderate'* |
| Secondary Broadleaved Forests and Scrublands | 'Moderate' | 'Moderate' | 'Moderate' |
| Mānuka, Kānuka Shrublands | 'Moderate' | 'Moderate' | 'Moderate' |
| Divaricating Shrublands | 'Moderate' | 'Moderate' | 'Moderate' |
| Indigenous Dominated Seepage Wetland - High Value (raupō wetland) | ~~'Very High'~~ **High** | 'Moderate' | 'High' |
| Indigenous Dominated Seepage Wetland - 'Moderate' Value (*Carex* dominated wetlands) | 'Moderate' | 'High' | 'Moderate' |
| Exotic Wetland (including pasture wetlands dominated by *Juncus edgariae*) | 'Moderate' | 'Moderate' | 'Moderate' |

# Attachment 7

## Updates to Table 2 to address inconsistencies

Corrections to the Tables are shown in <u>**underlined red**</u> for new text, and ~~strikethrough~~ for deleted text.

**Table 2: 'Ecological Values' assessment (as per EcIA guidelines) for each notable habitat present in the Project footprint**

| Ecosystem types | Value of Vegetation/habitats (as per EIANZ guidelines) | 'Ecological Value' (EcIAG) |
|---|---|---|
| Old growth forest (alluvial) | Representativeness: **High**<br>• Dominated by indigenous species.<br>• Generally a typical structure and composition with the exception of the lower tiers which have be grazed by stock.<br>• However, the impacts of grazing on the lower tiers and the absence of mammalian pest control suggest that the area may not support a full fauna assemblage, but will be more representative than many habitats given that old growth forest is now rare across the Region.<br>Rarity/distinctiveness: **High**<br>• Old growth hardwood forest is threatened in the Manawatū Region (Maseyk, 2007).<br>• The alluvial old growth forest occurs within a land environment where only 10 - 20% of indigenous cover remains (LENZ Level IV - Walker et al., 2015).<br>• Includes a stand of Threatened - Nationally Critical swamp maire.<br>• At Risk - Declining whitehead birds have been confirmed in this forest type.<br>• Likely to support At Risk and Not Threatened gecko species including:<br>– Barking gecko, Ngahere gecko, Raukawa gecko, Pacific gecko, glossy brown skink, ornate skink, northern grass skink.<br>– Note, this habitat is less likely to support ground-dwelling skinks due to stock access.<br>Diversity and Pattern: **High**<br>• A diverse indigenous vegetation assemblage but browsing pressure has resulted in decreased diversity the lower tiers.<br>• Unlikely to support sensitive ground-dwelling invertebrates due to stock degradation. | **Very High**: High for 3 or all of the four assessment matters |

| Ecosystem types | Value of Vegetation/habitats (as per EIANZ guidelines) | 'Ecological Value' (EcIAG) |
|---|---|---|
| | Ecological context: **High**<br>• Relatively large tract of forest with connectivity to the Manawatū Scenic Reserve.<br>• Part of a mosaic of alluvial habitats including raupō wetlands and swamp maire forest.<br>• The diverse, old-growth canopy suggests the area could be effectively restored via stock exclusion and targeted weed control/suppression. | |
| Old-growth forest (hill country) | Generally as above but noting:<br>• The hill country forest is located within a QEII covenant, grazing pressure is still evident in the lower tiers but notably less degradation compared to the alluvial forest described above.<br>• Swamp maire not present but Threatened - Nationally Critical *Lophomyrtus* species observed as well as Threatened - Nationally Vulnerable rata species.<br>• Historically hill country forest has not been under as much clearance pressure for agricultural purposes, however, it is old-growth tawa forest and still considered threatened in the region.<br>• This forest patch is not part of the alluvial mosaic but directly buffers a high value watercourse. | **Very High:** High for 3 of the assessment matters |
| Secondary broadleaved forests with old-growth signatures | Representativeness: **High**<br>• Dominated by indigenous species.<br>• Secondary forest subject to prior modification, but with old-growth characteristics demonstrating an advanced successional stage on a trajectory towards representative old-growth forest.<br>Rarity/distinctiveness: **High**<br>• These remnants occur across land environments where either, <10%, or 10 - 20% of indigenous cover remains (LENZ Level IV - Walker et al., 2015).<br>• Given advanced successional stage, I have assessed this habitat type as old-growth and is thus considered threatened under the One Plan.<br>• Threatened - Nationally Vulnerable rata species recorded in this habitat.<br>Diversity and Pattern: **High**<br>• Generally high flora diversity but does not contain the full range of old growth species present in the habitat types above. | **Very High**: High for 3 of the assessment matters, 'Moderate' for the remainder |

| Ecosystem types | Value of Vegetation/habitats (as per EIANZ guidelines) | 'Ecological Value' (EcIAG) |
|---|---|---|
| | • All of the fauna species described in the 'old-growth forest alluvial' habitat type above could potentially inhabit the patches of this forest type also.<br>• With the exception of the larger remnant (CH 10400 - CH 10500), the size of the patches and their isolation from the Manawatū Gorge Scenic Reserve suggest that the areas are less likely to support less mobile species such as lizards and ground-dwelling invertebrates. Although remnant populations could exist.<br><br>Ecological context: **'Moderate'**<br>• The patches of this habitat vary in size but three of the four patches are less than 0.5 ha.<br>• The sensitivity to edge effects of these small patches is somewhat mitigated because they are located within a mosaic of habitat types.<br>• The fourth remnant (CH 10400 - CH 10550) is part of an assemblage covering approximately 8.5 ha.<br>• The old growth trees are likely an important seed source for the less advanced habitat types within the mosaics.<br>• Only one small patch (CH 7300 - CH 7400) has direct connectivity to the Manawatū Gorge Scenic Reserve.<br>• These patches sit with an agricultural matrix and likely provide stepping stone habitat for mobile species when dispersing between the Scenic Reserve and forest patches to the north. | |
| Old-growth treelands | Representativeness: **'Moderate'**<br>• Canopy dominated by indigenous species<br>• Understory and ground tiers essentially absent thus structure and composition is not representative of pre-human old-growth forest.<br>• The limited structural and flora diversity suggests that these areas are unlikely to support the typical fauna assemblage expected of old-growth vegetation.<br>• The likelihood of the treeland patches supporting a representative fauna assemblage if further limited by the small size of the patches.<br>• The areas are not subject to pest control.<br>Rarity/distinctiveness: **High** | **'Moderate':** High for one matter, 'Moderate' and 'Low' for the remainder |

| Ecosystem types | Value of Vegetation/habitats (as per EIANZ guidelines) | 'Ecological Value' (EcIAG) |
|---|---|---|
| | • Although the treelands are not representative of pre-human old-growth forest, old-growth treeland is still considered threatened under the One Plan.<br>• The treeland remnants all occur across land environments where 10 - 20% of indigenous cover remains (LENZ Level IV - Walker et al., 2015).<br>• Threatened - Nationally Critical ramarama recorded in the habitat patch between Chainage 5700 - 5800. The threat status of ramarama was elevated from Not Threatened due the risk imposed by myrtle rust. There is evidence to suggest the *Lophomyrtus* species are particularly susceptible to myrtle rust.<br>• Threatened - Nationally Vulnerable rata species recorded in this habitat.<br>• The treeland areas are likely to be used, at least occasionally by mobile At Risk species such as whitehead but the limited flora diversity indicates that these areas are unlikely to support a diverse invertebrate assemblage and thus, are unlikely to be core habitat insectivorous species such as whitehead.<br>• Remnant populations of arboreal lizards such as Barking gecko, Ngahere gecko, Raukawa gecko and Pacific gecko could occur in this habitat. This is more likely in the patch between CH 4050 - CH 4150 because of its connectivity to the more intact old-growth forest.<br>• The heavily grazed ground tier suggests it is unlikely to support populations of Threatened or At Risk ground dwelling lizards or invertebrates.<br>Diversity and Pattern: **Low**<br>• The absence of all structural tiers except the canopy limits the diversity of these areas.<br>• The generally small size of the patches suggests the areas are subject to limited underlying abiotic diversity.<br>Ecological context: **'Moderate'**<br>• The individual patches (all smaller than 0.2 ha) are small and have limited structural and flora diversity to represent key source habitats in the landscape.<br>• However, the old-growth trees provide habitat characteristics such as cavities which are rare, and often a limiting resource for native species such as cavity-nesting birds and bats.<br>• These the mature trees will also provide a seed source to more intact habitat types in the surrounding landscape as well as a fruit source for birds. | |

| Ecosystem types | Value of Vegetation/habitats (as per EIANZ guidelines) | 'Ecological Value' (EcIAG) |
|---|---|---|
| Kānuka Forests | Representativeness: **Low**<br>• Dominated by indigenous species.<br>• Limited diversity of native broadleaved species in the canopy and in lower tiers.<br>• The understory and ground tiers are modified by ungulate grazing, the extent of stock damage varies between areas.<br>• kānuka forest occurring across the Project is an artefact of stock degradation suppressing broadleaved species from establishing. Kānuka forest would not have occurred in the area naturally.<br>• The limited structural and flora diversity suggests that these areas are unlikely to support the typical fauna assemblage expected of forest at this successional stage in the absence of ungulate browsing pressure.<br>• Only the area between CH 5100 - CH 5200 is subject to pest control.<br>Rarity/distinctiveness: **High**<br>• Kānuka is Threatened - Nationally Vulnerable.<br>• Given the direct connectivity to the Manawatū Gorge Scenic Reserve it is likely that the At Risk whitehead use the habitat at least occasionally. However, it is unlikely to be preferred habitat when compared to the old-growth forest types in close proximity.<br>• It is likely that At Risk lizards occur in this habitat given its direct connectivity to the Manawatū Gorge Scenic Reserve. This is particularly the case for arboreal lizards such as: Barking gecko, Ngahere gecko, Raukawa gecko, and Pacific gecko.<br>• Mature kānuka forest has been demonstrated to support a similar invertebrate assemblage to old-growth forest (but this is not case for less mature grazed stands). This forest type has the potential to support At Risk invertebrates such as *Meterana* species.<br>• Kānuka forest is considered threatened in the Horizons One Plan, but as above, kānuka forest would not have occurred in the area naturally.<br>• The Kānuka Forest patches all occur across land environments where 10 - 20% of indigenous cover remains (LENZ Level IV - Walker et al., 2015).<br>Diversity and Pattern: **Low**<br>• The diversity in this habitat type is limited. | '**Moderate**': high for one matter, 'Moderate' and 'Low'for the remainder |

| Ecosystem types | Value of Vegetation/habitats (as per EIANZ guidelines) | 'Ecological Value' (EcIAG) |
|---|---|---|
| | • As discussed above, the vegetation assemblage does not reflect underlying abiotic patterns, instead it is likely a result of heavy ungulate browse suppressing broadleaved species.<br>Ecological context: **'Moderate'**<br>• All kānuka forest patches are either contiguous with, or in close vicinity, to the Manawatū Gorge Scenic Reserve or the Western QEII covenant.<br>• The patch between CH 3900 - CH 4300, is large (approximately 3 ha) and forms part of the much large forest assemblage of the Scenic Reserve.<br>• The patch between CH 3900 - CH 4300 buffers to the raupō wetland immediately to the west.<br>• The other patches are smaller and limited in width but provide buffering to stream corridors. The sensitivity to edge effects is somewhat mitigated by the fact that these patches sit within a mosaic of habitat types.<br>• If protected from browsers these areas could be effectively restored. Succession towards broadleaf forest was observed in the patch between CH 5400 - CH 5600 which is fenced. | |
| Advanced Secondary Broadleaved Forest | Representativeness: **High**<br>• Dominated by indigenous species<br>• Diversity generally representative of the successional stage of the habitat type but lacking the diversity of the old-growth forest.<br>• The flora diversity indicative that the area will support a typical fauna assemblage for the successional stage of the vegetation.<br>• The area is fenced and subject to pest control which indicates a higher likelihood of more sensitive fauna occurring in these areas.<br>Rarity/distinctiveness: **High**<br>• Although generally comprised of mid-successional species, the vegetation is not characteristic of old-growth forest types classified as threatened in the Horizons One Plan.<br>• These remnants occur across land environments where either, <10%, or 10 - 20% of indigenous cover remains (LENZ Level IV - Walker et al., 2015). | **Very High**: high for 3 or all of the four assessment matters |

