# MOKIHINUI HYDRO PROPOSAL
# CONSENT APPLICATIONS
# REVIEW OF ASSESSMENT OF EFFECTS OF AQUATIC ECOLOGY AND WATER QUALITY

**July 2008**

Prepared by:
David Cameron
MWH NZ Ltd

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# 1.0 Introduction

## *1.1 Background*

This report provides a review of the assessment of environmental effects (AEE) provided by Meridian Energy Ltd (the applicant) in support of a range resource consent applications. These consent applications are to take, use and discharge water for hydroelectricity generation, along with associated construction and maintenance related consents which are part of the Mokihinui Hydro Proposal (MHP).

The Mokihinui Hydro Proposal includes a dam located on the Mokihinui River approximately 3 km upstream from the township of Seddonville and 11 km upstream from the river mouth, a new lake upstream of the dam extending to just below the Mokihinui Forks Ecological Area, a new transmission line to carry electricity from the power station to the existing Inangahua-Waimangaroa transmission line at Cedar Creek, and a new substation at Cedar Creek.

This report provides the decision-maker with information and advice related to the effects of the proposed activities on instream habitat and flow requirements.

## *1.2 Qualifications*

My name is David James Cameron. I have been employed by MWH NZ Ltd as a Senior Environmental Scientist since 1994. My qualifications are Bachelor of Science (Honours) majoring in Zoology, obtained from Victoria University of Wellington. I have twenty two years professional experience as an environmental scientist in New Zealand. I specialise in water quality and freshwater ecology, with a focus on benthic ecology.

## *1.3 Scope of Report*

To carry out this review of the consent application I have considered the relevant sections of the AEE submitted by Meridian, and the following technical appendices:

- URS 2007: Mokihinui Hydro Proposal – Construction Effects and Management Report.
- Jowett, 2007: Instream habitat and flow regime requirements in the Mokihinui River. NIWA Client Report: Ham2007-150.
- Floeder and Spigel, 2007: Mokihinui River Proposed Hydropower Scheme: Lake water quality and habitat report. NIWA Client Report: CHC2007-122.
- Suren and Kilroy, 2007: Mokihinui River Proposed Hydropower Scheme: Periphyton and Invertebrates Report. NIWA Client Report CHC2007-111.
- Bonnett, Jellyman, Graynoth, Kelly & Henderson 2007: Mokihinui River Proposed Hydropower Scheme: Native Fish and Fisheries Report. NIWA Client report CHC2007-060.
- Hayes JW, Hay J, Bickel TO, Closs GP and Bonnett M 2007: Mokihinui River Proposed Hydropower Scheme: Trout Movement and Passage. Cawthron Report No. 1383, prepared for Anderson Lloyd Lawyers on behalf of Median Energy Ltd.

- Te Rununga O Ngati Waewae, 2008: Mokihinui Awa Proposed Hydro Power Scheme Cultural Impact Assessment. Report prepared for Meridian Energy.

I have also taken into account issues raised by submitters in relation to the effects on water quality and aquatic ecology.

In addition I have carried out a site visit on the Wednesday 5th March 2008 and had discussions with the applicant's team to further inform me on the application. Further information was provided by the applicant in response to a Section 92 request for further information.

> Note: At the time of writing this report not all Section 92 information relating to aquatic ecological matters has been received. Material in response to further information requests 2.11, 2.12 and 2.13 has since been received, but the author of this report had been unavailable to review it. Further brief comment can be provided at the hearing.

# 2.0 Submissions

The following issues were raised by submitters in relation to the effects on water quality, aquatic ecology and fisheries in particular:

- The application does not promote the sustainable management of the natural and physical resources of the environment as required by Part 2 of the RMA.
- The application does not safeguard the life-supporting capacity of the gorge; and fails to adequately avoid, remedy or mitigate the adverse effects of the proposal on aspects of the Mokihinui River catchment.
- The application does not recognise and provide for matters of national importance contained in section 6 of the RMA. It is inconsistent with the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna.
- The river contains twelve indigenous fish species, some of which are considered to be threatened. Both the construction and operation of the proposed hydro scheme will result in considerable disturbance to these species through construction activities, altered flow regimes, loss of connectivity within the catchment, and the permanent loss of habitat.
- The Mokihinui is a significant trout fishery on the West Coast, and the proposed hydro scheme will adversely affect parts of this habitat.
- Insufficient information has been provided by the applicant to adequately gauge potential effects on the trout sports fishery, and in particular how the abundance of larger trout will be affected.
- Insufficient information has been provided by the applicant to adequately gauge potential effects on the Mokihinui River whitebait fishery.
- The likely adverse effects of the proposal on the whitebait fishery cannot be adequately mitigated or offset.
- The proposal will adversely affect the upstream and downstream migration of eels, and will adversely affect the sustainability of the freshwater eel industry.

# 3.0 Assessment of Effects

## *3.1 Introduction*

I have reviewed the assessment of effects on water quality, aquatic ecology and fisheries, and have taken into account the mitigation proposed by the applicant. This is discussed below, with a focus on the key issues.

## *3.2 Review of Assessment of Effects*

### 3.2.1 Effects from construction activities on surface water quality and aquatic ecology

The proposal includes a range of construction related activities that could potentially affect the quality of water in the Mokihinui River. These include:

(a) Stormwater discharges from the staging area (via retention ponds)

(b) Wastewater discharges from concrete batching plants (via primary settlement and retention ponds)

(c) Wash water discharges from water blasting (via primary settlement and retention ponds)

(d) Domestic wastewater discharges from temporary facilities (via subsurface disposal)

(e) Dewatering discharges (via retention ponds if required)

(f) Cofferdam and diversion flows (untreated)

(g) Construction of transmission line

Activities (a) to (f) all involve discharges to the main stem of the Mokihinui River while construction of the transmission line (g) involves relatively minor stormwater discharges to the main stem and tributaries of Mokihinui River and the main stem and tributaries of the Ngakawau River.

In respect of (a) Stormwater discharges from the staging area (via retention ponds), the applicant proposes that stormwater runoff from the staging area (including runoff from the dam), together with discharges from the primary settlement ponds (used to treat wastewater from the concrete batching plants and wash water from blasting) would be directed to stormwater retention ponds. The ponds are to be sized to retain more than 75% of sediment in stormwater from the 10% annual exceedence probability event.

The estimated area of the stormwater catchment is 19.3 hectares and the proposed volume of the sediment retention ponds is approximately 2000m$^3$ giving approximately 100m$^3$ retention capacity for each hectare of contributing catchment. This is at the low end of widely accepted design criteria for New Zealand conditions (i.e. ARC TP 90[1]), but would be appropriate for sand, soils (less than 8% clay and less than 40% silt).

[1] [1] ARC 1999: Erosion and sediment control guidelines for land disturbing activities in the Auckland Region. Auckland Regional Council Technical Publication No. 90.

However neither the AEE nor the URS construction effects report (URS 2007) provide a description of the soil type within the staging area.

The applicant advises that additional flows to the retention ponds from the concrete batching plants and wash water discharges from water blasting are likely to be less than 50 $m^3$/day (but cannot confirm volumes at this stage).

The applicant states in section 2.6.7 and in response to a S92 request for further information that the dewatering discharges from the cofferdam catchment may be pumped to the stormwater retention ponds “if water quality was such that it could not be directly discharged to the river”.  I recommend that dewatering discharges should be not be allowed to discharge directly to the river if they are likely, in combination with other activities at the site, to reduce black disc visibility by more than 33%, after reasonable mixing.  In my opinion compliance should be based on an upstream reference site located in the river 200m upstream of the construction area and a compliance site located in the river, near the true left bank, 300m downstream of the discharge from the stormwater retention pond.

I also consider it appropriate to adopt a conservative approach to pond sizing, and recommend that the retention ponds be designed and sized in accordance with the ARC TP90 guidelines, taking into account all potential input to the ponds.

The URS report states that the retention ponds would be unlined and that the majority of stormwater from the staging area during site establishment will infiltrate to ground through gravels in this area.  Overflow from the pond would discharge into the stormwater diversion drain, which discharges to the river some 300 metres upstream of a sharp left hand bend.

