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Ruataniwha Water Storage Project: Aquatic Ecology Assessment of Effects - Inception Report

RESEARCH BASED SOLUTIONS

CAWTHRON

Ruataniwha Water Storage Project: Aquatic Ecology Assessment of Effects - Inception Report

Iain Maxwell

Roger Young

Prepared for

Hawke's Bay Regional Council

Cawthron Institute
98 Halifax Street East, Private Bag 2
Nelson, New Zealand
Ph. +64 3 548 2319
Fax. + 64 3 546 9464
www.cawthron.org.nz

Reviewed by: Phil Mitchell . Approved for release by: Rowan Strickland

Phil Mitchell   Rowan Strickland

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1. INTRODUCTION

1.1. Background

Hawke's Bay Regional Council (HBRC) is embarking on a programme looking at a range of interventions and projects to strategically manage water supply and demand across its region.

Recent studies have identified that the Ruataniwha Basin (RB) is an area that has significant demand for water, a complex hydrogeology and significant over allocation of existing water resources. This implies that future consenting of water takes is likely to be problematic with little or no 'new' water being available. As a consequence tension between the conservation interests in the catchment and potential water users are expected to increase.

HBRC is investigating the feasibility of the Ruataniwha Water Storage Project (RWSP) to provide sustainable irrigation in the RB. The RWSP involves water harvesting, storage and distribution for servicing, in round terms, up to 22,500 hectares (net) of irrigable land in the plains. The Cawthron Institute (Cawthron) is providing services to complete an aquatic ecology assessment of effects (AEE) of the RWSP.

HBRC has now confirmed that a single, large dam site, in the Makaroro River is the preferred option for achieving the aims of the RWSP. This report confirms the AEE project scope and considers the impact of removing the Makaretu Stream dam option.

As a general outline the study scope will include:

- A review of the catchment's aquatic values.
- A review of how water quality scenarios would impact on instream habitats and catchment resources.
- A review of how water quantity scenarios would impact on instream habitats and catchment resources.
- Mitigation and monitoring options.

Our initial assessment is that the RWSP has the potential to prevent spawning and thermal refuge migrations of native fish and trout through damming, inundate non migratory native fish habitat, alter flow regimes and therefore physical fish habitat within the directly affected streams and the wider catchment, and to indirectly impact on available adult trout habitat through alterations to food availability as a result of increased nutrients from non-point source diffuse run off. These issues have also been raised by recent meetings with key stakeholder agencies and remain the issues of most significance to this proposal.

This Project Inception Report fulfils the first reporting milestone of the aquatic ecology AEE study.

1.2. Purpose and scope

The scope of this report is to - *Report on the review of existing information and discussions with HBRC project team and science team, along with the Department of Conservation and Fish & Game NZ representatives and outline the detailed methodology and work programme proposed with allocation of resources and requirements of other service providers and HBRC.*

The detailed description of the proposed methodology and plan was provided to HBRC in the Cawthron proposal in July 2011. This current "Inception Report" confirms that approach and provides further detail on the methodology, where required. We can confirm that in general the initially proposed approach will be the one implemented, but with some minor modifications that are noted in this document.

The purpose of this study is to investigate and report on the relevant aquatic ecology effects associated with the proposal to inform the development of a wider AEE to support resource consent applications. This assessment will largely pull together strands of work from other providers, combine it with some specific investigations by Cawthron and review the impacts of the proposed scheme against catchment values.

The purpose of this Inception Report is to:

- Review the relevance of work proposed in the original proposal against knowledge gained during the inception period.
- Note any proposed changes to the scope of work.
- Develop a forward plan to complete the study, identifying linkages with other parallel work streams and requirements for further information from others.

We note that HBRC have redefined the RWSP to now comprise a single dam on the Makaroro Stream. This has some minor implications for our work. On developing the original proposal we considered that the work required assessing two dams rather than one was not a significant issue. This was due to the fact that the tasks required were largely a revision of the work of others and that assessing effects was generic to both schemes, such as impacts on water quality within the wider catchment. The reduction to a single site however does reduce the field components of some of the work and this is reflected in our revision of the task schedule, timetable and associated costs. We caution however that this will be masked by the need to complete either instream habitat or historical flow assessments in the Makaroro. The reasons for this are detailed further in Section 1.3.