| Ecosystem types | Value of Vegetation/habitats (as per EIANZ guidelines) | 'Ecological Value' (EcIAG) |
|---|---|---|
| | • Although not recorded during site investigations, Threatened kānuka and rata species may be present.<br>• Given the direct connectivity to the Manawatū Gorge Scenic Reserve it is likely that the At Risk whitehead use the habitat.<br>• It is highly likely that At Risk lizards (both arboreal and ground-dwelling) occur in this habitat given its connectivity to the Manawatū Gorge Scenic Reserve, stock exclusion and predator control.<br>• Potential to support Threatened or At Risk invertebrate species, both aerial and ground dwelling.<br>Diversity and Pattern: **'Moderate'**<br>• Diversity generally representative of the successional stage of the habitat type but lacking the diversity of the old-growth forest.<br><br>Ecological context: **High**<br>• Both advanced broadleaved areas are part of a larger vegetation mosaic that is contiguous with the Manawatū Scenic Reserve.<br>• These patches all occur along the edges of these mosaics, providing buffer functionality but are subject to increase edge effects.<br>• The area sit within the Western QEII covenant which is legally protected and is less impacted by stock access. | |

| Ecosystem types | Value of Vegetation/habitats (as per EIANZ guidelines) | 'Ecological Value' (EcIAG) |
|---|---|---|
| Secondary Broadleaved Forests and Scrublands | Generally as assessed for 'Advanced Secondary Broadleaved Forest' except that Ecological Context Diversity and Representative are assessed as 'Moderate' because:<br>• Areas of this habitat type are scattered across the Project footprint and have various patch sizes and levels of connectivity to old-growth habitats.<br>• Represent an earlier successional stage and thus have a less diverse flora assemblage and structure.<br>• Many of these patches sit with an agricultural matrix and have been more modified by stock degradation and likely subject to higher pest pressure. | **'Moderate':** High for 1 of the assessment matters, 'Moderate' or 'Low' for the remainder |
| Mānuka, Kānuka Shrublands | Representativeness: '**Low**'<br>• Generally dominated by indigenous species (kānuka) but exotic broom is a notable canopy component in some areas.<br>• All mānuka, kānuka shrubland patches are highly modified by stock access. Consequently the understorey and groundcover tiers do not have a representative species assemblage and are often absent except for pasture grass.<br>• The low flora diversity and lack of habitat complexity suggests that the remnants are unlikely to support the full species assemblage that would be expected in a less modified early successional habitat type.<br>Rarity/distinctiveness: '**Moderate**'<br>• Mānuka and kānuka are both Threatened - Naturally Vulnerable however this status has been applied as a precautionary measure due to the currently unquantified risk myrtle rust poses to species in the Myrtaceae family. This conservation status does not reflect actual declines in either mānuka or kānuka.<br>• Manuka, kānuka shrublands occur across land environments where either, <10%, or 10 - 20% of indigenous cover remains (LENZ Level IV - Walker et al., 2015).<br>• Scrub and shrubland, not identified has being in the Manawatu-Wanganui Region historically. Mānuka, kānuka shrublands are a common early successional habitat types and not considered rare or threatened in the Region.<br>• It is unlikely that Threatened or At Risk birds, lizards or terrestrial invertebrates occupy the patches given their small size, fragmentation, low flora diversity, and lack of understorey habitat for ground dwelling species. | '**Moderate**' (High for one assessment matter and low for the other three) |

| Ecosystem types | Value of Vegetation/habitats (as per EIANZ guidelines) | 'Ecological Value' (EcIAG) |
|---|---|---|
| | • Notwithstanding the above, remnant populations of immobile species such as geckos are can sometimes occur such habitat. I consider this likelihood very low because of the evidence of herbicide application in these areas to prevent the encroachment of regenerating scrub across productive land.<br>• The habitat patches may be used as stepping stone habitat for mobile species but are unlikely to provide important breeding or foraging habitat for threatened or At Risk birds.<br>Diversity and Pattern: '**Low'**<br>• Low native diversity, limited to early successional species.<br>• Grazing regimes preventing advancement to a more diverse, later-successional assemblage.<br>Ecological context: '**Low'**<br>• A number of small vegetation patches, primarily occurring within grazed pasture, subject to stock modification and edge effects.<br>• The spread of the shrubland across the landscape suggest that that the patches contribute to landscape linkages for mobile species. | |
| Divaricating Shrublands | Representativeness: **'Low'**<br>• Canopy generally dominated by indigenous species but canopy cover is low and the areas are interspersed with exotic pasture.<br>• The divaricating shrubland patches appear to be induced through human modification, namely grazing pressure and aerial herbicide application to suppress mānuka/kānuka regeneration.<br>• The low flora diversity and lack of habitat complexity suggests that the remnants are unlikely to support the full assemblage of fauna that would be expected in a less modified early successional habitat type.<br>Rarity/distinctiveness: '**High'**<br>• The occasional mānuka and kānuka (both Threatened - Naturally Vulnerable) were recorded in these areas. However, this status has been applied as a precautionary measure due to the unquantified risk Myrtle rust currently poses to species in the Myrtaceae family. This conservation status does not reflect actual declines in either mānuka or kānuka. | **'Moderate'** (high for one assessment matter and 'Low' for the remaining 3) |

| Ecosystem types | Value of Vegetation/habitats (as per EIANZ guidelines) | 'Ecological Value' (EcIAG) |
|---|---|---|
| | • No other Threatened, At Risk, or locally uncommon plant species have been identified in the shrublands.<br>• All of the divaricating shrubland patches occur within land environments where only 10 - 20% of indigenous cover remains (LENZ Level IV - Walker et al., 2015).<br>• Scrub and shrubland, has not been identified as being in the Manawatū-Wanganui Region historically (Maseyk, 2007). Thus, divaricating shrubland is not considered rare or threatened in this Region.<br>• Divaricating shrubs are known to support a diversity of invertebrates often with specific host plant associations.<br>• Literature reviews undertaken during the NoR process identified two At Risk moths (*Meterana exquisita* and *M. grandiosa*) could inhabit the Project footprint and the divaricating shrublands could support these species.<br>• The lack of understorey refugia suggests limited habitat for ground-dwelling invertebrates and lizards but remnant populations of At Risk arboreal geckos, including barking gecko and Ngahere gecko, could be present.<br>• As described above, the application of herbicide suggests the persistence of any remnant populations of immobile species is unlikely.<br>• The limited structural integrity of the shrublands suggests that they are unlikely to provide important breeding or foraging habitat for Threatened or At Risk birds with the exception of NZ pipit (At Risk - Declining).<br>Diversity and Pattern: '**Low'**<br>• Low native diversity, limited to early successional species.<br>• Grazing regimes and herbicide application are preventing advancement to a more diverse, later-successional assemblage.<br>Ecological context: '**Low'**<br>• A number of small vegetation patches, primarily occurring within grazed pasture, subject to stock modification and edge effects.<br>• Unlike the mānuka, kānuka shrubland described above, the distribution of the divaricating shrubland patches is largely limited to a single sub-catchment and, therefore, the contribution to connective linkages on a landscape scale is limited. | |

| Ecosystem types | Value of Vegetation/habitats (as per EIANZ guidelines) | 'Ecological Value' (EcIAG) |
|---|---|---|
| Indigenous Dominated Seepage Wetland (raupō wetland) | Representativeness: **'Moderate'**<br>• Canopy dominated by indigenous species.<br>• The remnant swamp maire is representative of the swamp forest that would have likely occurred in the area prior to human modification but the remainder of the wetland is less representative of a pre-human assemblage.<br>• The limited structural diversity compared to the pre-human swamp forest suggests that the area is unlikely to support the typical fauna assemblage expected of intact wetland habitat.<br>• The area is not subject to pest control.<br>Rarity/distinctiveness: '**High'**<br>• Swamp maire is classified as Threatened - Nationally Critical (the threat status of Swamp maire was elevated from Not Threatened due the risk imposed by myrtle rust).<br>• The raupō seepage occurs within a land environment where only 10 - 20% of indigenous cover remains (LENZ Level IV - Walker et al., 2015).<br>• Native-dominated seepage wetlands are classified as rare under the One Plan.<br>• Intact wetlands generally are considered threatened with less than 5% remaining from pre-human extent (Maseyk, 2007).<br>• Several threatened wetland bird species potentially present though no wetland birds have been recorded during the acoustic monitoring and wetlands lack open water which lowers the value of this habitat for some wetland bird species<br>• New Zealand pipit which inhabit open habitats including rough grassland and may nest under amongst rushes or rank grass.<br>Diversity and Pattern: **'Moderate'**<br>• Low native diversity compared to the swamp forest that would have occurred on the alluvial soils originally. However, 'Moderate' diversity of native flora and fauna known or likely to be present<br>Ecological context: '**High'**<br>• Forms part of a mosaic of habitats with connectivity to old-growth forest and the Manawatū Gorge Scenic Reserve. | **'High'** ('High' for two matters and 'Moderate' or 'Low' for other matters) |

| Ecosystem types | Value of Vegetation/habitats (as per EIANZ guidelines) | 'Ecological Value' (EcIAG) |
|---|---|---|
| | • Given the threat status of wetlands generally due to specific hydrological requirements, the protection and restoration of wetlands is a priority under the RMA (Section 6) and the Draft National Policy Statement for Indigenous Biodiversity (Policy 12).<br>• The intact hydrology and its proximity to alluvial forest suggests that the area could be effectively restored if retired from grazing. | |
| Indigenous Dominated Seepage Wetland -<br>(*Carex* dominated wetlands) | Representativeness: **'Moderate'**<br>• Canopy dominated by indigenous species and known or likely to include flora and fauna typical of Carex dominated wetlands.<br>• The size of these seepage wetlands suggests that prior to forest clearance and stock degradation these seepage areas would likely have been characterised by lowland forest surrounding watercourses.<br>• The limited structural diversity compared to the pre-human swamp forest suggests that the area is unlikely to support the typical fauna assemblage expected of intact wetland habitat.<br>• The area are not subject to pest control<br>Rarity/distinctiveness: '**High'**<br>• The 'Moderate' value seepage wetlands occur within a land environment where only 10 - 20% of indigenous cover remains (LENZ Level IV - Walker et al., 2015).<br>• Native-dominated seepage wetlands are classified as rare under the One Plan.<br>• Intact wetlands generally are considered threatened with less than 5% remaining from pre-human extent (Maseyk, 2007).<br>• Several threatened wetland bird species potentially present though no wetland birds have been recorded during the acoustic monitoring and wetlands lack open water which lowers the value of this habitat for some wetland bird species<br>• New Zealand pipit which inhabit open habitats including rough grassland and may nest within or adjacent to the wetland.<br>Diversity and Pattern: '**Low'**<br>• Native component largely limited to *Carex geminata*, likely induced by prolonged stock access.  Low native diversity compared to forest habitat that would have occurred in these areas originally.<br>Ecological context: ~~'**High'**~~ **Moderate** | **'High'** ('High' for 2 matters and 'Low' or 'Moderate' for the remainder) |

| Ecosystem types | Value of Vegetation/habitats (as per EIANZ guidelines) | 'Ecological Value' (EcIAG) |
|---|---|---|
| | • Given the threat status of wetlands generally due to specific hydrological requirements, the protection and restoration of wetlands is a priority under the RMA (Section 6) and the Draft National Policy Statement for Indigenous Biodiversity (Policy 12).<br>• The intact hydrology of these wetland areas suggests that the area could be effectively restored if retired from grazing **but ecological connectance to native forest is low**. | |
| Exotic Wetland (including pasture wetlands dominated by *Juncus edgariae*) | Representativeness: **'Low'**<br>• Dominated by exotic pasture species, or occasionally the common native rush *Juncus edgariae* which often invades rough pasture.<br>• The size of these seepage wetlands suggests that prior to forest clearance and stock degradation these seepage areas would likely have been characterised by lowland forest surrounding small tributaries.<br>• The extent of modification to these areas resulting in a very limited structural diversity and a degraded hydrological system suggests that these areas are highly unlikely to support the typical fauna assemblage expected of intact wetland habitat.<br>• The areas are not subject to pest control.<br>Rarity/distinctiveness: '**High'**<br>• Wetlands, irrespective of condition are a threatened habitat type and the protection and restoration of wetlands is a priority under the RMA (Section 6) and the Draft National Policy Statement for Indigenous Biodiversity (Policy 12).<br>• The pasture wetlands occur within a land environment where only 10 - 20% of indigenous cover remains (LENZ Level IV - Walker et al., 2015).<br>• Native-dominated seepage wetlands are classified as rare under the One Plan but exotic dominated wetlands are not considered threatened under the One Plan.<br>• Although pasture wetlands score highly as an ecosystem type, the extensive modification of these areas suggests are very low likelihood of supporting Threatened or At Risk fauna.<br>Diversity and Pattern: '**Low'**<br>• Native component largely limited to a low cover of common rushes but generally characterised by pasture species.<br>• Heavily degraded by stock resulting in minimal habitat complexity. | **'Moderate' (**High for one matter, 'Moderate' and 'Low' for the remainder), |

| Ecosystem types | Value of Vegetation/habitats (as per EIANZ guidelines) | 'Ecological Value' (EcIAG) |
|---|---|---|
| | Ecological context: **'Moderate'**<br>These wetlands are likely to constitute important stepping stones and provide habitat for mobile species such as pied stilt or pukeko and aquatic invertebrates that are dependent on wetlands with ephemeral or intermittent hyperiods to complete their life cycle. | |