Domestic wastewater is to be treated via a package treatment plant.  The applicant has proposed that the treated effluent quality shall be equal to or better than 20 $g/m^3$ $BOD_5$ and 30 $g/m^3$ Total Suspended Solids.  The treated effluent is proposed to discharge to a subsurface disposal field adjacent to and just upstream of the sediment retention ponds. The treated wastewater discharge would infiltrate to groundwater through river gravels.

The applicant has not attempted to define a mixing zone for either the surface water discharge to the river or the groundwater plume extending from the pond and subsurface disposal area.  The surface water discharge is likely to be only partially mixed over the first 300 metres in the river but increased turbulence and transverse currents at the sharp left hand bend can be expected to achieve rapid mixing between 300 and 350 metres downstream.

Assuming ground water gradients follow the surface topography (more or less) in this area, it would appear that the majority of groundwater would enter the river near or just downstream of the proposed surface water discharge.  In that case the mixing of the groundwater plume with river water would be similar to the surface water discharge, and a high level of mixing can be assumed beyond 350 meters.  As there are no groundwater takes in this vicinity there appears to be no risk of a potable supply being contaminated by the groundwater plume.

I agree with the assessment in the URS report that, due to the relatively low wastewater flows in relation to the river flow, and the proposed treatment, these discharges will have no more than a minor effect on the water quality or aquatic ecology of the Mokihinui River, after full mixing. I consider that the 300m mixing zone proposed by the applicant is appropriate.

The potential for adverse effects *within* the mixing zone is less clear. The possibility of localised nutrient enrichment and development of undesirable biological growths in shallow water near the true left bank has not been assessed. If this does occur I would expect these effects to be localised (would not extend far from the true left bank) and temporary.

Construction of the cofferdam and diversion of flows down the bypass channel will be carried out by bulldozing bed material across the channel at the upstream and downstream locations. In the event of excessive leakage of the cofferdam a silt and gravel blanket may need to be placed to seal the leaks. All of these activities will result in elevated suspended sediment concentrations in the river. The applicant estimates that the construction of cofferdams and diversion of flows will result in a significant sediment discharge for less than 24 hours, and that the total sediment load will be small in comparison with natural flood events. There are no practical mitigation options to control this discharge. The applicant estimates that the placement of the cofferdam “blanket”, if required, would result in elevated suspended solids in the river for up to two weeks.

In my view, the sediment discharges resulting from temporary activities associated with the river diversion works and cofferdam construction, could reasonably be permitted to cause a “*conspicuous change in the colour or visual clarity*” beyond the 300m mixing zone, provided that effect did not last more than 48 hours, it did not occur during the whitebaiting season, and provided the applicant had notified the Regional Council and other specified interest groups at least 48 hours prior to the event.

Suren and Kilroy (2007) consider that the effects on periphyton and invertebrates resulting from construction activities mainly relate to increased sediment deposition in the river downstream of the dam site and are expected to be temporary and minor. I agree with that assessment (but consider that there may also be minor adverse effects associated with increased nutrient concentrations in the river within the mixing zone[2]).

### 3.2.2 Mitigation of construction effects on surface water quality

If consents are to be granted, the following consent conditions are recommended to mitigate adverse effects of construction activities on water quality and aquatic ecology:

(a) The sediment retention pond shall be designed and sized in accordance with ARC TP90 guidelines.

[2] It is acknowledged that S107 (1) allows for minor or more adverse effects on aquatic life within mixing zones.

(b) The permit holder shall measure black disc visibility once each week during normal working hours through the construction period. Monitoring shall be undertaken at an upstream reference site located in the river 200m upstream of the construction area and at a compliance site located in the river, near the true left bank, 300m downstream of the discharge from the stormwater retention pond.

(c) In the event that dewatering discharges, in combination with other discharges from the site, cause or are likely to cause more than a 33% reduction in black disc visibility between sites located in the river 200m upstream of the construction area and 300m downstream of the point of discharge from the stormwater retention pond, the permit holder shall ensure that all dewatering discharges pass through the stormwater retention pond(s) prior to discharge to the river.

(d) The permit holder shall collect water samples once each month through the construction period from the Mokihinui River at sites near the true left bank located 200m upstream of the construction area and at 300m and 500m downstream of the point of discharge from the stormwater retention pond. All samples shall be tested for pH, dissolved oxygen, temperature, black disc visibility, suspended solids, ammoniacal nitrogen, nitrate nitrogen, dissolved reactive phosphorus and *E. coli*.

