

**MOKIHINUI HYDRO PROPOSAL  
CONSENT APPLICATIONS  
REVIEW OF ASSESSMENT OF EFFECTS OF SEDIMENT  
TRANSPORT**

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## Table of Contents

1.0	Introduction .....	3
1.1	Background.....	3
1.2	Qualifications .....	3
1.3	Scope of Report.....	3
2.0	Submissions.....	4
3.0	Assessment of Effects.....	4
3.1	Introduction .....	4
3.2	Review of Assessment of Effects.....	5
3.2.1	Effect on Reservoir Sedimentation .....	6
3.2.2	Mitigation.....	6
3.2.3	Effect on the Riverbed Downstream of the Dam .....	7
3.2.4	Mitigation.....	8
3.2.5	Effect on Gravel Extraction.....	8
3.2.6	Mitigation.....	8
4.0	Conclusion .....	8
5.0	References.....	9

## **1.0 Introduction**

### **1.1 Background**

This report provides a review of the assessment of environmental effects (AEE) provided by Meridian Energy Ltd (Meridian) in support of resource consent applications as outlined in Appendix A of the Statutory Assessment Report. 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 will provide the decision-maker with information and advice related to the effects of the proposed activities on sediment transport.

### **1.2 Qualifications**

My name is Julia Samantha Beck. I have been employed by MWH NZ Ltd (MWH) as a water resources engineer since 2005. I hold a Bachelor of Engineering in Civil Engineering (1998), Master of Science in Engineering (2001) and Doctor of Philosophy in Engineering (2005), all obtained from University of Stellenbosch, South Africa. I have eight years professional experience as a water resources engineer in both New Zealand and South Africa. I specialise in sediment transport, with a focus on river and estuarine sedimentation issues.

### **1.3 Scope of Report**

This report is prepared under the provisions of Section 42A of the Resource Management Act 1991 (RMA).

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:

- Mokihinui River Proposed Hydropower Scheme: Sediment Report (Hicks, Rouse, Tunnicliffe and Walsh, 2007)
- Mokihinui River Proposed Hydropower Scheme: Shoreline Change around the Mokihinui River Mouth Report (Hicks, Dickson and Gorman, 2007)
- Mokihinui River Proposed Hydropower Scheme: Mokihinui Tidal Hydraulics: Implications of Mokihinui Hydro Project (Goring, 2007)

I have also taken into account issues raised by submitters in relation to the effects on sediment transport in the river and estuary.

In addition I carried out a site visit on the Wednesday 5<sup>th</sup> March 2008, including the proposed dam site, the river mouth and selected areas along the river in between the proposed dam site and river mouth.

In order to clarify some issues arising from the technical reports listed above, I had a discussion with Dr Murray Hicks of NIWA, member of the applicant's technical team, on Wednesday 19<sup>th</sup> March 2008. The issues discussed were the general lack of sediment related data and the effects of this on the findings of the technical reports. We also discussed the stability of the armour layer that is predicted to protect the river below the proposed dam site from major erosion, the potential for sediment bypassing the reservoir and the potential changes to the estuary due to changes in sediment transport dynamics.

## **2.0 Submissions**

The following issues were raised by submitters in relation to the effects on sediment transport in particular:

- The effect of reduced sediment loads on the sediment dynamics of the Mokihinui River, the river mouth and the coastline
- The effect of increased coastal and river erosion on the community
- The effect of landslides in the catchment on reservoir sedimentation and dam stability
- The effect of sediment accumulation in the reservoir on upstream water levels
- Potential changes in the character of the estuary due to erosion along the coastline and interrupted river sediment supply
- Potential for scour at the State Highway and Bridge
- Effects of reduced sediment supply on gravel extraction
- Stability of the armour layer in the river
- Changes in sediment grading/size on spawning areas and habitat
- General lack of information and data on catchment and coastal sediment supply
- Lack of mitigation and protection measures

## **3.0 Assessment of Effects**

### **3.1 Introduction**

The combination of the altered flow regime associated with hydro power generation and the disrupted sediment supply due to the sediment trapping capacity of the reservoir will potentially affect the sediment transport dynamics of the reservoir, the downstream river channel, the river mouth and the adjacent coast. Three technical reports were commissioned by Meridian to assess the potential effects of the MHP on the sediment transport, river mouth behaviour and coastal sediment supply (Hicks et al., 2007a, 2007b; Goring, 2007).

The first of these reports prepared by NIWA (Hicks et al., 2007b) covers the assessment of the potential effects of the MHP on the sediment transport dynamics of the Mokihinui River system and adjacent coast. This report includes information on the existing sediment transport dynamics of the catchment, river and coast. It also covers techniques and results from the sediment sampling that was carried out and the setup and results of numerical modelling to analyse the river sediment transport dynamics, including the significance of disrupted sediment supply on the river and coast.

The second of these reports prepared by NIWA (Hicks et al., 2007a) covers the assessment of the potential effects of the MHP on shoreline changes. This report includes tracking historical shoreline changes and erosion rates, as well as numerical modelling to assess the potential effects on the shoreline and erosion rates. Both reports address some mitigation and monitoring measures.