## Updates to Table 6 to address inconsistencies

**Table 6: 'Magnitude of Effect' for each habitat type in the Project footprint assessed using EcIAG methodology**

<table>
<tr><th>Vegetation/ habitat type</th><th>Direct impact (extent of vegetation removal)</th><th>Indirect impacts<br>(the quality of remaining habitat may be degraded due to changes in edge microclimate as a result of increased exposure to light and wind, increased incursions of pest plants, and from dust deposition)[1]</th><th>Minimisation measures</th><th>Magnitude of effect</th></tr>
<tr><td>Old-growth forest (alluvial)</td><td>0.10 ha, which equates to 2.4% of what is available within the designation corridor and noting that this habitat type is down to 2.5% of its original extent in the Region.<br>This habitat lies within the construction footprint and will be replaced in the long-term</td><td>Potential edge effects resulting from the proposed design have been assessed as "Negligible" for the following reasons:<br>- A very small area proposed for removal along an existing edge, minimising changes in exposure to the biotic and abiotic factors listed above;<br>- The proposed alignment is located downwind of the prevailing winds hence dust deposition during construction will be limited.<br>- Further fragmentation avoided as an existing edge is being removed.</td><td rowspan="2">- Physical delineation to ensure no over clearance of vegetation.<br>- Clearance extent minimised through pruning as opposed to felling of old-growth trees where possible.<br>- Clearance extent along habitat edges, avoiding fragmentation.<br>- Seasonal restrictions and/or pre-clearance protocols will be put in place to minimise harm to native fauna including native snails, lizards, and birds (Refer to the EMP in Volume VII).<br>- Epiphyte and coarse woody debris relocation will reduce harm to invertebrates and provide habitat enhancement in adjacent forest (Refer to the EMP in Volume VII).<br>- Dust suppression is proposed across the Project footprint during construction and monitoring will</td><td>'Moderate'</td></tr>
<tr><td>Old-growth forest (hill country)</td><td>Permanent loss of 0.85 ha. This equates to 48% of what is available in the designation corridor and <</td><td>Potential edge effects resulting from the proposed design have been assessed as 'Low' for the following reasons:<br>- Shifting the impact area to the head of the Western QEII gully avoids fragmentation and results in the shifting of an existing edge</td><td>'Moderate'</td></tr>
</table>

| Vegetation/ habitat type | Direct impact (extent of vegetation removal) | Indirect impacts (the quality of remaining habitat may be degraded due to changes in edge microclimate as a result of increased exposure to light and wind, increased incursions of pest plants, and from dust deposition)[1] | Minimisation measures | Magnitude of effect |
|---|---|---|---|---|
| | 1% of what is available on the local landscape (i.e., the adjacent Manawatū Scenic Reserve but noting that it is threatened ecosystem type in the region with 19% of its former extent remaining. | rather than the creation of two new edges in addition to the existing edge.<br>- The vegetation adjacent to the new edge is currently less than 100 m in width and therefore is likely already exposed to edge effects, albeit at a lesser extent.<br>- The existing alignment is located upwind of the prevailing wind and therefore dust deposition is more likely to occur during construction. | be undertaken at old-growth forest adjacent to Project footprint (refer to Technical Assessment E).<br>- Weed control and enrichment planting to be undertaken in newly created edges (Refer to the EMP in Volume VII).<br>- Replacement planting at a scale of 1:100 for any swamp maire pruned, or 1:200 for swamp maire felled.<br>- Replacement planting at a scale of 1:100 for any ramarama felled. | |
| Secondary broadleaved forests with old-growth signatures | Long-term loss of ~~0.04~~ **0.25** ha, which eq~~uates~~ to 1.3 **10.5**% of availability within the designation corridor and noting that this habitat type is uncommon in the wider landscape | Potential edge effects resulting from the proposed design have been assessed as **"Negligible" - 'Low'** for the following reasons:<br>- The impact areas are either already fragmented and exposed to edge effects (CH 7300 - CH 7400) or a very small area proposed for removal along an existing edge. Hence both areas are already exposed to edge effects, albeit at a lesser extent.<br>- The existing alignment is located upwind of the prevailing wind at both impact areas and therefore dust deposition is likely to occur | - Physical delineation to ensure no over clearance of vegetation.<br>- Clearance extent along habitat edges, avoiding fragmentation.<br>- Areas of the forest remnant between CH 10400 - CH 10600 that actually contain old-growth trees are avoided.<br>- Seasonal restrictions and/or pre-clearance protocols will be implemented to minimise harm to native fauna including native | ~~'Low'~~ **'Moderate'** |

| Vegetation/ habitat type | Direct impact (extent of vegetation removal) | Indirect impacts (the quality of remaining habitat may be degraded due to changes in edge microclimate as a result of increased exposure to light and wind, increased incursions of pest plants, and from dust deposition)[1] | Minimisation measures | Magnitude of effect |
|---|---|---|---|---|
| | | during construction. It is noted that the area located at CH 7300 - CH 7400 is already exposed to some dust deposition effects from an unsealed farm track that exists along this edge. | snails, lizards, and birds (Refer to draft EMP in Volume VII).<br>- Dust suppression proposed across the footprint during construction (refer to Technical Assessment E)<br>- Weed control and enrichment planting to be undertaken in newly created edges (Refer to the EMP in Volume VII). | |
| Old-growth treelands | Permanent loss of 0.13 ha, which equates to 32% of availability within the designation corridor and noting that this habitat type is **un**common in the wider landscape | Potential edge effects resulting from the proposed design have been assessed as **"Negligible"** for the following reasons:<br>- The treeland remnants are very small and open (< 30 m at the widest point) and hence will already be exposed to high levels of edge effects; and<br>- The understory is already dominated by exotic plants. | - Physical delineation to ensure no over clearance of vegetation.<br>- Clearance extent minimised through pruning as opposed to felling of old-growth trees where possible.<br>- The stormwater wetland proposed for the area has been modified to almost completely avoid the ramarama area.<br>- Seasonal restrictions and/or pre-clearance protocols will be put in place to minimise harm to native fauna including: lizards and birds (Refer to the EMP in Volume VII). | ~~'Low'~~ **Moderate** |

| Vegetation/ habitat type | Direct impact (extent of vegetation removal) | Indirect impacts (the quality of remaining habitat may be degraded due to changes in edge microclimate as a result of increased exposure to light and wind, increased incursions of pest plants, and from dust deposition)[1] | Minimisation measures | Magnitude of effect |
|---|---|---|---|---|
| | | | - Dust suppression is proposed across the Project footprint during construction (refer to Technical Assessment E) | |
| Kānuka forests | 1.3 ha, which equates to 29% of availability within the designation corridor. Although kānuka forest is considered threatened regionally, the kānuka forest available in the designation corridor appears to be created as a product of sustained grazing pressure, and is likely to be common in the surrounding | Potential edge effects resulting from the proposed design have been assessed as **'Negligible' - 'Low'** for both impact areas for the following reasons:<br>- The areas impacted are along existing edges. However in the case of CH 3900 - CH 4300, vegetation clearance will shift this edge considerably (>50 m), exposing an area of canopy that has previously been relatively protected from the abiotic effects. Notwithstanding this the area is grazed underneath and the understory is dominated by exotic plants. Hence the impacts of light-demanding pest plants colonising the new edge will be minimal; and<br>- The proposed alignment is located upwind of the prevailing wind but the construction of the viaduct will not create a large area of exposed earth, limiting dust deposition potential.<br>- At CH 5400 - CH 5600, a small area is proposed for removal and the proposed alignment is located downwind of the | - Physical delineation to ensure no over clearance of vegetation.<br>- Seasonal restrictions and/or pre-clearance protocols will be put in place to minimise harm to native fauna including: lizards, birds and bats (Refer to the EMP in Volume VII).<br>- Dust suppression is proposed across the Project footprint during construction (refer to Technical Assessment E)<br>- Weed control and enrichment planting to be undertaken in newly created edges (Refer to the EMP in Volume VII). | **'Moderate'** |

| Vegetation/ habitat type | Direct impact (extent of vegetation removal) | Indirect impacts (the quality of remaining habitat may be degraded due to changes in edge microclimate as a result of increased exposure to light and wind, increased incursions of pest plants, and from dust deposition)[1] | Minimisation measures | Magnitude of effect |
|---|---|---|---|---|
| | rural landscape. | prevailing winds hence dust deposition during construction will be limited. | | |
| Advanced secondary broadleaved forest | Long-term loss of 0.04 ha, which equates to 1.4 % of availability within the designation corridor.<br>Regenerating broadleaved forest at various stages of succession are common in the surrounding landscape and are not listed as threatened in the region. | Potential edge effects resulting from the proposed design have been assessed as **'Low'** for the following reasons:<br>- A small area is proposed for removal and this habitat type is located along an existing gully edge, limiting changes in exposure to the biotic and abiotic factors listed above; and<br>- The proposed alignment is located upwind of the prevailing wind and therefore dust deposition is likely to occur during construction. | - Physical delineation to ensure no over clearance of vegetation.<br>- Seasonal restrictions and/or pre-clearance protocols will be put in place to minimise harm to native fauna including: lizards, birds and bats (Refer to the EMP in Volume VII).<br>- Dust suppression is proposed across the Project footprint during construction (refer to Technical Assessment E)<br>- Weed control and enrichment planting to be undertaken in newly created edges, including temporary edges (Refer to the EMP in Volume VII) | **'Low'** |
| Secondary broadleaved forests and scrublands | 6.44 ha which equates to 39% of availability within the designation corridor. As above, | Potential edge effects resulting from the proposed design have been assessed as **Negligible' - 'Low'** all of the impact locations with the exception of two (details below). The reasoning is below: | - Seasonal restrictions and/or pre-clearance protocols will be put in place to minimise harm to native fauna including: lizards and birds (Refer to the EMP in Volume VII). | **'Moderate'** |

| Vegetation/ habitat type | Direct impact (extent of vegetation removal) | Indirect impacts (the quality of remaining habitat may be degraded due to changes in edge microclimate as a result of increased exposure to light and wind, increased incursions of pest plants, and from dust deposition)[1] | Minimisation measures | Magnitude of effect |
|---|---|---|---|---|
| | regenerating broadleaved forest at various stages of succession are common in the surrounding landscape and are not listed as threatened in the region. | - the secondary broadleaved forests and scrublands are comprised relatively early successional species that are robust to increased exposure abiotic factors listed above;<br>- Many of these areas are already small, fragmented by the existing land use, and interspersed with pest plants, namely broom.<br>- In most cases further fragmentation avoided as existing edges is being removed.<br>- These patches occur at different positions relative to the proposed alignment and thus will be impacted by dust deposition differently. However dust is unlikely to cause more than a 'Low'level effect in any instance.<br>The potential edge effects have been assessed as **'Moderate'** for the secondary broadleaved forest patches at CH 9800 - CH 10000 and CH 10800 - CH 11400. The following reasons apply:<br>- At  CH 9800 - CH 10000 a large proportion of this patch is proposed to be removed. Moreover the proposed alignment bisects the patch, resulting in the creation of a large amount of new edge and further fragmentation. However, the patch is less than 100 m in width and so is likely to be | - Dust suppression is proposed across the Project footprint during construction (refer to Technical Assessment E)<br>- Weed control and enrichment planting to be undertaken in newly created edges (Refer to the EMP in Volume VII).<br>- Translocation of *Adiantum formosum* located at CH 3800 - CH 4000 and additional planting of 1:15 for each relocated plant. | |

| Vegetation/ habitat type | Direct impact (extent of vegetation removal) | Indirect impacts (the quality of remaining habitat may be degraded due to changes in edge microclimate as a result of increased exposure to light and wind, increased incursions of pest plants, and from dust deposition)[1] | Minimisation measures | Magnitude of effect |
|---|---|---|---|---|
| | | exposed to some level of edge effects already;<br>- A large proportion of the patches at CH 10800 - 11400 is proposed to be removed creating a large amount of new edge. However all of the areas removed occur along existing edges, avoiding fragmentation and shifting existing edges as opposed the creation of additional edges.At:<br>- The mitigating factors listed above e.g. the high proportion of early-successional species applies to these areas, hence why they have been assessed as 'Moderate' as opposed to high. | | |
| Mānuka, kānuka shrublands | 2.11 ha, which equates to > 50 % of the availability within the designation corridor.<br>This shrubland type is common in the surrounding landscape and appears to readily | Potential edge effects resulting from the proposed design have been assessed as **"Negligible"** for the following reasons:<br>- All mānuka, kānuka shrubland patches are small, isolated and regularly impacted by stock. Consequently, the areas are already exposed to edge effects and are currently comprised of early successional species that are robust to increased exposure abiotic factors listed above. | - Physical delineation to ensure no over clearance of vegetation.<br>- Seasonal restrictions and/or pre-clearance protocols will be put in place to minimise harm to native fauna including: lizards and birds (Refer to the EMP in Volume VII).<br>- Dust suppression is proposed across the Project footprint during construction (refer to Technical Assessment E) | **'Moderate'** |