(e) Results of monitoring required by conditions of this consent shall be forwarded to West Coast Regional Council once every three months or on request.

(f) The permit holder shall ensure that discharges from the site during construction do not give rise to any of the following effects beyond a mixing zone extending 300m downstream of the discharge point from the stormwater retention pond:
   - (i) The production of conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
   - (ii) Any conspicuous change in the colour or visual clarity;
   - (iii) Any emission of objectionable odour;
   - (iv) The rendering of fresh water unsuitable for consumption by farm animals;
   - (v) A change in the temperature of the water by more than $3^0$ Celsius.
   - (vi) The depletion of dissolved oxygen concentrations below 80% of saturation concentration;
   - (vii) Any undesirable biological growths;
   - (viii) Any significant adverse effects on aquatic life; or
   - (ix) Any adverse effects on any take of water for human consumption.

   N.B. Standards (i) and (ii) above do not apply to discharges associated with the river diversion and construction of the cofferdam, provided those effects do not occur for more than 48 consecutive hours and do not occur during the whitebaiting season.

The construction management plan proposed by the applicant (Schedule A, draft condition 6) at (ii)(b), requires a description of all construction works, including those associated with the transmission line. In addition to the existing provisions of condition 6, I recommend the plan identify all watercourses potentially affected by the transmission line and access track works and provide a site specific stormwater management and sediment control plan for each those areas, subject to approval of WCRC.

### 3.2.3 Effects of scheme operation on water quality

The potential water quality effects associated with the ongoing operation of the proposed Mokihinui Hydro proposal (MHP) have been assessed by Floeder and Spigel (2007) for the applicant. They conclude that the lake will be thermally stratified from spring to autumn, that in the long-term the trophic status of Mokihinui reservoir will be oligotrophic to mesotrophic, supporting low to moderate levels of primary productivity, and that the formation of large algae blooms and surface scum is unlikely. These conclusions appear to be well founded.

Nevertheless the authors have identified a significant short term issue associated with the decay of submerged vegetation that will lead to the occurrence of anoxic conditions 25-30 metres below the surface in the reservoir during summer over the first two or three years of operation. This is not expected to affect the migration of trout, eels or whitebait, which predominantly utilise the surface or near surface waters of deep water bodies.

However, it raises the possibility of anoxic waters being discharged to the river downstream of the dam, with potentially serious consequence on downstream river biota. The dam will have a single outlet 13 m below the spillway crest, to withdraw water for power generation. The position of the outlet is expected to exert a strong influence on the depth of the main thermocline (the region over which temperatures change most rapidly with depth), which is expected to form just below the outlet and extend over a depth of 10-15 m. The authors conclude, however, that all but the highest inflows will flow into the reservoir within or above the thermocline. Inflows that enter the main body of the reservoir at the level of the thermocline will flow more or less directly to the outlet, and the anoxic water below the thermocline will remain almost completely isolated.

Floeder and Spigal state that it is virtually impossible for anoxic water to be discharged over the spillway given the depth of the thermocline and the constant rapid renewal of water above the thermocline by inflows. They also state that any discharge of anoxic water would have to come through the turbines, and note two circumstances in which it might be possible for a significant fraction of generation outflow water to be drawn from below the main thermocline, with the risk of oxygen depleted water being discharged downstream. The first is that of a very large flood that might force bottom water against the dam to rise to the level of the offtake. Under this circumstance it is likely that such outflows would be rapidly diluted by water flowing over the spillway. The second circumstance is that of a sudden increase in generation outflows following a long period of low flows. Such an increase in outflow could only occur if river inflows were also increasing rapidly. This circumstance could be avoided by modifying the operating strategy, e.g., by increasing outflows very gradually until sufficient water was flowing over the spillway to dilute the outflow.

The authors do not anticipate problems in meeting standards for Class AE Waters (as established in the Regional Water Management Plan) in the river downstream of the dam for temperature, pH, oxygen, sediment deposition or contaminants.