There has been an out-of-river hydroelectric (HEP) add-on proposed (to be confirmed by the end of October 2011) to provide generation from storage and residual flow generation from the base of the dam. This proposal is formed on the basis of the HEP add-on going ahead.

1.3. Links to other studies

As this study is to be undertaken in parallel with other workstreams close interaction with other providers is essential. These studies include:

- Scheme design and operation (Tonkin and Taylor)
- Catchment hydrology (Tonkin and Taylor)
- Reservoir water quality (Aquanet/NIWA)
- Land use impacts on water quality and periphyton (NIWA/AgResearch)
- Geomorphology (Tonkin & Taylor/HBRC)
- Modelling of ground/surface water flows, to provide an understanding of the effects of the proposed Ruataniwha Water Storage project on Ruataniwha groundwater and Tukituki catchment surface water quantities and flows (Tonkin and Taylor/HBRC)
- Trout spawning investigation (Technically Trout).

Further detail on the linkages to other providers is shown in Section 4.

As a consequence, the scope of particular investigations is still subject to potential amendment in light of the outputs from those other workstreams.

2. PROGRESS IN THE INCEPTION PERIOD

Within the period from signing the contract to the time of writing this Inception Report (10 October 2011) the most significant progress has been made around confirmation of the site and meeting with key stakeholders in order to clarify the proposed direction of the aquatic ecology assessment, discuss aquatic ecology values and the availability of additional 'grey' literature or unpublished information.

Other activities include:

- Development of a projects page within Cawthron's intranet for internal project management and allocation of resources. It is intended that this system be made available to the wider project team in future to allow the transfer of information and review of documents.
- Meeting with HBRC project team on 27 July 2011 – project kick-off and general discussions.
- Visit to dam site on 25 August 2011.
- Stakeholder meeting and discussion on 26 August 2011.
- Core project team meeting 5 October 2011.

3. PROPOSED WORKSTREAMS

3.1. Summary

We see that this investigation requires three key steps:

- To establish a process to identify and confirm the ecological resources of the respective catchments.
- To assess the effects of the RWSP on the ecological resources.
- To produce a comprehensive AEE that provides not only an assessment of effects but proposes options for avoiding, remedying or mitigating these effects. That process is likely to be iterative as the most likely means of "mitigation" will involve engineering and operational considerations and therefore require discussions with other providers.

3.2. Ecological resources assessment

Aquatic ecology resources

A review of the species of significance within the affected reach and wider catchment has been undertaken and has included a gaps analysis in conjunction with stakeholder workshops.

A comprehensive understanding of the aquatic ecological resources within the catchment is vital for informing the development of the scheme. We propose to use a combination of existing data, models, stakeholder workshops and field inspections to refine a list of species of significance to then allow the development of mitigation options. Based on our experience with consenting large water takes and dams, getting this aspect of the work correct is critical to identifying issues early and allowing constructive dialogue with the other service providers and stakeholders to ensure appropriate investigations are conducted. We believe that in many cases there is sufficient information either currently available, or in workstreams underway (such as the spawning assessment that HBRC consultants are undertaking) to largely inform our resource knowledge. Input to this through direct communication with those (and other) service providers and key stakeholders is also critical to allow the site-specific information to be clarified, and then some direct field observations may be required to inform the locations of particular species such as non-migratory 'pencil' galaxiids like Dwarf Galaxias.