| Vegetation/ habitat type | Direct impact (extent of vegetation removal) | Indirect impacts (the quality of remaining habitat may be degraded due to changes in edge microclimate as a result of increased exposure to light and wind, increased incursions of pest plants, and from dust deposition)[1] | Minimisation measures | Magnitude of effect |
|---|---|---|---|---|
| | establish in pasture. It is not threatened in the region. | | - Weed control and enrichment planting to be undertaken in newly created edges (Refer to the EMP in Volume VII). | |
| Divaricating shrublands | 0.33 ha, which equates to > 50 % of the availability within the designation corridor. The divaricating shrublands within the designation corridor appear to be closely associated with the manuka, kanuka shrubland. It appears to be **moderately** common in the landscape. It is not threatened in the region. | Potential edge effects resulting from the proposed design have been assessed as **"Negligible"** for the following reasons:<br>- All divaricating shrubland patches are small, isolated and regularly impacted by stock. Consequently, the areas are already exposed to edge effects and are currently comprised of early successional species that are robust to increased exposure abiotic factors listed above. | - Physical delineation to ensure no over clearance of vegetation.<br>- Seasonal restrictions and/or pre-clearance protocols will be put in place to minimise harm to native fauna including: lizards, birds and terrestrial invertebrates (Refer to the EMP in Volume VII).<br>- Dust suppression is proposed across the Project footprint during construction (refer to Technical Assessment E)<br>- If *Meterana* spp. Recorded in the area - a grazing or mowing regime will be continued across the remaining divaricating shrubland patches within the designation to promote the areas remaining in a stalled successional trajectory dominated by divaricating shrubs (Refer to the EMP in Volume VII). | ~~Low~~ Moderate |

| Vegetation/ habitat type | Direct impact (extent of vegetation removal) | Indirect impacts (the quality of remaining habitat may be degraded due to changes in edge microclimate as a result of increased exposure to light and wind, increased incursions of pest plants, and from dust deposition)[1] | Minimisation measures | Magnitude of effect |
|---|---|---|---|---|
| Raupō-dominated seepage wetlands (high value) | 0.11, which equates to 20 % of the availability within the designation corridor.<br><br>Raupō wetlands appear to be rare in the wider landscape and in the region noting that only 3% of wetlands remain in the region. | **High**<br>- The raupō wetland occurs within a matrix of forest, scrub and grassland and is generally quite open. The dominant wetland component, raupō, is adapted to open environments and are robust to increased exposure abiotic factors associated with the creation of new edge.<br>- Wetlands are naturally fragmented across the landscape due to the specific landforms they occur within. Hence the species that inhabit wetlands are generally mobile and fragmentation resulting from the Project is unlikely to impact the movement of fauna or dispersal of seed more than the existing agricultural matrix.<br>- Notwithstanding the above, fragmentation of the high value raupō wetland has been avoided by the extension of BR03 to limit impacts in the area.<br>An indirect impact specific to wetland habitat types is changes in hydrology impacting species assemblages.<br>- The hydrology of the raupō appears to be somewhat impacted by stock access but is generally intact. Geotechnical investigations have found that the raupō wetland is located above an artesian | - Physical delineation to ensure no over clearance of vegetation.<br>- The staging piles will be capped to ensure artesian aquifer is not ruptured, thus maintaining the current hydrology.<br>- Seasonal restrictions and/or pre-clearance protocols will be put in place to minimise harm to native wetland birds potentially nesting in the area (Refer to the EMP in Volume VII). | **'Moderate'** |

| Vegetation/ habitat type | Direct impact (extent of vegetation removal) | Indirect impacts (the quality of remaining habitat may be degraded due to changes in edge microclimate as a result of increased exposure to light and wind, increased incursions of pest plants, and from dust deposition)[1] | Minimisation measures | Magnitude of effect |
|---|---|---|---|---|
| | | aquifer. Construction of the Project has the potential to rupture this aquifer which would change the hydrology of the raupō wetland considerably. | | |
| Indigenous-dominated seepage wetlands ('Moderate' value) | 0.44 (which equates to 66.7 % of this type of wetland available in the designation corridor)<br><br>Indigenous dominated seepage wetlands appear to be rare in the surrounding landscape and in the region. | **"Negligible"**<br>- All of the 'Moderate' and 'Low' value wetlands on the site occur in open areas and the species inhabiting the different wetland types are adapted to open environments and are robust to increased exposure abiotic factors associated with the creation of new edge.<br>- Wetlands are naturally fragmented across the landscape due to the specific landforms they occur within. Hence the species that inhabit wetlands are generally mobile and fragmentation resulting from the Project is unlikely to impact the movement of fauna or dispersal of seed more than the existing agricultural matrix.<br>An indirect impact specific to wetland habitat types is changes in hydrology as well as sedimentation and pollution impacting species assemblages.<br>- The hydrology of the 'Moderate' and 'Low'value wetlands appear to be impacted by stock pugging and the native species | - Physical delineation to ensure no over clearance of vegetation.<br>- Seasonal restrictions and/or pre-clearance protocols will be put in place to minimise harm to native lizards, and birds potentially nesting in the area (Refer to the EMP in Volume VII). | **'High'** |
| Pasture wetlands, dominated by exotic species or the common | 4.23 ha, which constitutes an unknown but likely high proportion of wetlands in the | | - Physical delineation to ensure no over clearance of vegetation.<br>- Seasonal restrictions and/or pre-clearance protocols will be put in place to minimise harm to pipit | **'Moderate'** |

| Vegetation/ habitat type | Direct impact (extent of vegetation removal) | Indirect impacts (the quality of remaining habitat may be degraded due to changes in edge microclimate as a result of increased exposure to light and wind, increased incursions of pest plants, and from dust deposition)[1] | Minimisation measures | Magnitude of effect |
|---|---|---|---|---|
| native rush *Juncus edgariae* (low value)<br><br>Numerous locations across the Footprint | designation corridor.<br>Wetlands in improved pasture are common in the surrounding landscape, but noting that freshwater wetlands are down to 3% of their formal extent in the region. | dominating these wetlands (*Juncus edgariae* and *Carex geminata*) are not limited to strict hydrological conditions. Consequently it is unlikely that any hydrological changes caused by the Project will have a discernible impact on these wetland assemblages. | eggs and unfledged chicks (Refer to the EMP in Volume VII). | |

## Updates to Table 8 to address inconsistencies

**Table 8. Level of residual effects for terrestrial and wetland habitats and associated species after effects avoidance and minimisation measures (as per EcIAG step 3)**

| **Biodiversity value within the Project footprint (ha)** | **'Ecological Value'** | **'Magnitude of Effect' after avoidance and minimisation** | **'Level of Effect' after avoidance and minimisation** |
|---|---|---|---|
| **Vegetation/ habitat type** | | | |
| Old-growth forest (alluvial) | 'Very High' | 'Moderate' | 'High' |
| Old-growth forest (hill country) | 'Very High' | 'Moderate' | 'High' |
| Secondary broadleaved forests with old-growth signatures | ~~'High'~~ **Very High** | 'Moderate' | 'High' |
| Old-growth treelands (+ ramarama) | ~~'High'~~ **Moderate** | 'Low' | 'Moderate'* |
| Kānuka Forests | 'Moderate' | 'Moderate' | 'Moderate' |
| Advanced Secondary Broadleaved Forest | ~~'High'~~ **Very High** | 'Low' | 'Moderate'* |
| Secondary Broadleaved Forests and Scrublands | 'Moderate' | 'Moderate' | 'Moderate' |
| Mānuka, Kānuka Shrublands | 'Moderate' | 'Moderate' | 'Moderate' |
| Divaricating Shrublands | 'Moderate' | 'Moderate' | 'Moderate' |
| Indigenous Dominated Seepage Wetland - High Value (raupō wetland) | ~~'Very High'~~ **High** | 'Moderate' | 'High' |
| Indigenous Dominated Seepage Wetland - 'Moderate' Value (*Carex* dominated wetlands) | 'Moderate' | 'High' | 'Moderate' |
| Exotic Wetland (including pasture wetlands dominated by *Juncus edgariae*) | 'Moderate' | 'Moderate' | 'Moderate' |

## Attachment 8: Raupō Wetland Memorandum

# Te Ahu a Turanga: Manawatū Tararua Highway Project

**Memorandum**

| | |
|---|---|
| **To** | **Damien McGahan & Julia Lovelock** |
| **Copy** | **David Hughes** |
| **From** | **Jack McConchie** |
| | |
| **Date** | **28 April 2020** |
| **File** | **5-C3567.49** |
| **Subject** | **Hydrological Integrity of Raupō Wetland – s92 response** |

Item 16 of Horizons' s92 request for further information relates to the maintenance of the hydrological integrity of the raupō-dominated seepage wetlands; located above the true left bank of the lower reaches of Stream 7. Specifically:

16. *Could the Applicant and the Project Ecologists please provide comment as to the level of confidence that the hydrological integrity of the Raupō-dominated seepage wetlands will remain intact?*

# 1 Introduction

The raupō wetlands have formed on an elevated terrace formed from colluvial and alluvial deposits above the true left bank of Stream 7 (Figure 1-1). Seepage wetlands are dynamic and often transient features that evolve hydrologically, and consequently ecologically, over time. The current raupō wetlands are surrounded by both indigenous forest and exotic scrubby vegetation. It is likely that this vegetation will continue to encroach into the current extent of the raupō wetlands over time; particularly if stock is excluded from the area.

**Figure 1-1 : Location of the raupō-dominated wetland on the elevated terrace above Stream 7.**

# 2 Setting

The raupō wetlands are a response to impeded drainage and the abrupt break in slope between the hillside behind the wetlands and Stream 7 at their toe, as shown in Figure 2-1 (a high-resolution 1m DTM generated from LiDAR showing these drainage characteristics and potential overland flow paths).

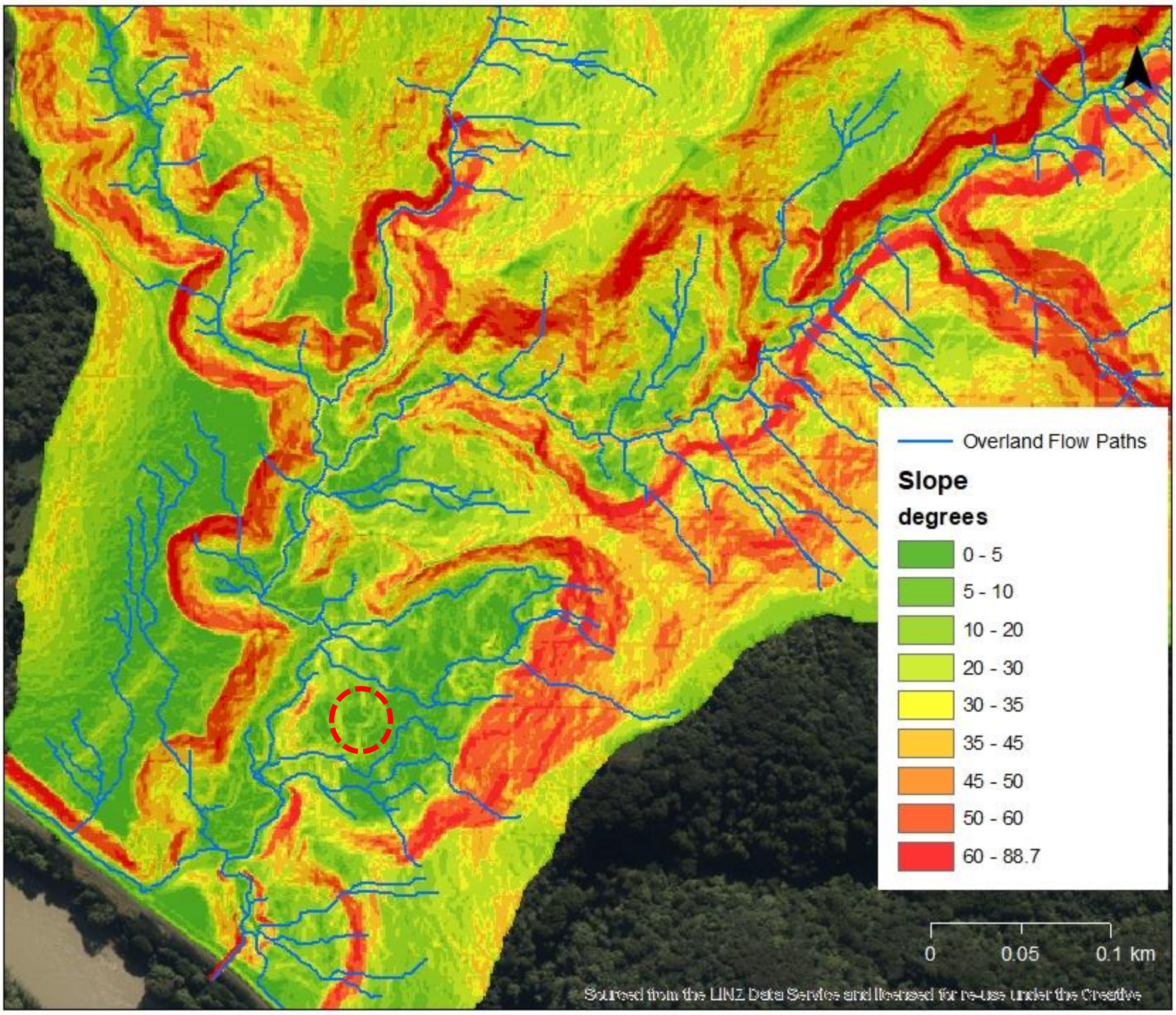


**Figure 2-1:** **Slopes in the lower reaches of Stream 7. The area of generally 'flat' terrain that hosts the Raupō-dominated wetlands is highlighted (red circle).**