I agree with this assessment and would also support the authors' recommendation that a programme be put in place to monitor the seasonal evolution of oxygen and temperature in the reservoir near the dam, and at other locations, to allow operators to respond appropriately, as described above, should the need arise.

### 3.2.4 Mitigation of effects on water quality

If consents are to be granted, the following consent conditions are recommended to mitigate adverse effects on the water quality in the river downstream of the dam:

(a) The permit holder shall prepare and implement a programme to monitor the seasonal changes in dissolved oxygen and temperature at different depths in the reservoir near the dam, and at two points in suitable cross sections, with one being located in the tailrace channel and one at a specified distance downstream in the river.

(b) Results of monitoring required by conditions of this consent shall be forwarded to the West Coast Regional Council once every three months or on request.

(c) The permit holder shall implement measures to ensure that dissolved oxygen concentrations in the river below the dam exceed 80% of saturation concentration at all times. Such measure may include:
  - (i) Increasing outflows very gradually until sufficient water is flowing over the spillway to dilute the outflow
  - (ii) Discharging through the bypass valve until sufficient water is flowing over the spillway to dilute the outflow.

(d) The permit holder shall ensure that operation of the hydro electric power scheme does not give rise to any of the following effects beyond a mixing zone extending 300m downstream of the tailrace discharge:
  - (i) The production of conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
  - (ii) Any conspicuous change in the colour or visual clarity;
  - (iii) Any emission of objectionable odour;
  - (iv) The rendering of fresh water unsuitable for consumption by farm animals;
  - (v) A change in the temperature of the water by more than $3^0$ Celsius.
  - (vi) The depletion of dissolved oxygen concentrations below 80% of saturation concentration;
  - (vii) Any undesirable biological growths;
  - (viii) Any significant adverse effects on aquatic life; or
  - (ix) Any adverse effects on any take of water for human consumption.

### 3.2.5 Effects on benthic ecology

The potential effects of the MHP on periphyton and invertebrates have been assessed by Suren and Kilroy (2007) for the applicant. The fundamental issues are the presence of a dam (and subsequent loss of riverine habitats upstream of this) and daily flow fluctuations below the dam.

Formation of a reservoir upstream of the dam will transform a fast flowing river habitat into a lake environment, which will change the composition of both periphyton and invertebrate communities. The authors assessed the effects of the change on periphyton as minor to moderate and on invertebrates as major, within this reach.

The modified flow regime in the river below the dam will result in daily fluctuations between 16 and 120 $m^3s^-1$ except at times of very low or very high inflows to the reservoir. The authors have identified a range of effects on habitat quality. They conclude that this may result in a reduction in invertebrate density below the dam, but will probably not affect biodiversity, and that periphyton biomass may increase in the permanently wetted areas as a result of increased substrate stability, but is unlikely to reach undesirable levels.

I am in general agreement with this assessment. However, there is a question around the likely reduction in invertebrate production in the 14 km reach upstream of the dam and in the river below the dam, and in particular about the significance of this reduction on fish food supply (refer Section 3.2.7).

Suren and Kilroy note that the MHP is expected to increase the suitability of the lower Mokihinui River for establishment of the invasive alga *Didymosphenia geminata*, but expect that biomass would be limited by the relatively frequent large floods that affect this river. I support the suggestion by the applicant for monitoring in the lower river to track any *D geminata* standing crop, and to require an appropriate flushing flow to reduce biomass.

### 3.2.6 Mitigation for benthic ecology

If consents are to be granted, the following measures are recommended to mitigate adverse effects on the benthic ecology in the river downstream of the dam (it may be appropriate to include these as requirements for the Aquatic Ecology Management Plan, and to require that monitoring and management programmes are subject the approval of WCRC):

(a) The permit holder shall develop and undertake a programme to monitor periphyton standing crop in the lower river*.* It shall also include a mechanism for measurement, monitoring and control of the invasive alga *Didymosphenia geminata*, and for the avoidance of other undesirable biological growths in the lower river, by the use of flushing flows and/or other means as appropriate:

  (i) The initial periphyton monitoring programme should be implemented in the lower river at three sites at 4-monthly intervals, to detect *D. geminata* if it appears. If *D. geminata* is detected the frequency should increase to monthly, and should include visual assessment of *D. geminata* standing crop. Continued monitoring will therefore track standing crop in relation to flows and enable determination of an appropriate flushing flow to reduce standing crop, should a persistent high biomass develop.

