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IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of an application by **TRUSTPOWER LTD** to the **BAY OF PLENTY REGIONAL COUNCIL** for water permits associated with the operation of the Matahina Hydroelectric Power Scheme

BAY OF PLENTY REGIONAL COUNCIL
ENVIRONMENTAL HAZARDS GROUP
LEGAL SUBMISSIONS AND EVIDENCE

IN THE MATTER	of the Resource Management Act 1991
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Bay of Plenty Regional Council Environmental Hazards Group Legal Submissions and Evidence

65750 - 65753
A76246

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of an application by **TRUSTPOWER LTD** to the **BAY OF PLENTY REGIONAL COUNCIL** for water permits associated with the operation of the Matahina Hydroelectric Power Scheme

OUTLINE OF SUBMISSIONS OF COUNSEL FOR THE ENVIRONMENTAL HAZARDS GROUP OF THE BAY OF PLENTY REGIONAL COUNCIL

1. INTRODUCTION

1.1 These submissions are presented in support of a submission lodged by the Environmental Hazards Group ("EHG") of the Bay of Plenty Regional Council ("BOPRC") in opposition to the TrustPower application to reconsent the Matahina Dam, including amendments the flow regime.

1.2 The EHG is the part of the Regional Council which has responsibility for maintaining the Rangitaiki-Tarawera Rivers Scheme ("river scheme") under the Soil Conservation and Rivers Control Act 1941. The EHG's functions and responsibilities will be addressed in the evidence of Dr Tarboton.

1.3 EHG's concern relates to the impact which the flow regime proposed by TrustPower will have on the river scheme, assessed by reference to the damage the existing flow regime already causes.

Synopsis of EHG position

1.4 EHG acknowledges that the dam is a "physical resource" which forms part of the existing environment which needs to be sustainably managed in terms of section 5 of the RMA. That is why the Regional Plan provides for the consent renewal as a controlled activity. But the river is a natural resource and the river scheme a physical resource which similarly needs to be sustainably managed and, in that regard, EHG's evidence makes clear that the operation

of the dam in terms of TrustPower's flow regime is causing erosion related damage that would not arise if a more natural flow, i.e., "run of river" flow regime applied, including the impact that the flow regime has in terms of increasing the vulnerability of the river system to damage.

1.5 The obvious way to address the additional damage which TrustPower causes over and above that which would naturally occur is for compensation to be paid on an annual basis. Indeed, as noted by counsel, an agreement already exists between TrustPower (as successor to Electricorp) and BOPRC which provides for an annual compensation payment (albeit one which is manifestly inadequate). EHG and TrustPower have been in "without prejudice" discussions with a view striking an appropriate contribution but unfortunately agreement has not been reached.

1.6 EHG acknowledges that the matters of control in Rule 47C of the Regional Plan may not provide scope for the Committee to impose a condition requiring a financial contribution. In that regard, it is interesting to note that Judge Jackson faced a similar issue in *Alexandra District Flood Action Society Inc v Otago Regional Council*[1] where His Honour said:[2]

> *"There is some doubt whether we have the power to impose a compensation provision on Contact although our analysis of the meaning of "remedying" in section 5(2) of the Act suggests those doubts are misplaced. In any event we can create an incentive for Contact to volunteer one..."*

1.7 We do not take that matter any further and the EHG case proceeds on the assumption that financial contributions cannot be required on the basis that Rule 47C is not one of the rules specifically recognised in the Table 46 of the Land and Water Plan as "regional rules where financial contributions may be applicable".

1.8 To its credit, TrustPower has proffered a condition under the principle in *Augier* which would require an annual payment of approximately $50,000. The EHG welcomes that offer – clearly this will go further than the $15,000 that TrustPower currently pays.[3] But the Group's position is that this sum does not adequately compensate the EHG for the effects of the current operating regime let alone the proposed TrustPower flow regime.[4] For reasons which will be expanded on presently, it is submitted that effects can

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1 Environment Court (C 102/05).
2 Para [207].
3 See Evidence of Mr Crabbe in relation to increasing rates as compared with TrustPower contribution.
4 Evidence of Mr Williams.

be considered by reference to a regime which assumes the existence of the dam but does not equate to the current consent – as long as the Committee factors in the existence of the dam, this could include a natural "run of river" regime, which would not create any adverse effects at all – in which case compensation would not be necessary.