We propose the following review of existing data:

- Interrogate the Freshwater Fish Database. Refine species presence/absence lists.
- Workshop stakeholder input to presence/distribution of species of significance and gaps in resource information.
- Model distribution of fish in the catchment identified as being of significance and likely to be directly affected by damming, intakes or affected by wider alteration of catchment flows using the FFDB, stakeholder input and models developed by Leathwick et al. (2008). Provide GIS mapping of likely distribution and probability of occurrence. If the available information is not of a fine enough resolution, this will then direct and focus efforts to where site-specific investigations are required.
- Review of spawning survey results carried out by HBRC consultants to determine the locations and extent of use of the affected catchment by trout. The early indications from this review (as yet not formally reported) are that there is limited spawning occurring. This would usefully be complemented by an assessment of juvenile trout production above the proposed dam site to review the value of the reach isolated by the proposed dam to spawning trout.
- Site-specific fish investigations in the affected reach generally following the protocols outlined in David et al. (2010). This will inform the distribution model which may not have sufficient resolution to determine any population 'hotspots'. This is important to fully understand the potential impact of the dam footprints on any localised populations of significance of non-migratory galaxiids.
- Modest synoptic macroinvertebrate survey (up to 30 samples – this work to be completed by HBRC staff with Cawthron input to site selection), in order to:
    - Describe community and habitat types in the affected reach.
    - Estimate macroinvertebrate densities (as estimate of food availability for fish and birds) in the affected reach.
    - Better inform the BITHABSIM model (Benthic Invertebrate Time series Habitat Simulation) if required.
- Recreational angling – most recent National Anglers Survey (NAS) suggests limited use of the affected reach. Limitations of the NAS sampling means that some specific investigation through discussion with expert anglers should occur to more accurately determine the use and significance of the affected reach. Workshop the values for the

affected reach with Fish & Game NZ (F&GNZ) staff and anglers who have expert knowledge of the affected reach.

- Review, when available, the draft Regional Land and Water Strategy where relevant to the Tukituki catchment to inform values assessment

Angling amenity and native fish habitat of canal and storage lake(s)

The creation of any storage impoundments or canal has the potential to create habitat for trout and native fish to exploit. This creates potential for angling amenity and traditional harvest opportunities. This has the potential to create a powerful mitigation option, if carefully scoped and implemented, although some stakeholders will see this as ‘artificial’ and may not be supportive. We would also caution that the extent of water level fluctuation in the reservoir and canals is likely to be significant and this will limit the quality of habitat in both places. Never-the-less, they could potentially create habitat for native fish species and this should be assessed.

Potential for new habitat creation would require literature reviews and possibly some angler surveys and input from Fish & Game NZ as the key stakeholder. It would also require subsequent input to design through discussion with the project team.

3.3. Water quality

Reservoir water quality

Review predicted water quality from the proposed reservoir as modeled by Aquanet Consulting Ltd (Aquanet/NIWA) and assess effects (including periphyton growth) of any change on aquatic values. Propose mitigation (including minimum flows and flushing flows, as discussed further in Section 3.4) where possible.

Land use intensification effects on water quality

Review NIWA/AgResearch modelling of the effect of land use intensification on water quality and periphyton under different farming regimes. Link predicted effects of water quality to effects on aquatic values. Propose mitigation where possible. As discussed in later in Section 3.4, ensuring an appropriate downstream flow regime (for both water quality and ecological reasons) will be critically important.

Civil works water quality

Review likely impacts of construction activities on aquatic values. Inform construction techniques as required.

Geomorphology
Consider effects of geomorphological changes as assessed by others, comment on effects of changes on aquatic ecology values. Propose mitigation where possible.

3.4. Water quantity

The flow modification resulting from the RWSP (including HEP add-on) requires an assessment of instream habitat, namely:

- A suitable residual flow in reaches two[1] and three[2].
- The size and duration of any flushing flow through reaches two and three.
- Fluctuating flow analysis below the HEP outfall.

The HEP add-on has generated a specific need for the fluctuating flow analysis.

Hydraulic modelling options
Instream habitat modelling involves constructing a computer model to predict how instream habitat availability for selected species varies over a range of flows. We propose the use of RHYHABSIM (River HYdraulics and HABitat SIMulation; Jowett 2004), purpose designed software developed by Mr Ian Jowett (formerly of NIWA) and BITHABSIM (Benthic Invertebrate Time-series HABitat SIMulation; see appendix one). This type of habitat modelling is based on combining predictions from a series of cross-sections, which have been selected to provide a realistic approximation of the variability in habitat throughout the reach of interest. Reaches and cross sections will be determined using habitat mapping.