The slope map shows that the raupō-dominated wetlands lie within a 'bowl' surrounded on three sides by steep slopes (Figure 2-1). The floor of this 'bowl' is generally flat and undulating. Because of this topography, water drains rapidly from the surrounding slopes and runoff, both surface and subsurface, is concentrated within the 'bowl'. Here the flatter slopes and undulating terrain reduce the rate of runoff and ponding occurs. There is poor definition of any potential watercourses in this area, despite the very small flow threshold used in the terrain analysis. The poor drainage and ponding in this area have created conditions suitable for raupō-dominated wetlands (Figure 2-2). It should be noted that the various drainage lines shown in Figure 2-2 are based solely on terrain modelling and have not been confirmed in the field. The actual drainage density is likely to be significantly less than indicated in Figure 2-2.

It is noted, however, that wetlands are dynamic ecosystems and subject to change under natural conditions. For example, the raupō-dominated wetlands would be affected by any further erosion of material from the slopes above. This is because the 'bowl' in which the wetlands are located is the depositional area for any material eroded from the upper slopes.

Also, the natural and ongoing incision of Stream 7 has the potential to caused headward erosion of any small streams and gullies which have formed into at the toe of the wetlands.

Over time, this headward erosion will form a more mature drainage network that could adversely affect the wetlands by increasing drainage at the distal end. All these processes, however, are natural and will not be affected by the Project.

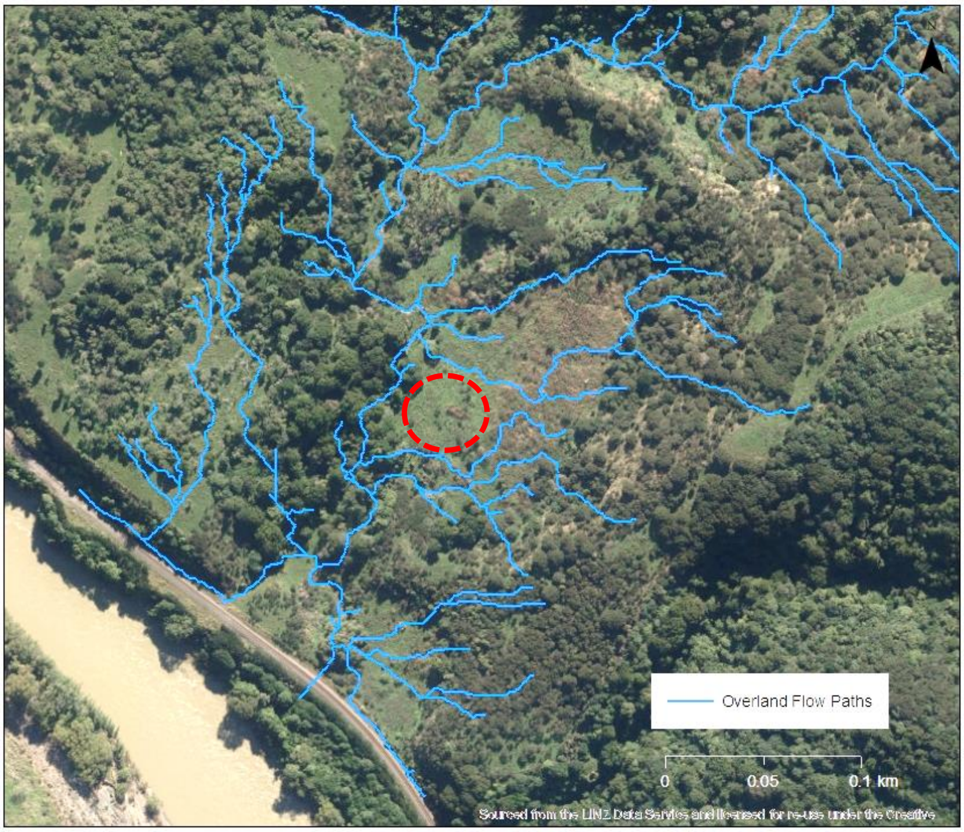


**Figure 2-2: Potential overland flow paths. The area of generally 'flat' terrain with no drainage network that hosts the raupō-dominated wetlands is highlighted (red circle).**

# 3 Proposed works

The construction of the Eco-viaduct will involve two piers within the raupō-dominated wetlands and one on the western edge where drier conditions might be expected. Walking tracks will be formed on boardwalks to minimise any effect on the form and function of the wetlands. Consequently, the only direct effect on the wetlands will be the footprints of the piers which are required to support the Eco-viaduct and works associated with their installation. On Figure 3-1, the area where conditions are suitable for a raupō-dominated wetland is shown in pink, and the piers as 'dashed boxes' beneath the bridge; one of which is has the BR03 – Eco Bridge label attached.

While tracks will be required to construct the piers, these will be perpendicular to the contours. This will minimise any potential effects on the wider raupō-dominated wetlands. While runoff is likely to be greater from these tracks, water will be directed towards the wetland on each side. This will mitigate any longer-term effects on the hydrology of the wetland.

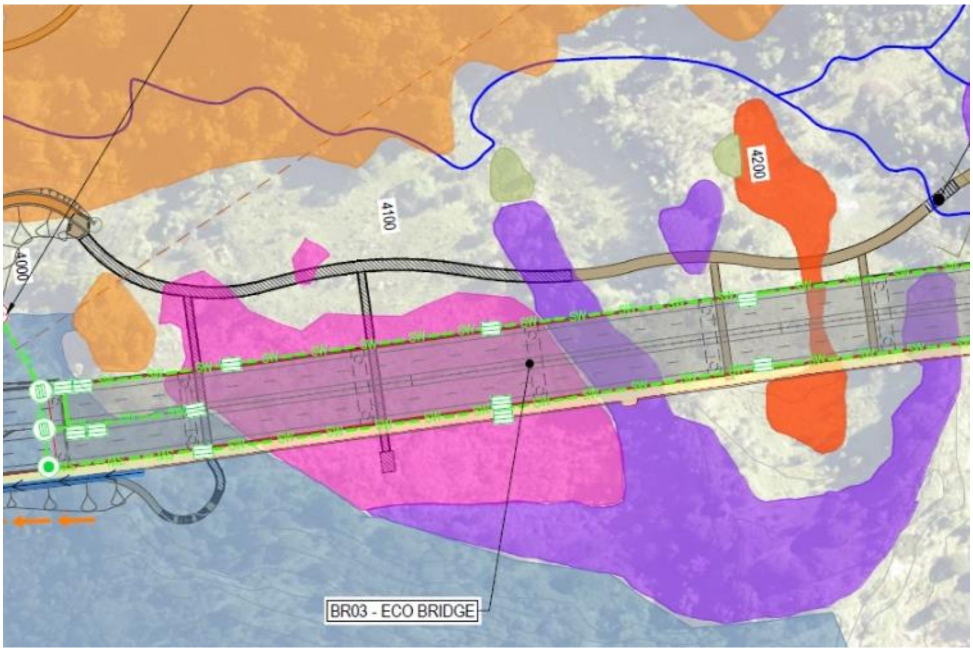


**Figure 3-1: Proposed works near the raupō-dominated wetlands (preliminary drawings).**

As far as possible, the piers and boardwalks have been kept to the perimeter of the raupō-dominated wetlands. These are the areas already prone to vegetation change and hydrological variability. Therefore, construction in these areas will mitigate any potential effects on the more hydrologically-vulnerable areas of the raupō-dominated wetlands. Only one pier is located towards the centre of the wetlands. This, however, is on the steeper upper slopes which, because of improved drainage conditions, is likely to be a less suitable habitat for raupō-dominated wetlands. The footprint of the piers occupies only 3.6% of the area of the raupō-dominated wetlands. Their very small footprint means that the piers will have only a low impact on the hydrological functioning of the wetland.

Therefore, the construction and presence of the piers will have a low, most likely negligible, impact on the hydrological functioning and dynamics of the wetland. The works will not affect the overall water balance of the wetlands, the drawdown of groundwater, or facilitate the drying out the soils (either by exposure or altering the permeability).

Considerable confidence can be placed in the maintenance of the hydrological integrity of the raupō-dominated wetlands because of both the low proportion of potential habitat affected and the negligible effect on wetland hydrology.

To minimise any potential effect on the hydrology and water balance of the raupō-dominated wetlands, the boardwalks will be slightly elevated above the existing terrain to avoid them acting as 'drains'. The boardwalks will allow all the existing hydrological processes to continue to operate, both up-slope and down-slope.

Consequently, there will be no changes to the catchment area and water balance of the raupō-dominated wetlands. Where small impervious areas will be formed by the construction of the piers, runoff from these areas will be directed into the wetland with the aim of achieving hydraulic neutrality. It is likely that slightly more runoff per unit area of wetland will occur because of the proposed works; however, any change will be small. This change will act to enhance the hydrological conditions necessary for a raupō-dominated wetland.

# 4 Conclusion

Overall, any effects on the hydrology of the raupō-dominated wetlands by the Project will, in my expert opinion, be less than minor. Given the existing environment, the form and hydrology of raupō-dominated wetlands, and the small scale of the potential effects of the proposed works, considerable confidence can be placed in this conclusion.

# 1 Document Status

The most recent revision of this document is in Sharefile as the initial Documentation Management System.

# 2 Application

This Procedure forms a part of the Erosion and Sediment Control Plan (ESCP) for Te Ahu A Turanga: Manawatū Tararua Highway (the Project). The proposed construction works on the Project include bulk earthworks operations and haul roads that will require dust management.

The purpose of this plan is to ensure that the required level of dust management is achieved on site during these operations.

# 3 Scope of works

The proposed construction works on the Project will include the following:

- Ground improvements
- Excavations
- Bridge construction (inside & outside highly sensitive ecological areas)
- Upgrading of existing road network
- Construction of roundabouts on existing road network
- Construction of a visitor centre

# 4 Potential Environmental Impacts of Activities.

The key potential environmental aspects and impacts relating to dust generation are:

| Aspects | Impacts |
|---|---|
| Dust generation from earthworks, material movement, crushing, vehicle movements and bare soil particularly during dry, windy weather conditions. | Nuisance to local residents from airborne dust and dust on local roads.<br>Health and safety hazard to site workers from airborne dust particles<br>Deposition of dust to surrounding terrestrial and aquatic habitats, contributing to sediment loads.<br>Dust particles in the environment affecting wind turbines |

# 5 Key Responsibilities

**Responsibilities**

The ***Environmental Manager*** is responsible for:

- Communicating upcoming weather forecasts to the team
- Reviewing and updating this Procedure
- Organising monitoring as required;
- Developing and delivering training material on dust control;

The ***Earthworks Manager*** is responsible for:

- Ensuring the implementation of this Procedure;
- Communicating requirements to relevant site personnel; and
- Ensuring personnel have received appropriate training to competently carry out their duties with respect to this procedure.

The ***H&S Manager*** is responsible for:

- Inspections and checks in order to verify conformance with this Procedure;
- Assisting the Construction Manager in their duties.