1.9 In light of that, a related question is the nature of the conditions, if any, that the Committee can impose to ensure that Trustpower's effects could be avoided, remedied or mitigated. EHG's submission is that it is not appropriate to impose obligations on Trustpower to undertake physical engineering works in the river system in order to address its effects; that is a task which the EHG is already carrying out but at a very significant cost to the ratepayers served by, and who are paying for, the scheme.

1.10 Thus, given:

(a) That it is not appropriate for Trustpower to carry downstream engineering works to address the damage it causes;

(b) The lack of agreement between Trustpower and EHG and the inadequacy of the condition which has been proffered; and

(c) The inability of the Hearing Committee to impose conditions requiring an appropriate contribution –

EHG's position is that in light of the adverse effects which have already been created and are anticipated, the Committee should impose conditions that limit the TrustPower flows to a regime which would avoid further damage resulting from the operation of the Matahina Dam or that conditions should be imposed which restrict the flow regime so that the level of damage caused by Trustpower would more closely approximate the contribution it is prepared to make e.g., approximating the 1989 regime prior to it being varied in 2003 to allow for twin peaking. In that regard, EHG's submission is that the contribution proffered by TrustPower is inadequate to address the effects which the current operating regime has on the river and flood protection works and that a flow regime with single peaking and limited amplitude would come closest to being compensated by this sum.[5]

1.11 EHG acknowledges that TrustPower's contribution to erosion and stopbank instability on the Rangitaiki River is difficult to quantify. However, it is

[5] See evidence of Mr Williams and Mr Burchett.

submitted that TrustPower should not derive the benefit of the doubt in that regard and that it is appropriate for the Committee to adopt an approach which resolves this doubt in favour of the public not-for-profit agency carrying out statutory responsibilities at ratepayers' expense. (Indeed, the EHG's resources are significantly impacted in simply mounting this case to protect the interests of its ratepayers.)

1.12 In that regard, it is also submitted that conditions requiring monitoring, reporting and independent analysis should be imposed will, over time, enable this uncertainty to be reduced and provide greater clarity as to the mechanisms causing damage and the impact of TrustPower's operations. It is acknowledged that the conditions proposed by TrustPower require monitoring and reporting but it is submitted that they are of limited effectiveness insofar as they ultimately only lead to the ability to review the conditions of the consent. To that extent, they fall well short of being an effective adaptive management regime, particularly having regard to the limited scope of the conditions that can usefully be reviewed.

1.13 The effectiveness of such conditions is also limited by the fact that EHG undertakes ongoing repairs – so that the effects of the TrustPower operation can be masked in terms of the monitoring and reporting regime proposed.[6] The monitoring regime will need to recognise EHG responses to the monitoring results on an ongoing basis and, in that regard, a key concern is that the effects observed by the EHG are not reflected in the monitoring and reporting currently undertaken.[7]

1.14 In EHG's submission the new consent needs to be more adaptable to the way it can responds to new information rather than effectively re-running these issues via condition reviews – an exercise which represents a much greater barrier to the EHG than it does the consent holder whose profits will be increased substantially by implementation of the multiple peaking low flow regime for which consent is sought.

1.15 It is submitted that it would be more appropriate if the outcomes of the monitoring were reviewed by independent experts in the form of a Peer Review Panel (as is common for geothermal consents) so that BOPRC gains an increasing body of knowledge in relation to the impacts of the TrustPower flow regime and the nature of adjustments to the flow regime that are necessary to reduce damage (or the level of appropriate contribution if the

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6 Evidence of Mr Crabbe.

rules of the regional plan ultimately enable financial contributions conditions to be imposed so that TrustPower can for the first time bear the full responsibility for the damage it causes).

1.16 The EHG's evidence will demonstrate that the altered flow regime sought by TrustPower increases the level of generation from the Matahina Dam in a very minor manner – the increase in generation as a result of the proposed flow regime is some 3GWh or only a 1% increase on current generation.[8] Mr Burchett's evidence is to the effect that the changes to the flow regime are simply a means of enabling TrustPower to better manage its generation assets and thus increase profits – which rather puts into perspective the significance of the Renewable Energy NPS in this context.

1.17 In other words, the amendments to the flow regime which will result in these adverse effects on BOPRC ratepayers and other submitters represent a benefit to TPL and its shareholders (in terms of increased profit) – to the extent that one of the externalities of the altered flow regime is greater damage to the river scheme, the Trustpower operation will effectively be subsidised by the ratepayers who would be forced to bear the costs of that damage.