The fieldwork component of the process involves:

i. reach selection
ii. habitat mapping
iii. cross-section placement
iv. water-level and flow measurements over a range of flows, for calibration
v. survey of depths, velocities and substrate at each cross-section.

The objective of an instream habitat survey is to get the best possible representation of the characteristics of a segment of river. The morphology of a segment of river depends on the gradient, strength of the bed material, and the magnitude of channel forming flood flows. If any of these factors change along the length of a river (e.g. due to tributary inputs, or the river flowing into a different underlying geology), then the morphological character of the river will change. This needs to be taken into consideration when selecting a reach, or reaches, for habitat modelling and instream values (e.g. reaches with high fisheries values). The

[1] From the dam outfall to the HEP outfall
[2] From the HEP outfall to the Waipawa confluence

methodology is designed to select a reach or reaches that are representative of a longer segment of river (in terms of gradient, flow and channel confinement) in which the flow regime is to be altered by upstream abstraction.

Habitat mapping involves recording the proportion of each habitat type (e.g. run, riffle, pool) comprising a relatively long reach of the stream, often by pacing out or measuring a representative length of the reach. This information is used to decide how many cross-sections should be allocated into each habitat type, and in the modelling process each cross-section is given a percentage weighting based on the proportion of the habitat in the reach that it represents. The predictions of subsequent modelling then relate to the reach that was mapped, with the underlying assumption that the cross-sections measured provide a reasonable representation of the variability in habitat throughout the reach and the broader river segment of interest.

Following habitat mapping, cross-sections are selected to cover the range of variability in habitat types. The number of cross-sections required will depend on the morphological variability of the channel; relatively fewer cross-sections will be required in relatively homogenous channels compared to those that are variable. Studies have shown that relatively few cross-sections can reproduce the shape of the weighted usable area (WUA; habitat index) versus flow relationship obtained from a survey with a large number of cross-sections. For example, Payne *et al*. (2004) sub-sampled several very large data sets to determine how many cross-sections were required to produce a robust WUA versus flow relationship. They found that 18-20 cross-sections gave results nearly identical to results for 40-80 cross-sections per reach and that only a few cross-sections were required to reproduce the general shape of the relationship. Several such studies were summarised in a recent guide to instream habitat surveys and modelling (Jowett et al. 2008). The recommendation from that guide was that the total number of cross-sections needed to generate a robust result should be proportional to the complexity of the habitat hydraulics. They suggested 6-10 cross-sections for simple reaches and 18-20 for diverse reaches. They also recommended that the number of cross-sections should be sufficient to ensure that no individual cross-section receives a weighting of more than 5-10%, to minimise the influence of outliers. We anticipate that 10-15 cross sections will be adequate for reaches 2 and 3.

At each cross-section a temporary staff gauge, usually a warratah or short length of reinforcing bar, is driven into the bed. This allows changes in the water level (or stage) at each cross-section to be recorded at several measured flows (referred to as calibration flows), and this information is used to calibrate the model.

At one flow (referred to as the survey flow) water depths, velocities and substrate composition are recorded at a series of points across each cross-section. These measurements describe the cross-sectional shape of the channel and the velocity distribution across it. Points on the banks, above water level, along the cross-sections are also surveyed to allow model predictions to be made at flows higher than the survey flow. The stage at zero flow (i.e. the water level at which surface flow would cease and water would simply be ponding in hollows in the bed) is also estimated at each cross-section to facilitate fitting of rating curves and for making model predictions at low flows.

These data allow calibration of a hydraulic model to predict how depths, velocities and the area of different substrate types covered by the stream will vary with discharge in the surveyed reach. For each cross-section a rating curve is developed, describing how water level changes with flow. In combination with the cross-sectional survey data these rating curves are used to predict the changes in depth and therefore cross-sectional area at each cross-section, and the model can then predict how velocities across the cross-section would have to change to accommodate the change in discharge.

