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Dear Peter

Monitoring for assessment of effects of infiltration gallery maintenance works on the Awatere River

Advice has been requested from Cawthron regarding a proposed monitoring programme to assess sedimentation and its effects in the Awatere River due to the instream construction and/or maintenance of infiltration gallery (IG) style water intakes. A previous report produced by Cawthron Institute (Hay and Gabrielsson 2016) highlighted that such works resulted in the exceedance of water quality standards stipulated in the Wairau Awatere Resource Management Plan. It raised the possibility of significant effects on fish feeding and productivity and recommended that Marlborough District Council (MDC) should monitor sedimentation in the vicinity of instream works, and consider continuous turbidity monitoring. This letter is to provide more detail regarding such monitoring.

Two approaches to the monitoring of sedimentation effects were considered. The first approach was to attempt to measure the effect of sedimentation along the entire affected length of the river. The report by Hay and Gabrielsson (2016) indicated that sedimentation due to the instream work is likely to be relatively localised. Therefore, if monitoring was to capture the effects from all IG work events, it would involve many monitoring sites. This is considered to be impractical. The second approach and the one recommended here, is to monitor the effects resulting from one or two IG work events and then extrapolate to the river scale according to the number of IG sites and frequency of works. As such the efficacy of this approach is highly dependent on MDC gaining an accurate picture of the spatial and temporal distribution of instream works. A survey to obtain such information was recommended in Hay and Gabrielsson (2016).

We recommend that MDC conduct a pilot programme over one summer and use the data to reassess the approach. Further targeted work may then be possible to fill data gaps such as cumulative effects, as well as inform the positioning of longer term monitoring such as continuous turbidity analysis in the lower river.

The following monitoring programme is recommended (more detail provided in annotated notes);

1. Survey of works. MDC should conduct a survey of consent holders to gain an accurate estimate of the number and location of IG's as well as the approximate scale, frequency and timing of maintenance work.

2. Monitoring of effects. The effects from two work events at separate IG sites should be monitored. This monitoring should be conducted during summer low-flow conditions and

should be timed in order to minimise the effect of fresh events immediately prior to and after the works.

Sampling should be conducted as follows;

i. Select one site upstream (u/s) of all Awatere IG sites = Control site[Note A].

ii. Select 2 x IG sites with consent holders who notify MDC of impending works[Note B].

iii. At each of the two IG sites select one u/s sample site above the works and three downstream (d/s) sample sites at 500, 1500 and 2500 m below the work sites (= 4 x sample sites at each IG). The river reach selected at all sites (including the control site) should be as similar as possible in terms of geomorphology, flow characteristics and substrate.

iv. When work is proposed at an IG, sampling should be conducted at the control site and at the 4 x sample sites (associated with the IG where work is undertaken) as per the following schedule:

    a. immediately prior to works (the day before)
    b. during/ immediately after works (within 6 hrs)
    c. 1 week, 2 weeks and 1 month after works

v. Sampling at each site should be as follows;

    a. Turbidity analysis
    b. Bankside visual estimate of % sediment cover of the reach (as per sediment protocols in Clapcott et al 2011)
    c. Quorer sampling of targeted edge of run habitat[Notes C, D] (as per sediment protocols in Clapcott et al 2011)
    d. Resuspendible sediment (shuffle index) of targeted edge of run habitat[Note E] (as per sediment protocols in Clapcott et al 2011)
    e. Surber-sampling of targeted edge of run habitat for macroinvertebrates[Notes D, F]. (as per Protocol C3 in Stark et al 2001)
    f. Continuous turbidity analysis at the u/s sample site and the 2500m sample site over the period of works (6 hours)[Note G]. If no turbidity logger is available, 15 min spot analyses would do the same job but may require multiple staff.

vi. Continuous turbidity analysis at the Control site for the duration of the pilot programme.

vii. Repeat at second IG site when work there is proposed.

viii Consideration could also be given to utilising a drone to obtain aerial footage of the monitored work events. This may give some indication of sediment plume distribution and likely sediment settling areas downstream of the works, relative to the selected sampling sites.

3. <u>Extrapolation of effects</u>. The effects observed at the individual IG work sites should then be qualitatively scaled-up to the affected reach of the Awatere River by comparison with the 'Survey of works'. Such extrapolation will also need to consider river morphology, notably the slope, as well as river flow and possible tidal influence as these will all affect the distribution of sediment deposition. If not already available it is recommended that MDC quantifies river morphology, flows and tidal influence. The extrapolation will inform

qualitative assessment of the spatial and temporal trends in sedimentation during low-flow summer months and guide future monitoring efforts.