Additional information and clarifications on some of the issues addressed in these reports were sought from and replied to by the applicant (refer to Section 92 Request for further information). The same issues were raised in my discussion with Dr Murray Hicks of NIWA as described in Section 1.3 above.

The third report prepared by Mulgor Consulting Ltd (Goring, 2007) addresses the potential effect on tidal hydraulics. Changes in tidal hydraulics can potentially alter the sediment transport dynamics in the estuary and vice versa. The discussion on the potential impacts of changing sediment transport dynamics on tidal hydraulics is, however, limited.

One issue that has been raised by most parties concerned is the lack of measured sediment transport data. This makes it difficult to thoroughly assess potential effects on the sediment transport dynamics, as this data is needed to accurately describe the current sediment transport state. In my opinion, however, a great deal of effort has been made to make up for the lack of measured sediment transport data, in considering alternative sources of information and techniques, which I consider adequate in assessing the sediment transport dynamics, as further discussed below.

### **3.2 Review of Assessment of Effects**

I have reviewed the assessment of effects on sediment transport, and have taken into account the mitigation proposed by the applicant. This is discussed below, with a focus on the key issues:

- Quality and quantity of sediment transport related data,
- Assumptions,
- Modelling outputs, and
- Effects not considered in detail by the applicant.

### 3.2.1 Effect on Reservoir Sedimentation

Reservoir sedimentation will always occur as a consequence of damming a river, especially when sediment loads are high. The Mokihinui River catchment does have a reasonably high sediment yield. The incoming bedload will most likely be trapped completely within the reservoir until such time as the reservoir has completely filled with sediment and will be operated as run-of-river. Some fraction of the suspended sediment load can still bypass the reservoir during larger flood events. Large flood events can often transport significant quantities of sediment, so there is the possibility that some suspended sediment may still reach the downstream river system.

The potential effects of the MHP on reservoir sedimentation were assessed through numerical modelling. The models that were used are relatively basic, but considering the uncertainty in input parameters, I consider this appropriate as complex models will only be of benefit if the appropriate input data is available. An effort has been made to increase the level of confidence in the conclusions to be drawn. This included looking at various sources of data and information on sediment sources and loads, such as field investigations, sediment sampling, survey data and independent calculations. A sensitivity analysis was carried out for the main model, and this was then verified by a second model. I consider these approaches reasonable.

The effects of the disrupted sediment supply could potentially impact on other areas not discussed here, such as river mouth behaviour, tidal hydraulics and coastal processes. These are covered primarily by Dr Single's review report.

### 3.2.2 Mitigation

The applicant has not addressed any mitigation measures related to reservoir sedimentation in detail. One option that is briefly discussed is the partial drawdown of the reservoir during floods or landslide events, which would enable suspended sediment to bypass the reservoir. I have asked for a more detailed description and comment on the potential for sediment bypassing the reservoir from the applicant (refer to Section 92 Request for Further Information). The reason given for not investigating this mitigation option in more detail was that it could potentially have adverse effects on the downstream river environment. While I do not dispute that there may be adverse effects, these should be considered together with the potential benefits and practical applications of this mitigation option and should at the very least be discussed in greater detail, before any final decision can be made regarding the feasibility of such mitigation.

I consider this an option which needs to be investigated in view of the potentially significant contributing effects to the existing coastal erosion that the disrupted sediment supply will have. The potential effects on the downstream environment will, however, have to be monitored if this is to be implemented. Suitable coastal monitoring is recommended in Dr Single's review report.

The applicant has proposed a monitoring programme that should be implemented to assess the reservoir sedimentation which would include:

- Regular surveys of the reservoir bed level combined with regular sediment sampling in the reservoir (every 5 years) to determine sedimentation rates

- Regular long-term sediment sampling in the river (especially during flood events) to determine sedimentation rates and sediment size gradings, including the Rough and Tumble Creek and Maori Creek arms.
- Sediment sampling in the downstream river channel up to and including the river mouth during partial reservoir drawdown to determine sedimentation rates and suspended sediment concentrations.

### **3.2.3 Effect on the Riverbed Downstream of the Dam**

The potential effects of the MHP on the riverbed downstream of the dam were assessed through numerical modelling. NIWA's GRATE model was used to predict changes in the mean bed level and bed surface texture downstream of the dam. From my discussion with Dr Murray Hicks it is my understanding that this model is being updated according to recent developments and has been compared to more established models such as MIKE 11 (DHI software). It is my opinion that the model is a reasonable tool to use. The model was also validated against measured data.

There would be a significant decrease in the bedload supply to the downstream river reach, as most of this material would be trapped within the reservoir and the downstream catchments contribute little to the overall bedload budget. The suspended sediment load would also be reduced, but not quite as significantly as some suspended sediment would still bypass the reservoir. It is thus a reasonable prediction that with the hydro dam in place the finer bed material would gradually be flushed from the riverbed downstream of the dam and the bed material would become coarser. The daily flow fluctuations may facilitate this progress, while on the other hand the dampening of freshes and small floods may reduce bed load transport. I tend to agree with Hicks et al. (2007b), that the effect of this would be minimal as most sediment transport occurs during larger flood events and that the effects of the sediment trapped in the reservoir would be much more significant.