  (ii) The permit holder shall ensure that the operation of the MHP does not result in any of the following effects in the river downstream of the dam:

    - filamentous algae greater than 2cm in length covering more 30% of riverbed surfaces,
    - maximum chlorophyll a concentrations greater than 120 $mg/m^2$, or
    - maximum AFDM concentration greater than 35 $g/m^3$.

(b) The permit holding shall monitor macroinvertebrate communities in the main stem of the Mokihinui River immediately upstream of the proposed reservoir and in the main stem of the river at sites approximately 1km and 2km downstream of the dam site.

This monitoring survey is to be undertaken once each year on at least 3 years before dam construction and 7 years after construction.

Other consent conditions recommended to mitigate adverse effects on the benthic ecology in the river downstream of the dam include:

(c) The permit holder shall ensure that the station discharge flow shall not be less than $16m^3/s$, except when inflows into the reservoir are less than $16m^3/s$. During these periods the station will be operated so that the discharge to the river below the dam matches inflows to the reservoir as closely as practicable until such time as a flow of $16m^3/s$ or greater is reinstated.

(d) The consent holder shall ensure that the generation discharge flow shall not be greater than $120m^3/s$, except when water is passing over the spillway crest, at which time the generation flow shall not exceed $139m^3/s$.

### 3.2.7 Effects on native fish

The potential effects of the MHP on native fish and fisheries have been assessed by Bonnett *et al* (2007) for the applicant. They note that twelve native freshwater fish are known in the Mokihinui River catchment, including four (giant kokopu, shortjaw kokopu, lamprey and longfin eel) classified by the Department of Conservation as threatened. This assemblage is described as typical for the region.

Potential effects may arise as a result of reduced habitat quality in the river downstream of the dam (due to changes to the flow regime, water quality, substrate size and food production) or due to the dam interfering with fish migration and so limiting the range of some species. The authors reached the following conclusions in respect of habitat quality:

- The altered flow regime would not have any significant effect on native fish habitat (Jowett 2007).
- The altered flow regime may reduce invertebrate production but the likely effect on native fish food supply is likely to be minor or less than minor.
- Water quality downstream of the dam is predicted to be very similar to that of water flowing into the reservoir.
- No significant bed scour would occur, but the already coarse surface armour may coarsen further as finer gravel and sand would be swept to the coast by flood, with only minor replenishment from tributaries downstream from the dam.
- Overall the MHP is likely to have minor or less than minor effects on native fish populations in the mainstem of the Mokihinui River.

These conclusions generally appear to be well founded. There is a risk however that the combined effects of increased periphyton biomass, increased bed armouring and reduced invertebrate habitat may reduce food production to a greater extent than acknowledged in the report.

I note also that the authors have not considered construction effects in their assessment.

Despite these reservations I agree with the overall conclusion that the MHP is likely to have no more than minor effects on native fish populations below the dam.

In respect of fish migration, for most species the dam will present few problems, as normally they do not penetrate much further upstream than the proposed dam site. For other species which may penetrate further inland, a dam would prevent juvenile fish from moving upstream into their preferred habitat. Bonnett *et al* identified the longfin eel and koaro as being of most concern because these species are widely distributed throughout the Mokihinui River catchment. For eels, a dam would also affect downstream passage of sexually mature adults.

I would support Meridian's recommendation that upstream passage of all migratory native fish past the dam should be assisted. However, Meridian has not proposed a methodology for achieving this. They have stated that a "trap and transfer" pass is likely to be the preferred (and most effective) approach, but that they and their consultants "will continue to investigate this and other approaches to ensure that the adopted approach effectively achieves the objective of enabling upstream migration of native fish species to continue". The lack of information not only about the method to be employed but also the likely performance of that method introduces considerable uncertainty as to the likely effects of the MHP on koaro and longfin eel populations.

In respect of downstream passage of eels the authors note that it is now widely accepted that stocks of longfin eels nationally are in decline, and that arguably the most effective freshwater stage to focus on for ensuring sustainability of stocks is the sexually maturing downstream migrant. They state also: "In a typical year, during autumn, about 785 adult longfin eels will migrate downstream in the Mokihinui River on their way out to sea to breed".