Modelled depths, velocities and substrate types can then be compared with habitat suitability criteria (HSC) describing the suitability of different depths, velocities and substrate sizes as habitat for given species of interest. These criteria take the form of habitat suitability curves, which have been developed by observing the depths and velocities used by various species in rivers, both in New Zealand and overseas. Comparison of the HSC with the modelled physical characteristics of the study stream provides a prediction of the availability and quality of habitat in the stream. Habitat modelling is undertaken over a range of flows to predict how habitat availability will change with flow.

Site specific data is required to inform modelling from reaches two through four[3]. Existing data is available that could be utilized in RHYHABSIM modelling for the Waipawa River (Johnson 2011). HBRC would need to provide Cawthron with the input data (cross section locations, depths, velocities and substrate) and any other inputs used for the 2011 RHYHABSIM modelling of the Waipawa River for further analysis.

Historical flow analysis

Historical flow methods are based on flow records and are the simplest and easiest to apply. They have been described as 'standard setting' because they are generally desktop rule-of-thumb methods based on a proportion of a flow statistic to specify a minimum flow (Stalnaker et al 1995). Examples of historical flow setting options can be found in Beca (2008).

The aim of historical flow methods is to maintain the flow within the historical flow range, or to avoid the flow regime from deviating largely from the natural flow regime. The underlying assumption is that the ecosystem has adjusted to the flow regime and that a reduction in flow will cause reduction in the biological state (abundance, diversity) proportional to the reduction in flow; or in other words, that the biological response is proportional to flow. This is often not the case and is compounded by the fact that such flows don't optimise the needs of specific resources. In other words, natural flow regimes cannot automatically be assumed to be 'the best' flow regime.

[3] These reaches include those from the dam to the proposed irrigation intake on the Waipawa

The draft NES for flows suggest that an historical flows approach is not appropriate where critical instream values are high or where there is a large change proposed to the natural flow regime.

Determining flows for the RWSP

Determining suitable flow regimes for the reaches in the RWSP will be a stepwise process. We propose the following:

i. Critical to informing the level of detail and extent of investigation required (standard setting vs modelling) will be the catchment values. This would inform us on where the flows should be set and t the specified ecological outcome sought to be achieved. Candidates for critical value status might include flow-sensitive rare or endangered species, or species with high fishery value.
ii. Once values are determined, consider what level of accuracy is required around the flow estimates, this being a function of the significance of the values and the sensitivity of the flow/habitat relationship. This would occur in line with the proposed National Environment Standard (NES) for environmental flows, where there is a graduated scale of investigation required as the degree of hydraulic alteration and significance of the values that are to be protected increase.
iii. Implement the required approach. This would either be detailed hydraulic modelling (RHYHABSIM & BITHABSIM) or historical flow analysis. We recommend that hydraulic modelling be undertaken, given the limitations of the historical flow method noted above.
iv. If hydraulic models are required but are unable to be completed this summer due to a lack of suitable flows then the historical flow analysis could suffice as an interim measure, provided it was acknowledged that an adaptive management approach would be required, based on the results of subsequent monitoring and the completion of hydraulic modelling at some future point.
v. It would be helpful to gain an early appreciation of what flow augmentation and/or flushing flows are possible from the storage. There is a possibility that augmenting flows at critical (summer) periods could be explored as mitigation for any proposed flow regime.

To model flows using RHYHABSIM and BITHABSIM field effort is required for habitat modelling, cross section placement and subsequent gauging. We are aware that there is data available from the Waipawa River (Johnson 2011) so the field work should focus in the Makaroro, selecting cross sections (likely to be between 10-15), establishing pins for stage heights at the cross sections, conducting a depth, velocity and substrate survey at the cross sections and then gauging flows through a period of flow recession. Ideally key stakeholder groups would be involved during the habitat mapping and cross section selection to ensure they concur that the habitats mapped are accurate and the cross sections capture the range of habitats available.

The field effort will involve:

- Cawthron and HBRC staff completing habitat mapping, cross section selection and initial gauging.
- HBRC staff complete all other gauging and provide data.