With the finer sediment flushed from the riverbed, Hicks et al (2007b) predict that an armour layer would develop on the surface which would prevent significant erosion in the downstream river channel. While I agree that this armour layer would probably develop, it is my opinion that the armour layer may not be stable due to the reduction in finer sediment fractions. An armour layer, while protecting the underlying finer sediment, needs a range of smaller sediment particles to wedge between the larger cobbles and boulders to create a stable matrix. However, from my discussion with Dr Murray Hicks it is my understanding that there are a number of bedrock controls, such as erosion-resistant bedrock and large boulders which would not break down rapidly, in the river channel which would prevent extensive erosion of the downstream riverbed if the armour layer should fail.

Not all areas of the downstream river channel would, however, be protected by bed rock controls and in some areas significant erosion may occur, i.e. along sandy beaches, before an armour layer may develop. It is my opinion therefore, that although erosion in the downstream riverbed would probably not affect the whole river reach, and there would most probably be areas where significant erosion may occur.

The effects of the changes to the river morphology could potentially impact on other areas not discussed here, such as aquatic ecology, recreation and river access. These are covered by the appropriate technical experts in their relevant review reports.

### **3.2.4 Mitigation**

The following mitigation measures have been proposed by the applicant:

- Protection of river banks on an as-needed basis.

The following monitoring requirements have been proposed by the applicant:

- Bed level and substrate size grading along the lower river channel.

I consider that in addition to the above mentioned mitigation and monitoring, river bank and river bed erosion needs to be monitored in the lower river channel as well. Concerns have been raised about potential erosion along SH67, at the State highway bridge and properties along the lower river, as well as the loss of access to the beach from Mokihinui to Old Man Rock and the impact on whitebaiters.

### **3.2.5 Effect on Gravel Extraction**

The disrupted sediment supply due to the MHP will mean that any gravel taken out of the river bed downstream of the dam will not be replenished as the sediment supply from the downstream contributing catchment is minor. This means that if gravel is taken, this will affect the stability of the river bed, potentially causing significant erosion in places. Removal of gravel from the river bed also means any sediment still coming down the river would be more likely to accumulate in the areas where sediment extraction is taking place, which in turn means less sediment is likely to reach the coastline.

In addition to this, Hicks et al (2007b) indicate that the daily flow fluctuations due to hydro generation will probably make river gravel extraction difficult.

### **3.2.6 Mitigation**

It is proposed that a halt be called to any gravel extraction in the lower Mokihinui River. Alternative gravel sources would have to be located to meet aggregate needs, depending on existing gravel extraction consents, and considering potential future users. If consent is granted, consent-holders would need to be compensated for any additional cost incurred in securing these alternative gravel sources if such costs arise. However, the existing gravel extraction consents will either have expired or are likely to expire prior to the Mokihinui Dam being commissioned.

## **4.0 Conclusion**

Potential effects of the MHP relating to sediment transport dynamics include reservoir sedimentation, riverbed armouring and potential riverbed degradation, estuary deepening and bank erosion in the tidal reach, as well as coastal erosion. While the lower river channel may not be as severely affected as the estuary and coast, effects will start to become evident shortly after the dam is built.

In this case the general lack of recorded sediment-related data such as long-term suspended sediment sampling, coupled with the inherently complex dynamics of sediment transport patterns, is reflected in the uncertainty ranges of the results and conclusions. This is why I consider it vital that sampling, surveying and monitoring are included as conditions.

I also consider that the potential for sediment bypassing the reservoir is an issue which has not been assessed in enough detail. If any conclusions have been drawn as to the feasibility of these options, those should be documented together with the processes by which these conclusions were drawn.

Due in part to the uncertainty in sediment related information and data, detailed mitigation measures could not be provided by the applicant. Instead monitoring and data collection are proposed, which I consider a practical and very important process. The adaptive management plans proposed by the applicant however need to adequately address all relevant issues with appropriate conditions.

## **5.0 References**

Goring (2007). Mokihinui River Proposed Hydropower Scheme: Mokihinui Tidal Hydraulics: Implications of Mokihinui Hydro Project. Report prepared for Anderson Lloyd on behalf of Meridian Energy Ltd, August 2007.

Hicks, Dickson and Gorman (2007a). Mokihinui River Proposed Hydropower Scheme: Shoreline Change around the Mokihinui River Mouth Report. Report prepared for Anderson Lloyd Lawyers Ltd on behalf of Meridian Energy Ltd, November 2007.

Hicks, Rouse, Tunnicliffe and Walsh (2007b). Mokihinui River Proposed Hydropower Scheme: Sediment Report. Report prepared for Anderson Lloyd Lawyers Ltd on behalf of Meridian Energy Ltd, November 2007.