While acknowledging that the potential effects on the eel population is significant, a methodology for assisting downstream passage of adult eels is not proposed in the application. It is noted that "at this stage, a subsurface bypass (reinforced by night lights to encourage diversion towards such a bypass) leading to a holding cage, appears to be the preferred method." Bonnett et al also note that turbine mortality could be limited by intake screens with a 30 mm bar spacing, and that intake screens need to have a low approach velocity to avoid eels becoming trapped. They propose to monitor eel migration timing and patterns in the Mokihinui River during autumn using DIDSON acoustic camera technology in combination with monitoring of environmental factors such as river flow, rainfall, water temperature and turbidity. That monitoring is proposed to be undertaken over two years from autumn 2009. The intention is that this data will enable the finalisation of design of an optimal downstream passage option for migrating longfin eels.

In my opinion there is not yet sufficient information on the likely performance of methods proposed by the applicant to assist upstream and downstream migrations of koaro and longfin eel, nor to reliably determine whether the potential effects on these populations will be minor or more than minor.

The Mokihinui River is a highly regarded and popular whitebaiting river. The whitebait catch is dominated by koaro which makes up 59 to 100% of the catch. Inanga makes up 0 to 38% of the catch, while the other 3 whitebait species (banded kokopu, giant kokopu and shortjawed kokopu) probably make a minor contribution.

Modifications to the flow regime in the lower river have the potential to interfere with whitebait runs during the whitebait season. Accordingly, it is understood that Meridian proposes to operate the MHP in a manner more closely aligned to 'run of river' during the 10 week period for September to mid-November. Flow in the lower river will not vary more than it would have done naturally during that period. As a consequence it is likely that neither the flow regime, sediment transport nor water quality effects from the MHP will affect the whitebait fishery.

A more pressing issue for the whitebait fishery revolves around the extent to which the dam and reservoir may hinder upstream passage of juvenile koaro towards their preferred adult habitat in small swiftly flowing forest streams, and the extent to which the reservoir and dam may hinder the downstream passage of newly hatched larval koaro to the sea. An associated question is whether or not a landlocked population of koaro will establish in the reservoir. The following combination of factors appears to be a realistic possibility:

- The methods employed to transfer koaro upstream past the dam are only partially successful and provide access for significantly fewer koaro than occurs at present;
- A landlocked population of koaro fails to become established in the reservoir;
- A large proportion of larval koaro moving downriver to the sea are trapped in the reservoir, or predated, resulting in a significantly reduced contribution from the Mokihinui River to regional whitebait stocks;
- A reduced regional whitebait population leads to significantly reduced whitebait runs into the Mokihinui River.

In my opinion the applicant has not provided sufficient information to adequately assess whether the effect of the MHP the Mokihinui River whitebait fishery will be minor or more than minor.

### 3.2.8 Mitigation for native fish

If consents are to be granted, the following mitigation measures are recommended for inclusion in the Construction Management Plan:

- Detailed plans of any culverts, bridges, fords or other in-stream structures required during the construction phase. For each such structure the applicant shall specify site specific measures proposed to mitigate potential adverse effects on fish passage. All culverts shall be designed and constructed in accordance with the guidelines provided by Boubee et al 1999.[3]

If consents are to be granted, the following mitigation measures are recommended for inclusion in the Aquatic Ecology Management Plan:

- Design and implementation of a catch and transfer system to provide upstream passage past the dam for native fish including juvenile eels and koaro.
- Monitoring of the catch and transfers of native fish to refine knowledge of fish migration patterns, and where appropriate, to refine the operation of the catch and transfer system for maximum effectiveness.

[3] Boubee, Jowett, Nichols and Williams, 1999: Fish Passage at Culverts – A review, with possible solutions for New Zealand indigenous species. Report prepared by NIWA and Department of Conservation.