Subsequent stage height and gauging data would need to be supplied in Excel spreadsheet format and a template of this can be provided.

Review of Regional Land and Water Strategy

In addition to the modelling proposed, we propose to undertake a concurrent review of the draft Regional Land and Water Strategy (RLWS) and proposed regional plan variations or changes. We would then assess strategy direction and proposals with regards to environmental flows and final scheme design.

In any event, it is likely that this aspect will require specific attention, and be one of the key project determinants. In order to assess scheme impacts we would want to be able to review the following aspects of any plan or strategy:

- Proposed environmental flows
- Proposed flow regimes
- Proposed variability.

Key matters for the effects assessment process

Environmental flows and flow variability

Key issues requiring effects assessment are likely to be harvesting mid-range flows and subsequent reduction in these, the proposed ‘minimum’ flows and overall flow variability. The availability of this information and the proposed flow regime from the reservoir is critical to informing effects assessments, the appropriateness of what is being proposed and mitigation options.

Proposed flushing flows, timing, extent and duration

Low, stable flow conditions are more favourable for excessive periphyton growth, increasing the frequency, duration and peak biomass of such growths. Algal proliferation can affect water quality and the abundance and structure of macroinvertebrate communities, with possible flow-on effects to higher trophic levels (fish and birds). Periphyton can also affect the aesthetics and recreational usage of waterways. In addition, cyanobacteria (“blue-green algae”) are one part of the periphyton community and can form blooms under suitable conditions. Cyanobacteria are of particular concern as some taxa may produce toxins which pose a risk to humans and animals (*e.g.* dog deaths) if algal matter or water is consumed. We will conduct an investigation of mitigation options such as minimum and/or flushing flows required to manage/remove the buildup of undesirable periphyton growths around the main dam outfall, HEP outfall and within the residual reaches. Flow regime effects on periphyton will need to be included in any habitat modelling (noted above) and related flushing flow analysis undertaken – to determine the magnitude and frequency of floods required to avoid periphyton proliferations.

In order to understand the effects of flow regime change on periphyton (and whether guidelines will be breached) the interaction with water quality should also be included in investigations.

Fluctuating flows (Hydropeaking)

The need for a review of this will be informed by the final scheme design and the final design of the HEP add-on.

If hydropeaking is to occur there are three main issues that need consideration:

- Effects of artificially varying water levels and velocities on fish stranding and on benthic invertebrate habitat.
- Effects of ramping rate on fish stranding.
- Effects of ramping on downstream human safety, although this is outside the scope of our investigation.

Effects of hydropeaking on benthic invertebrate habitat can be assessed as part of RHYHABSIM and BITHABSIM habitat modelling.

3.5. Fish passage and screening

We proposed to undertake a literature review to consider screening options against the proposed final scheme design. Depending on the size and timing of out-migrating juvenile fish, screening will have to be considered for the main reservoir outlet, the irrigation off-takes and/or the penstock inlets, if HEP is included. Determining the size and timing of out-migrating fish is critical to informing the design of fish screens.

We would review any turbine design (if HEP add-on proceeds) with regards to fish survival with the design team. This is more relevant if the size of migrants is large (most relevant to juvenile salmonids and adult eels).

The findings of our desktop review of fish distribution and synoptic fish surveys would inform the need for and/or practicalities of providing fish passage. These findings would be considered in discussions with the engineering design team. Given the height of the proposed dam wall only passage for the strongest of migrants such as eel elvers and koaro is likely to be possible. Eel trap and transfer techniques are now well developed so it may also be possible to use this technology. This and any other species specific requirements would be incorporated into any design recommendations.

3.6. Peer review process

Phil Mitchell (Mitchell Partnerships) has peer reviewed our approach and will peer review the draft aquatic ecology assessment. We have chosen Phil as we see that it is critical to have a person who has had a broad exposure to consenting large dams, has a detailed knowledge of the RMA and Environment Court processes (both as a practitioner and Hearings Commissioner) and will quickly focus on the critical issues for decision makers and stakeholders. This approach is likely to draw out any issues at an early stage.