All ***Site Personnel*** involved in activities with a potential to generate dust are responsible for:

- Following the requirements of this Procedure;
- Following the requirements of the Emergency Spill Response Procedure (Appendix 5 to the ESCP) in the event of spills (e.g. from stockpiles);
- Reporting any defects, incidents or accidents to the Construction Manager or Environmental Manager.

For activities with a potential to generate dust, relevant Work Instructions will establish the controls to be applied. During the development of Work Instructions, the following issues will be considered.

# 6 General Procedure

It is a key principle for the Project that a proactive approach will be taken to dust management on the site, rather than a reactive approach involving dust control once effects are occurring. As construction of the Project involves large scale earthworks and pavement construction, both of these activities have the potential to generate dust. To minimise potential dust nuisance:

- Earthworks will be staged (as far a practicable) so as to minimise the length of time that areas are exposed to drying;
- The route and speed of vehicles working on the site will be controlled appropriately, limiting vehicle speeds over unsealed surfaces to 20 km/hr during dry weather, when within 100 m of sensitive receptors; and
- Materials will be applied on surfaces to minimise dust generation.
- Pavement works will be closely monitored during the time of stabilisation to ensure there is no cement dust mobilisation from the works.

For activities with a potential to generate dust relevant Work Instructions will establish the controls to be applied. During the development of work methods, the following issues will be considered, although the main controls will be stabilisation and watercarts.

# 7 Dust Management

## 7.1 Dust Sources & Generation

The construction activities that will take place throughout the Project that may generate discharges of dust to air are:

- Earthworks, including vegetation removal, stripping of topsoil.
- Vehicle movements on unpaved surfaces.
- Loading and unloading of materials.
- Wind generated dust from dry exposed surfaces such as stockpiles and yard areas
- Use of cement and/or lime for assisting in structural fill compaction.
- Pavement construction (cement stabilisation)

### 7.1.1 Factors Influencing Dust Generation

The major factors that influence dust generation are:

- Wind speed across the surface;
  - The critical wind speed for pickup of dust from surfaces is 5 m/s (18km/h) as an hourly average.
  - Pickup increases rapidly above 10 m/s (36km/h) as an hourly average.
- The percentage of fine particles in the material on the surface.
- Moisture content of the material on the surface.
- The area of exposed surface.
- Disturbances such as traffic, excavation, loading and unloading of materials.
- The height of the source above the surrounding ground level (for drops of material).

The smaller the particle size of the material on the surface of a road or an exposed surface, the more easily the particles are able to be picked up and entrained in the wind. Moisture binds particles together preventing them from being disturbed by wind or vehicle movements.

The larger the area of exposed material the more potential there will be for dust emissions. Vehicles travelling over exposed surfaces tend to pulverise any surface particles. Particles are lifted and dropped from the rolling wheels and the road surface is exposed to strong air currents due to turbulence between the wheels and the surface. Dust is also sucked into the turbulent wake created behind moving vehicles.

## 7.2 Dust Monitoring

Due to large areas of the Project alignment being isolated from the surrounding community we recognise that any potential dust nuisance is likely to be confined to a small group of sensitive receivers in close proximity to the Project works. As such, dust monitoring and mitigation will be focused on these areas/receivers. Monitoring will consist of visual checks made by the Site Engineers and Site Supervisors during the day.

Specific dust monitoring will include the use of nephelometers ~~near houses at either~~at the Woodville end of the alignment that are downwind under prevailing winds and close to the works. For sensitive ecological areas ~~(~~(F2, F4, F7, E1, E2, E4 and B1). and where wind turbines are downwind and within 100 metres of the site, (TAP9, TAP10, TAP47 and TAP50) deposition monitors will be installed.

## 7.3 Meteorological Monitoring

Meteorological monitoring at a location near the Project on the Ruahine Ranges will be undertaken so as to inform staff of the occurrence of strong wind conditions (10 m/s hourly average or greater), which can exacerbate dust emissions from exposed areas.

The equipment is to include the measurement of wind speed and direction at a height of 10 m above ground level. The equipment will be set up at a location near the Project alignment on the Ruahine Ranges where there is sufficient cell phone coverage for telemetry purposes and no nearby obstructions, such as buildings of tall vegetation. The equipment is to be setup in accordance with 'AS2923 – 1987 Ambient Air Grade for Measurement of Horizontal Wind for Air Quality Applications'

Real time meteorological data from station will be continuously recorded using an electronic data logging system with an averaging time for each parameter of not more than two minutes. The results are be available to staff in real time, with the logging system automated to send messages to site operations to alert them that wind speeds are 10 m/s or greater.

## 7.4 Sensitive Receivers

A small number of neighbouring properties have been identified as sensitive receivers due to their proximity and exposure to strong winds from the direction of ~~to~~ the construction works. These properties are located into three discrete groups along the alignment. (Refer Table 1 below and Figures 1 – Sensitive receivers map).

**Table 1 Sensitive Receivers**

| Reference | Address | Building Type | Distance to Works |
|---|---|---|---|
| TAP09, TAP10 | Ruahine Range Area | Turbines | Within 100m of Project works in direction of West to N'westerly winds from Project site |
| F2, F4, E1, E2 | Ruahine Range Area | Ecological | Within 100m of Project works in direction of West to N'westerly winds from Project site |
| B1 | Ballantrae Area | Research | East & north of Project works within 100m |
| TAP4~~6~~7, TP4509~~9~~ | Ballantrae Area | Turbines | Within 100m of Project works |
| F7, E4 | Ballantrae Area | Ecological | Within 100m of Project works |
| R5, R6, R7, R9 | Woodville Area | Residential | Within 100m of Project works in direction of East & S'Easterly winds from Project site |

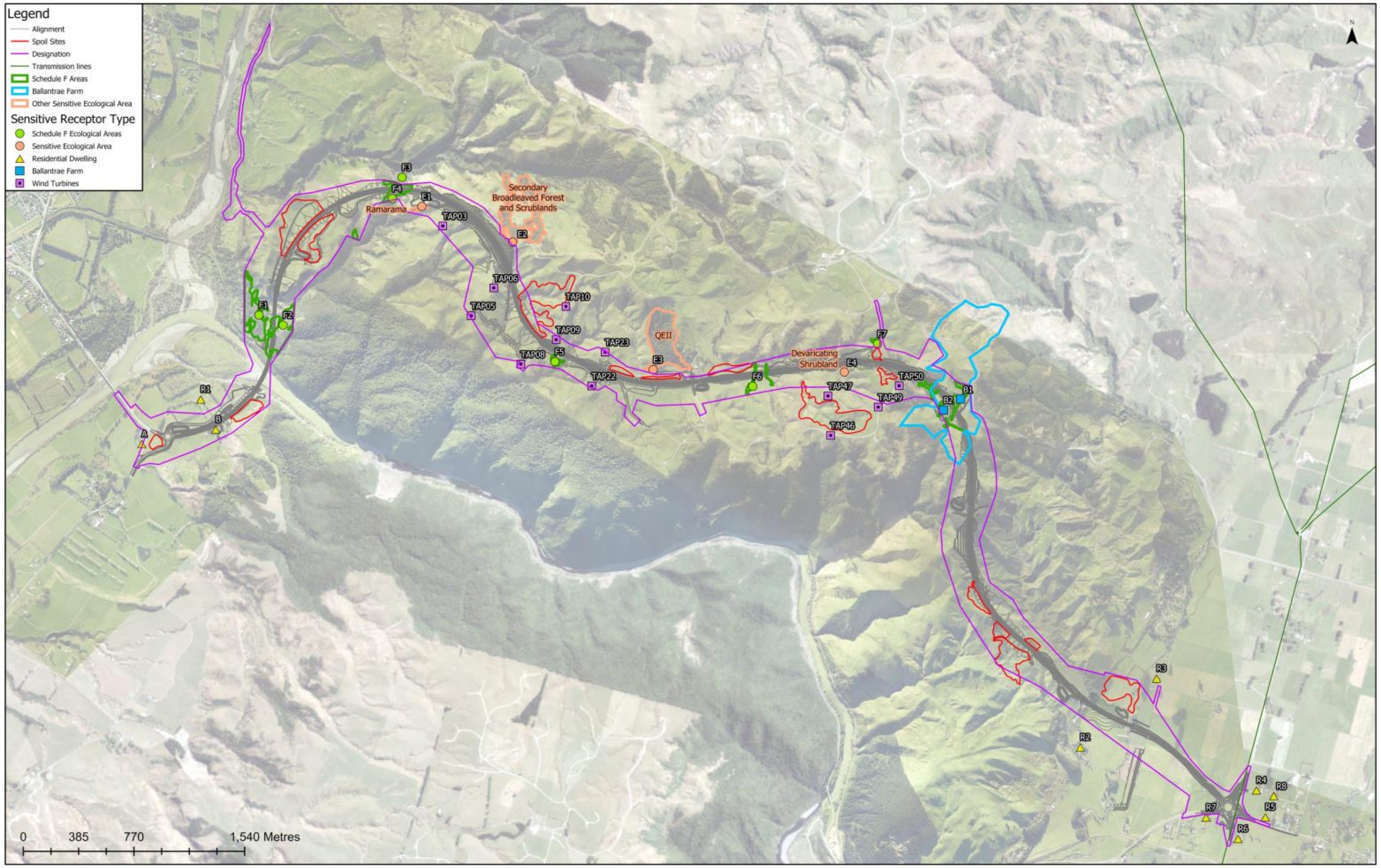


**Figure 1 Sensitive Recievers**

Dust Risk zones have been defined by reference to the location of these receivers and are shown below in Table 2.

**Table 2 Extent of Dust Risk Zones**

| Sensitive Receiver Group | Dusk Risk Zone Extent (Chainage Start and Finish) |
|---|---|
| Ruahine Range Area | TBC |
| Ballantrae Area | TBC |
| Woodville Area | TBC |

## 7.5 Dust Monitoring

There will be daily observations of active work areas for any significant visible dust emissions. This monitoring will focus on haul routes, frequently trafficked areas, excavation sites and fill/spoil areas, with particular attention of the areas within 200m of residences and 100 of those other areas (i.e., wind turbines and sensitive ecological areas) identified as being sensitive receivers. During prolonged dry weather, observations will be carried out more frequently.

Checks of weather forecasts at the start of each day (particularly the absence of rain and whether strong winds are expected) will be used to inform activities to be undertaken, including advising staff of the potential risk for dust impacts.

All staff working in these areas will be trained on what to look for and required to be aware of the potential for dust nuisance. Work instruction and daily toolboxes will reinforce this requirement.

For the sensitive residential receivers detailed above (being R4, R5 and R7 near Woodville), instrumental continuous dust monitors (nephelometers) will be established in general accordance with AS/NZS 3580.12.1:2015[1] or similar. These monitors will provide real-time feedback on dust levels near these sensitive locations, to provide notice of elevated dust levels and to allow a pro-active response. ~~This monitor~~These monitors will be located between the construction works and receptors R4, ~~and~~ R5 and R7 when construction works are within approximately 100m of any of those receptors.

A 1-hour average trigger level for $PM_{10}$ is the most suitable for managing dust when using nephelometer instruments. The following concentration trigger will be used, but may be reviewed subject to operator experience and/or community feedback:

Trigger concentration ($PM_{10}$): 150 µg/m³, hourly average

Should this trigger level be reached then an automated message will be sent to site operations. Dust generating activities will cease in that location until such time that emissions can be adequately controlled, and concentrations reduce to within the trigger levels. This may mean an increase in water application, using polymers to increase the effectiveness of the water management, reconsidering construction activities, and/or ceasing work in some areas.

Dust deposition monitoring will be undertaken in and around the most exposed wind turbines (TAP9, TP10, TAP47 and TAP50) and sensitive ecological areas (F2, F4, F7, E1, E2, E4 and B1) for the duration of construction works in a given area (i.e., those located within 100m of the Project works and downwind during

[1] AS/NZS 3580.12.1.2015. Methods of sampling and analysis of ambient air – Part 12.1: Determination of light scattering integrating nephelometer method.

prevailing winds of construction works). Deposition monitors once set up collect deposited material. A baseline sample will be collected over a month, after which the collected sample is retrieved and sent to a laboratory for analysis to confirm the rate of measured deposition. The results can then be compared to a trigger value of 4 grams per square metre per 30-days above background levels (4 g/m³/30-days) (Ministry for the Environment's '*Good Practice Guide for Assessing and Managing Dust'* (MfE 2016) for the duration of the construction works.

The results of deposition monitoring should be reviewed each month against site activities for the period coinciding with the monitoring. Where results are elevated (i.e., those that approach or exceed the above trigger value) then the potential causes will be investigated, and where possible additional control measures implemented to minimise ongoing emissions. This could include (but not be limited to) an increase in water application, using dust suppressants to increase the effectiveness of the water management, or reconsidering construction activities.