- Design and implementation of systems to ensure safety of, and to provide downstream passage to sexually mature adult eels (including penstock intake screens with 30 mm bar spacing, from March to May)
- Intake screen design shall ensure a low approach velocity (< 0.5 m/s) to significantly reduce the risk of eels being entrained or trapped.
- Monitoring of native fish populations for at least three years before dam construction and seven years after, in the upper catchment, the reservoir and the lower river below the dam.
- Investigation and implementation of a programme for enhancing inanga spawning habitat either in the lower Mokihinui River and/or its tributaries, or in other catchments in the region.
- Procedures for reporting monitoring information and effectiveness to the Consent Authority.

### 3.2.9 Effects on trout

The potential effects of the MHP on the brown trout population and sports fishery have been assessed by Hayes *et al* (2007) for Meridian. The applicant acknowledges that the Mokihinui catchment supports one of the best headwater trout fisheries in the upper South Island. Juvenile brown trout are widespread in the catchment but not very abundant. Adult trout are moderately abundant in the North and South Branches and in the lower main stem of the Mokihinui River.

The investigation undertaken by Hayes et al provides evidence that a relatively small proportion of fish move to the estuary and that adult fish in both the lower reaches and headwaters do not generally use the estuary as an essential component of their life history. However, dispersal and migration within the freshwater reaches of the catchment appears to be a common feature of the life history of the trout. Downstream populations are clearly linked to upstream river reaches through the supply of juveniles, and some adult fish migrate between the upstream and downstream reaches of the river.

The MHP will disrupt trout passage and increase mortality of downstream migrants. Hayes et al conclude however that they do not expect the dam to have a major effect on the trout population because most trout live above the proposed dam site and these fish well continue to return to the headwaters to spawn and seed the wider catchment including the lower river below the dam.

A key issue is the need to maintain downstream passage so as to sustain the lower river trout population. Hayes *et al* consider this is likely be the case with the MHP as trout are expected to be able to pass downstream (over the spillway) and small trout at least will be able to pass through the turbines with low mortality. The available evidence indicates that a slight reduction in trout abundance may occur in the lower river due to mortality of fish passing through the turbines and over the spillway, but that Hayes *et al* consider the effect on the lower river population will probably be undetectable. Large trout ($\geq$ 30 cm), which will be in the minority, will experience high mortality, in the order of 50-60%.

The authors acknowledge that the effects of the dam on the headwater fishery are harder to predict. The dam will disrupt the return of downstream migrants that may have grown large in the lower river or estuary. The question is whether or not this will lead to a reduction in the numbers of large fish upstream of the dam. Evidence of relatively limited movement by trout and good conditions for trout growth in the South Branch suggests that this risk is low for the South Branch, but is low to moderate for the North Branch. It is noted however that potential loss of adults and recruitment may be offset by potential benefits of impoundment to the trout population.

On the basis of information provided by the applicant I conclude that the MHP could potentially have significant adverse effects on trout populations and the trout fishery, but that these effects can be adequately mitigated by monitoring and the mitigation measures proposed (see below).

### 3.2.9 Mitigation for trout

If consents are to be granted, the following mitigation measures are recommended for inclusion in the Aquatic Ecology Management Plan:

- Monitoring of the trout population for at least three years before dam construction and seven years after.
- Permanent screening (30 mm-bar screens) of penstock intakes to avoid turbine mortality of trout $\geq$ 30 cm;
- In the event the trout population declines by more than 30%, over at least five years, the following methods be researched, consulted on with interested parties and, if appropriate, implemented:
    - Trap and transfer of upstream migrant adult over the dam;
    - Construction of a hatchery and stocking.

## 4.0 Conclusion

The construction and operation of the MHP has the potential to have significant adverse effects on river water quality, benthic ecology, and populations of native fish and trout. In most respects these effects can be adequately mitigated by a combination of monitoring and mitigation actions as recommended in this report.

However, in a number of cases, in my opinion, there is not yet sufficient information to determine whether the potential effects are likely to be minor or more than minor. The potential effects of the MHP on populations of koaro (the principal whitebait species in the Mokihinui River) and the threatened longfin eel, remain uncertain. In both cases there is little doubt that passage upstream and downstream past the dam will be able to be provided for a proportion of migrating fish and that the populations will be able to be sustained at some level. However there is a reasonable prospect that they will be sustained only at a significantly lower level than they are at present. In the case of koaro that may result in a reduced contribution to regional whitebait stocks, possibility leading to reduced whitebait runs into the Mokihinui River.