Estimated budget

The following budget is an estimate of the sample analysis costs associated with this proposed monitoring programme. It assumes all samples are analysed and does not account for staff time. All figures are ex GST. Costs of continuous turbidity monitoring are also not included.

	Samples per IG work site	Sample cost	Cost of Single IG work site	Cost of Two IG work sites
Sediment				
Volume, TSS and VSS analysis of Quorer samples	175[1]	$34.46	$6 030.50	$12 061.00
Macroinvertebrates				
Genus level analysis of Surber samples	25[2]	$200.00	$5 000.00	$10 000.00
Total (ex GST)			$11 030.50	$22 061.00

[1] (7 samples per site, 5 sites, 5 sampling events)
[2] (1 sample per site, 5 sites, 5 sampling events)

NB: These costs can be reduced significantly if not all samples are analysed as suggested in sampling programme notes C and E.

Summary

A limited, targeted pilot monitoring programme is recommended in order to gain a preliminary understanding of the magnitude of the effects of sedimentation from IG works in the Awatere River. The programme is designed to gain an understanding of the sedimentation effects associated with single discrete instream work events of differing magnitudes. These effects will then be scaled-up to the affected river-reach scale by use of information from a 'Survey of works' which quantifies the number and locations of IG sites and the frequency, duration and magnitude of works at each site.

In summary we recommend that MDC should;
1. Undertake a 'Survey of works' as described above.
2. Establish a 'control' site upstream of all IG sites and instigate continuous turbidity monitoring at this site.
3. Undertake a monitoring programme as detailed above in order to gain an understanding of the effects of single work events.
3. Gain an understanding of the morphology and flows of the lower Awatere River.
4. Use the work detailed in 1-3 above to extrapolate the sedimentation effects associated with single work sites to the scale of the affected river-reach.
5. Use the extrapolated effects to plan further monitoring, targeting data gaps such as cumulative sedimentation effects (i.e. overlap of effects from multiple work sites) and the location of the most suitable sites for d/s continuous turbidity monitoring.

Please contact us if you require any further advice.

Yours sincerely

Scientists

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Notes for sampling programme

A. A possible control site is the Awapiri flow monitoring site- however this will need to be confirmed as being above all IG sites.

B. Ideally the selected IG sites should be well downstream of any other sites in order to isolate the effects of a single site i.e. to reduce the confounding influence of cumulative effects. If possible the selected work events should cover works of differing scales i.e. major and minor intended works, in order to assess the possible range in magnitude of effects.

C. Due to spatial variability in sediment deposition and the accompanying difficulties in detecting a signal of sediment input (J. Clapcott, Cawthron, pers. comm.), it is suggested that the Quorer sampling is targeted at benthic habitat of concern. 'Edge of run' is considered to represent such habitat for species such as bullies, which were identified as potentially affected species in Hay and Gabrielsson (2016). Sampling of the edge of run habitat should be conducted between 1 and 3 m from the wetted edge (sampling too close to the wetted edge risks including terrestrial fauna).

D. Not all samples requiring laboratory analysis (Quorer and macroinvertebrates) need be analysed initially. The 1 and 2 week sampling provides some insurance against a 'fresh' event occurring before the 1 month sampling. Such an event will likely overwhelm an effect signal from the IG works and certainly would make it hard to distinguish the effect of the 'works' from the effect of the 'fresh'. It is suggested that if the 1 month sampling is able to be conducted (i.e. no fresh event), that these samples be analysed first. If an effect is detected, analysis of 1 and 2 week samples may not be required.

E. While the shuffle index results may be rendered somewhat redundant due to the Quorer sampling, it is recommended here as it is very quick to do and, if well correlated to the Quorer results in this environment, may provide a future alternative to the Quorer which would be much quicker and cheaper.

F. Sampling for macroinvertebrates; 6 x Surber-samples should be collected and pooled together at each site. The pooled sample should then be sub-sampled for analysis. Samples should be analysed to genus level for EPT metrics and taxa richness (as per Protocol P3, Stark et al 2001). If resourcing is a concern, the subsamples could be stored and only analysed if a significant effect is detected from the sediment sampling.

G. Continuous turbidity analysis by Hay and Gabrielsson (2016) detected a sediment plume 1.8 km d/s of instream works which began approximately 1 hour after the commencement of work and lasted approximately 1 hour. The plume was not detected 3.2 km d/s of works. However it was noted that this may be due to tidal influence in the river. The 2500m d/s site recommended here should add to information regarding the downstream extent of sediment plumes associated with these works.

References

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