Directional dust deposition gauges in relation to monitoring downwind of identified wind turbines will be used. The methodology is set out in AS/NZS 3580.10.2:2013[2].
In relation to ecological receptors, where deposition on horizontal surfaces is more a concern, a traditional dust deposition gauge will be used. The methodology is set out in AS/NZS 3580.10.1:2016[3].

## 7.6 Dust Management Toolbox

The following dust management and mitigation measures will be undertaken as required to minimise overall dust emissions and nuisance.

### 7.6.1 Water Resources

The Project will have one surface water take authorised by Horizons as described in Table 3 below.

**Table 3: Consent to take Water**

| Resource Consent | Description of Authorised Activity | Instantaneous Take Rate Restriction | Daily Allocation | Annual Allocation |
|---|---|---|---|---|
| TBC | To take xxm3 of water from the Manawatū River | | | |

This consent will be utilised. Water will be withdrawn and made available for water carts by way of a pump system from the Manawatū River and will be pumped along the alignment and to three separate water reservoirs located for water trucks to access for dust control purposes.

Each reservoir will have the capacity to hold 3000 cubic meters of water. This allows the team to take the water from the Manawatū River at a slow and consistent rate, while having enough water for construction and dust control at the times when it is needed.

[2] AS/NZS 3580.10.2:2013. Methods for sampling and analysis of ambient air. Determination of particulate matter - Impinged matter - Gravimetric method.
[3] AS/NZS 3580.10.1:2016. Methods for sampling and analysis of ambient air. Determination of particulate matter - Deposited matter - Gravimetric method.

### 7.6.2 Water Carts

Water carts or tankers will act as the primary method for controlling dust on site (Refer Photo 1 and 2). Water cart use will be focused in the dust risk zones described in Table 2 (Section 6.3). The number of carts required, and the frequency of watering will be determined by the Earthworks and Environmental Managers who will consider vehicle movements, weather conditions, and the proximity of the nearest sensitive receiver.


**Photo 1: Water Cart in Operation**


**Photo 2: Water Tanker in Operation**

### 7.6.3 Surface Application of Dust Suppressants

Biodegradable dust suppressants may be used to protect the high-risk areas and be applied to surfaces where dust has been identified as a significant risk. The inert nature of these products makes them ideal as an environmentally friendly application. The decision as to whether a polymer stabiliser will be utilised rests with Construction and Environmental Managers.

Polymer stabilisers will not only be used to treat dust nuisance issues but also as a soil binder if it is deemed suitable. Polymers added to water can improve the efficiency and effectiveness of the water application for dust suppression on high risk haul roads that have the potential to cause significant dust concerns.

### 7.6.4 Hay Mulch Stabilisation

Hay mulch stabilisation will eliminate open areas as sources of dust. Hay mulch may also be used to stabilise finished areas adjacent to sensitive receivers or neighbours to mitigate as much dust nuisance as possible.

Hay mulch is only effective in low wind zones unless it is applied with a tacifier to reduce the likelihood of it being blown off before the area can be stabilised. It is noted that a large percentage of the route is a high wind zone.

### 7.6.5 Progressive stabilisation

Areas of work will be progressively stabilised, either temporary or permanently, including the rolling and finishing off areas as works progress. This helps to minimise the duration that areas could give rise to dust emissions impacting on sensitive locations.

### 7.6.6 Loading and Unloading of Materials

The drop height of material from the operation of diggers and loaders is to be minimised to reduce the potential for wind-blown dust. Digger and loader operators should be trained to ensure that the material being dropped from the digger/loader bucket is done as close as practicable to the truck or surface being loaded and not from an unnecessary height.

### 7.6.7 Top Soil Stockpile Management

Topsoil stockpiles will all be located as far from sensitive receptors as possible and the surface of the stockpile stabilised with grass seed and hay or straw mulch upon their completion. Topsoil stockpiles will also be constructed with a low profile wherever possible to reduce the height of the bund and thus further reduce the stockpiles ability to generate dust as it has a lower profile exposed to wind. Wherever practically possible stockpiles will not be positioned any closer than 100m from a dwelling house.

### 7.6.8 Entranceways

Stabilised entranceways will be constructed at all site entrances to minimise the tracking of material out of the construction areas and onto local roads where it would dry and become a source of dust. The standard of the construction for these entranceways is described in the Auckland Council Guideline Document 2016/005 *Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region*, June 2016 (GD05).

Portable water blasters and water carts will be available to wash the road adjacent to the entranceways in the event of construction vehicles tracking material onto either local roads or the State Highway. Road sweeper vehicles and sucker trucks will routinely maintain the roads around the site entrances in order to keep fine material accumulating on the road surface where vehicle movement might generate dust.

### 7.6.9 Restriction of Work

If wind conditions are severe enough, construction activities may need to be restricted or cease altogether in order to mitigate any potential dust issues when within 100 m of sensitive receivers. The decision to restrict or cease all work will be made by the Construction Manager and the Environmental Manager.

To assist in making the decision the following criteria shall be reviewed:

- Wind speed and direction currently prevailing (such as 10 m/s as an hourly average).
- The construction activity currently being performed, and the length of time that activity is to continue.
- The distance to the nearest sensitive receptor and the nature of their sensitivity (such as 200m of a dwelling, 100m of a wind turbine or sensitive ecological area).
- The presence of historical complaints and the outcome of investigations into those complaints.
- The existence of a current complaint.
- The mitigation measures currently being applied and the additional measures that might be utilised.

### 7.6.10 Sensitive Area Screening

As a contingency measure for sensitive locations within 50 m of potential dust sources and should monitoring (described in Section 7.5~~5.5~~) indicate the need, wind break fencing could be erected between the sensitive location and the source to help further minimise dust impacts on the receptor.

### 7.6.11 Site Wide Communication of Dust Risk

On site delineation of the dust sensitive zones will be marked with Dust Risk signs (Refer Photo 3) to prompt and remind construction staff that they are operating in a sensitive area. Site wide text message warnings will be issued by the Environmental Manager to Project Engineers & Site Engineers, (including pavement crews) when environmental conditions reach a point where a dust nuisance is possible.


**Photo 3: Dust Risk Signs will assist with Communicating the Risk to Construction Staff**

### 7.6.12 Complaints

Complaints may be received by one or more of the regulatory authorities, a member of the public, or a member of the Project team. It is the responsibility of the Environmental Manager to respond to and follow up all complaints relating to dust. The Environmental Manager is responsible for ensuring suitably qualified personnel are available to respond to complaints at all times including after hours and on weekends when complaints regarding dust could be received.

On call staff will be notified of the complaint via the Communications Manager acting in accordance with the complaint management procedures detailed in the Communications Management Plan. The on-call staff will respond by visiting the area in question and then implementing dust mitigation measures where it is deemed necessary and in accordance with direction from the Environmental Manager.

### 7.6.13 Weather Monitoring

The Environmental Manager will obtain daily forecasts and circulate to all Zone Managers and Project ~~Enginers~~Engineers and other appropriate Project staff. Dust control measures will be prepared if dry, windy conditions are forecast.

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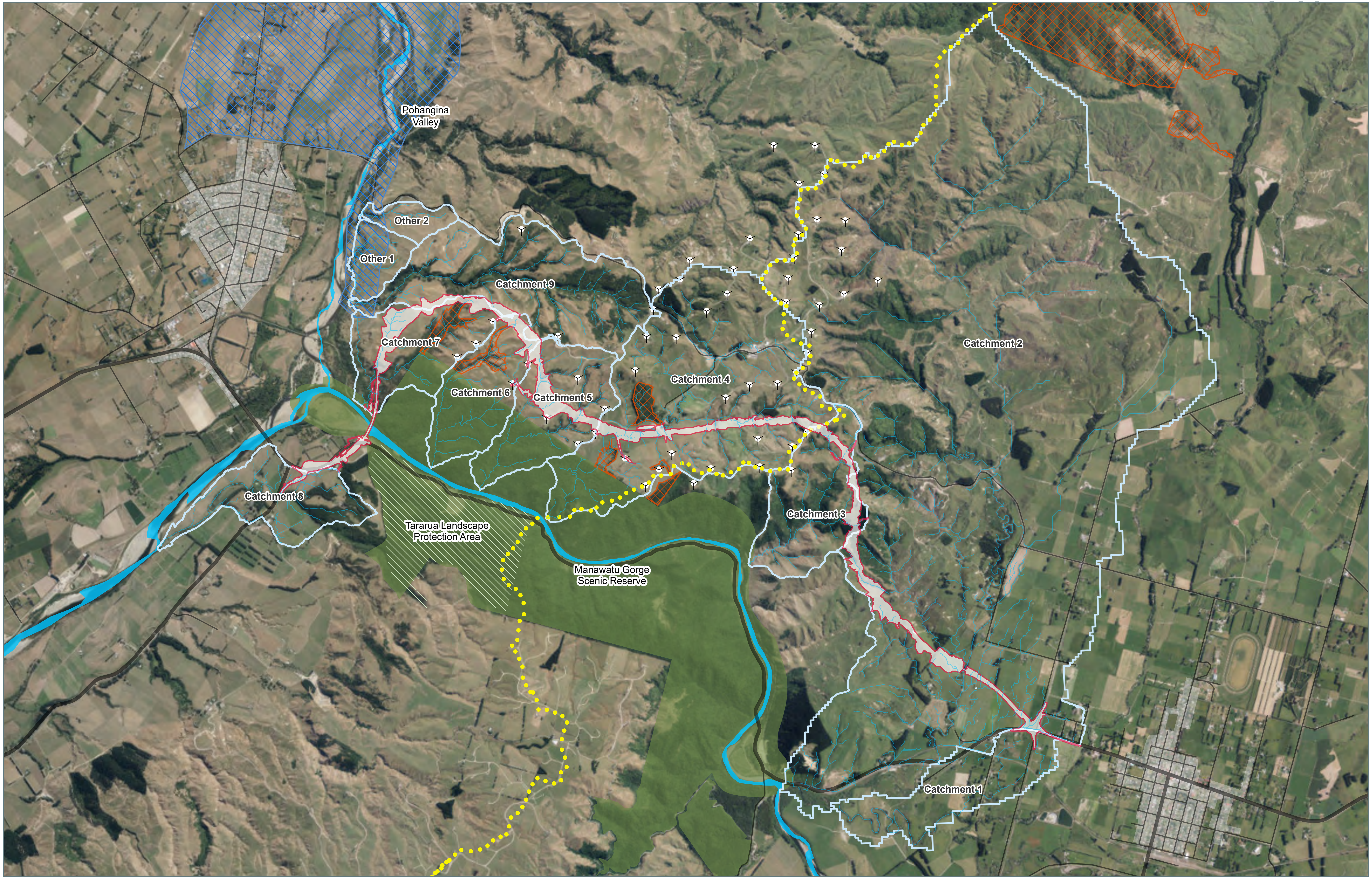




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*Data Sources:* WSP, BML, Aerial: Sourced from the LINZ Data Service and licensed for re-use under the Creative Commons Attribution 4.0 New Zealand licence

*Projection:* NZGD 2000 Wanganui Circuit

- Proposed Route
- Wind Turbine
- Catchment
- Waterway
- Taraua & Ruahine Ridgeline / Skyline
- QEII Covenant
- Pohangina Valley MDC revised 31 October 2017
- PNCC Tararua Landscape Protection Area
- Manawatu Gorge Scenic Reserve