4. TASK SCHEDULE AND TIMETABLE

Workstream	Proposed approach	Resources required	Timeframe	Requirements of others
Values assessment	Interrogate Freshwater Fish database	Internal - Cawthron staff	Immediately	Nil
	Model fish distribution	Internal - Cawthron staff	Immediately	Nil
	Review spawning site assessment	Internal - Cawthron staff	On production of report to Cawthron	HBRC contractors to supply report
	Assessment of juvenile trout abundance above dam site	Field team to visit site in low flows early spring	The need for this is informed by the report above, but is dependent on river flows but likely Oct-Nov 2011	Nil, but could be usefully informed by site assessments with F&GNZ staff
	Site-specific assessment of non-migratory fish species within impoundment footprint	Field team to visit site in low flows early spring	Dependent on river flows but likely Oct-Nov 2011	Nil, but could be usefully informed by site assessments with DOC staff
	Modest macroinvertebrate survey of the affected reach	Internal - Cawthron staff	Dependent on river flows but likely Jan-Feb 2012	HBRC to provide complete sample results from sites selected by Cawthron staff
	Review value of Makaroro to trout anglers	Internal - Cawthron staff	October 2011	Input from F&GNZ staff to select expert anglers and assist with convening meeting. F&GNZ to supply Rivas survey results.
	Review angling amenity value of canal and reservoir	Internal - Cawthron staff	On provision of final scheme design	Requires detail of reservoir shape and depths and operating ranges from Tonkin & Taylor Ltd (TT). Requires details of canal

Workstream	Proposed approach	Resources required	Timeframe	Requirements of others
				lengths and depths from TT
	Review value of reservoir and canal for native fish	Internal - Cawthron staff	On provision of final scheme design. Needs to be September 2011	Requires detail of reservoir shape and depths and operating ranges from TT. Requires details of canal lengths and depths from TT
	Review values as outlined in the draft Regional Land and Water Strategy	Internal - Cawthron staff	On provision of draft strategy from HBRC staff. Needs to be Oct 2011.	HBRC staff to supply required documents
Water quality	Review reservoir water quality. Assess effect of discharges from reservoir on aquatic ecology of Makaroro and Waipawa rivers	Internal - Cawthron staff	On provision of report from Aquanet. The report needs to be provided end of December 2011.	Provision of a comprehensive report detailing reservoir water quality from Aquanet to Cawthron staff. This report also detailing the predicted quality of water through the residual flow and HEP scheme
	Review the modeled impacts of land intensification on water quality in the Waipawa and Tukituki catchments. Assess impacts of water quality changes on aquatic ecology of the Waipawa and Tukituki catchments	Internal - Cawthron staff	On the provision of a report from NIWA. Initial report needs to be provided end of Dec 2011, with 3 further scenarios by early Feb 2012	Provision of a comprehensive report detailing the modeled changes in water quality resulting from the various land use scenarios selected by the project team. The details of the study scope being outlined in Water Quantity/quality Study 3.
	Assess likely impacts of construction activities on	Internal - Cawthron staff	On confirmation of the final scheme design and	Input to the design phase and proposed construction

Workstream	Proposed approach	Resources required	Timeframe	Requirements of others
	aquatic ecology. Inform construction techniques as required		proposed construction methods. Provide at the time final scheme proposed.	methods. Requires details to be provided by TT.
	Review proposals for sediment management downstream of the dam and HEP outfall. Assess effects of changes in geomorphology on aquatic values	Internal - Cawthron staff	On provision of a report on geomorphology issues by TT. Needs to be by November 2011.	Provision of a report from TT detailing sediment transport processes and prediction on geomorphology changes in the Makaroro and Waipawa rivers
Water quantity	Review direction of proposed plan changes and RLWS around flows and allocation in the Tukituki catchment	Internal - Cawthron staff	On provision of proposed plan changes and proposed RLWS by HBRC staff. Needs to be by end of October 2011	HBRC planning staff to confirm proposed direction. At this point 90% habitat retention proposed.
	Environmental flows	Possible field assessment of instream habitat modelling sites. The confirmation of what work is occurring in this area is significant to confirming Cawthron involvement	Completion (if required) of instream habitat assessments and modeled flow predictions. This work needs to be completed over a range of declining flows during summer months and so is flow- and weather-dependent. To be completed by Feb 2012. If not possible historical flow method is a possible alternative. This would	HBRC staff to provide field assistance on initial site selections and then undertake gauging and record stage heights for calibration flows on declining hydrograph (up to 3 occasions). HBRC staff to provide RHYHABSIM inputs from Johnson (2011).

Workstream	Proposed approach	Resources required	Timeframe	Requirements of others
			require provision of flow records.	
	Mid-range flow variability/invertebrate productivity	Internal - Cawthron staff	Requires the completion of the flow assessment noted above and macroinvertebrate data.	HBRC science staff to provide macroinvertebrate data. Cawthron to model productivity.
	Flushing flow analysis/assessment of periphyton	Internal - Cawthron staff	Requires the completion of the flow assessment noted above and provision of periphyton data from HBRC science staff	HBRC science staff to collect periphyton data, if required, at the time invertebrate samples collected. Provision of stage heights and gauging data from HBRC staff from IFIM work.
	Flow peaking analysis	Internal - Cawthron staff	Requires the completion of the flow assessment noted above and comprehensive details on the proposed HEP operation	TT to provide details on flow variation.
Fish passage/screening/turbine design	Fish passage	Internal - Cawthron staff	On provision of the final detailed technical design aspects of the proposed dam, including proposed flow regimes, spillways, release points. Needs to be by end October 2011. Also requires the completion of fish distribution modelling by Cawthron.	HBRC project team and TT to supply sufficient design details to undertake passage analysis
	Screening	Internal - Cawthron staff	On provision of the final	HBRC project team and TT

Workstream	Proposed approach	Resources required	Timeframe	Requirements of others
			detailed technical design aspects of the proposed dam, including proposed flow regimes, spillways, release points. Needs to be by end October 2011. Also requires the completion of fish distribution modelling by Cawthron.	to supply sufficient design details to confirm screen design details
	Turbine design	Internal - Cawthron staff	On provision of the final detailed technical design aspects of the proposed dam, including proposed flow regimes, spillways, release points, turbine size, blade spacing and head. Needs to be by end October 2011. Also requires the completion of fish distribution modelling by Cawthron.	TT to supply sufficient design details to allow confirmation of "fish-friendly" design options taking into account the design, construction and operation of the turbine systems.
Peer review	AEE review	Internal - Cawthron staff, Mitchell Partnerships Ltd	Completed by end Feb – early March	Nil

5. CONCLUSION

This work has three critical elements, accurately describing the aquatic ecology values of the catchment, thoroughly reviewing the effects of the proposed project against the catchment values and where possible providing mitigation options to balance effects.

We see water quality and quantity along with fish passage and screening being the areas of greatest potential concern.

The likely success of this project will be assured through the involvement of the aquatic ecology team with the other service providers at all stages of the scheme design.

6. REFERENCES

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7. APPENDIX

Appendix 1. Benthic Invertebrate Time-series Habitat Simulation Model (BITHABSIM)

BITHABSIM is recently developed software that can be used to assess the effects of water abstraction on invertebrate populations whilst taking into account the effects of disturbance caused by high flows and patterns of post-disturbance recovery of invertebrate numbers. The inclusion of disturbance and post-disturbance recovery should increase the ecological realism of the modelled responses of macroinvertebrates to hydrological alteration of rivers.

The inputs to BITHABSIM included (all in comma-delimited text files):

1. A WUA-discharge relationship for larvae of the common mayfly *Deleatidium*.
2. A sediment flushing-discharge relationship for the median flow channel.
3. The invertebrate recolonisation rate represented by a logistic relationship with r = 0.025.
4. A discharge and wetted area relationship.
5. Naturalised, 'status quo' (existing abstraction) and abstraction hydrographs for the three years and six scenarios.