**TE AHU A TURANGA; MANAWATŪ TARARUA HIGHWAY**

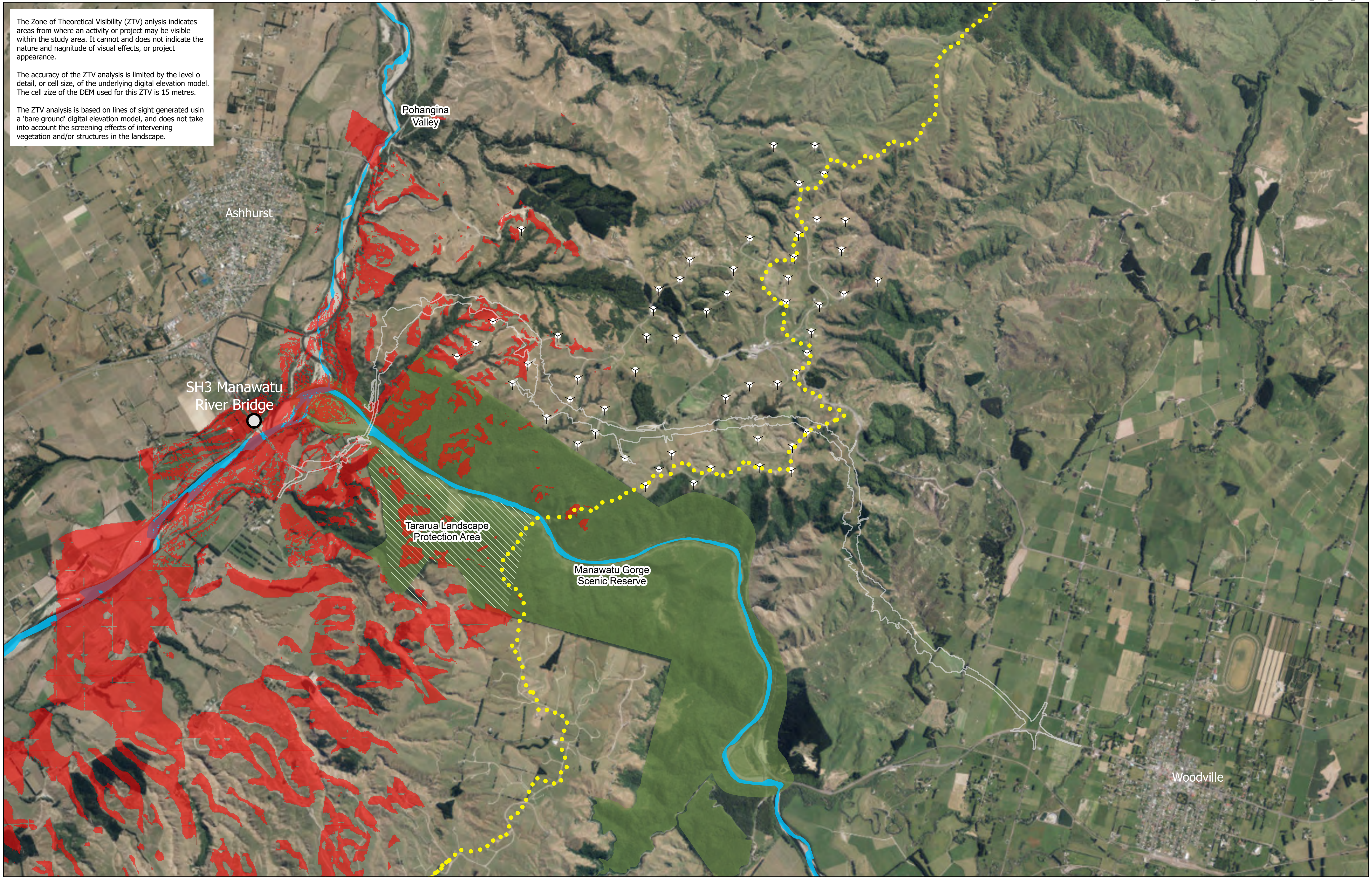
ONFL Context

**Date: 29 April 2020 | Revision: 0**

Plan prepared by Boffa Miskell Limited

*Project Manager:* **Boyden.Evans@boffamiskell.co.nz** | *Drawn:* HHu | *Checked:* BEv

**Figure 1**

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*Projection:* NZGD 2000 Wanganui Circuit

LEGEND

- Observer Point
- Visible from Viewpoint
- Taraua & Ruahine Ridgeline / Skyline
- Proposed Route

**PROJECT NAME**

ZTV Analysis - SH3 Manawatu River Bridge

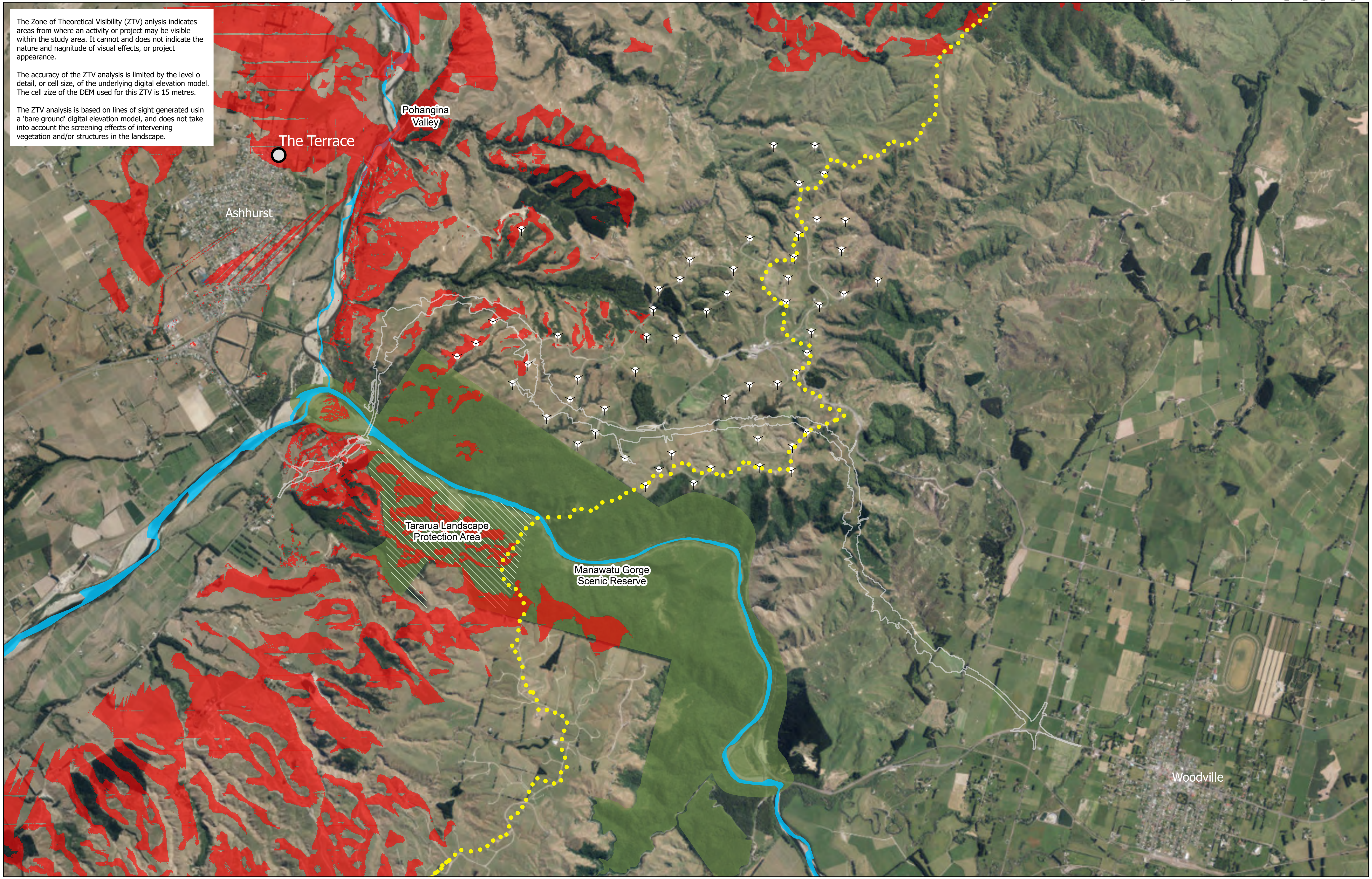
**Date: 29 April 2020 | Revision: 0**

Plan prepared by Boffa Miskell Limited

Project Manager: boyden.evans@boffamiskell.co.nz | Drawn: Dlr | Checked: BEv

**Figure 2**

File Ref: W18061_ArcGIS_Pro_20200417.aprx / W18061D_ZTV_The_Terrace_A3L

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*Projection:* NZGD 2000 Wanganui Circuit

DRAFT

**LEGEND**

- Observer Point
- Visible from Viewpoint
- Taraua & Ruahine Ridgeline / Skyline
- Proposed Route

**PROJECT NAME**

ZTV Analysis - The Terrace, Ashhurst

**Date: 29 April 2020 | Revision: 0**

Plan prepared by Boffa Miskell Limited

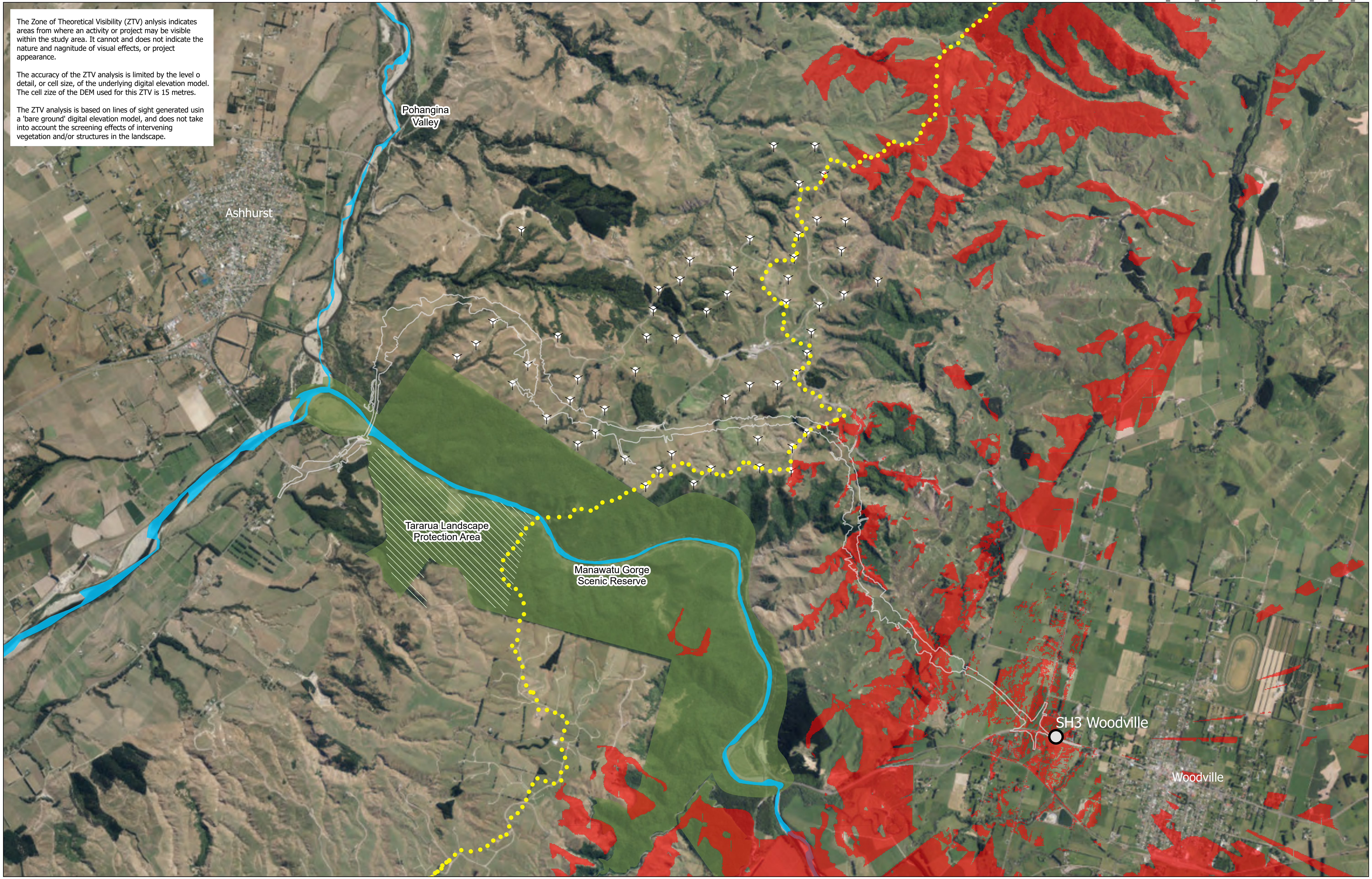
Project Manager: boyden.evans@boffamiskell.co.nz | Drawn: Dlr | Checked: BEv

**Figure 3**

The Zone of Theoretical Visibility (ZTV) anlysis indicates areas from where an activity or project may be visible within the study area. It cannot and does not indicate the nature and nagnitude of visual effects, or project appearance.

The accuracy of the ZTV analysis is limited by the level o detail, or cell size, of the underlying digital elevation model. The cell zize of the DEM used for this ZTV is 15 metres.

The ZTV analysis is based on lines of sight generated usin a 'bare ground' digital elevation model, and does not take into account the screening effects of intervening vegetation and/or structures in the landscape.

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*Projection:* NZGD 2000 Wanganui Circuit

DRAFT

LEGEND

- Observer Point
- Visible from Viewpoint
- Taraua & Ruahine Ridgeline / Skyline
- Proposed Route

**PROJECT NAME**

ZTV Analysis - Woodville

**Date: 29 April 2020 | Revision: 0**

Plan prepared by Boffa Miskell Limited

Project Manager: boyden.evans@boffamiskell.co.nz | Drawn: DIr | Checked: BEv

**Figure 4**