1.18 A separate but closely related issue is the ability of the Matahina Dam to be used to regulate flood flows and reduce risk associated with flood events. The EHG seeks a number of specific amendments to address this issue, which is addressed in Mr Meadowcroft's evidence. Mr Dawson recommends conditions to address the matters raised by Mr Meadowcroft.

EHG's case - evidence to be presented

1.19 It follows from what has been said that the EHG's case is not directed towards establishing what an appropriate financial contribution would be. Having said that, evidence will be presented which gives some sense of scale in terms of the costs of the river scheme and the proportion of the damage which is attributable to Trustpower and what a more realistic contribution would be.

1.20 Rather, EHG's case is primarily directed towards:

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7 Evidence of Mr Crabbe.

8 Evidence of Mr Burchett.

(a) Demonstrating that the existing flow regime causes damage which is adversely affecting the river scheme and imposing costs on the ratepayers which EHG represents and protects; and

(b) Making suggestions as to the appropriate resource management response (in terms of conditions and terms) in light of jurisdictional constraints within which the Committee is operating.

1.21 The EHG will present evidence from the following witnesses in support of its case:

(a) **Ken Tarboton** – Dr Tarboton is the Group Manager of the EHG. His evidence provides a high level overview of the functions and responsibilities of the EHG, its mandate (per BOPRC's AMP and LTP processes) and funding. This evidence will provide important context for understanding the basis of EHG's concerns.

(b) **Colin Holmes** – Mr Holmes is a former mayor of Whakatane and a member of the Rangitaiki River Scheme Liaison Group. He will provide a perspective from the point of view of the people served by the river scheme and the importance of TrustPower meeting its obligations.

(c) **Bruce Crabbe** – Mr Crabbe is the EHG Rivers and Drainage Operations Manager with overall responsibility for the day-to-day operations of the various rivers and drainage schemes which are managed by that Group. His evidence will describe the Rangitaiki-Tarawera Rivers Scheme, with a particular focus on the operation of the scheme in the three reaches downstream of the Matahina Dam, and the type of works which are required on an ongoing basis in order to protect the interests of the ratepayers who rely on, and pay for, the scheme. Mr Crabbe's evidence will also address the costs and funding of the scheme and, in that context, will provide examples of the damage and costs incurred in recent flood events. His evidence will also comment on the effects of the TrustPower operation on the river scheme based on EHG staff observations.

(d) **Gary Williams** – Mr Williams is an independent consulting civil engineer with particular expertise in river hydrology and processes, and the mechanisms that cause erosion of river banks and failure of flood protection works, etc., and the management of rivers for that

purpose. In particular, Mr Williams is experienced in relation to the effects of hydro-operations and flow regimes on rivers. Mr Williams will address the effects of the existing TrustPower flow regime on the river scheme which differs markedly from the evidence given by Mr Levy for TrustPower. That evidence will demonstrate that in the absence of TrustPower volunteering to make a significantly greater contribution to the scheme that it is currently prepared to make, the flow regime should be altered to eliminate or significantly reduce the fluctuations caused by the peaking permitted by the existing resource consent.

(e) **Dr Marianne O'Halloran** – Dr O'Halloran is a geotechnical engineer with long experience in considering matters relating to the stability of earth structures, groundwater flow and slope stability. In that regard, she has undertaken a significant amount of work with respect to geotechnical issues facing the Rangitaiki River and its stopbanks following the 2004 flood event. Dr O'Halloran will provide expert opinion to the Committee on the causes of bank slumping and stopbank failure and, in that context, the additive effect of the existing and proposed TrustPower operations.

(f) **Roger Burchett** – Mr Burchett is a civil engineer with expertise in the electricity industry. Mr Burchett's evidence will address the significance of the proposed TrustPower flow regime in the context of the electricity industry, making clear that the altered flow regime sought produces little benefits by way of additional generation. Mr Burchett also developed a "live model" for the purposes of negotiations with TrustPower prior to the hearing which enables the impost created by the TrustPower flow regime to be assessed. The approach which Mr Burchett took in developing that model differs from that ultimately taken by Mr Levy and Mr Philpott, but Mr Philpott agrees that a "live model" is required to take account of changing costs of the River Scheme. Mr Burchett therefore provides his assessment of an appropriate contribution in terms of the approach taken by Mr Philpott.

(g) **Dr Brent Wheeler** – Dr Wheeler is a qualified planner and economist with a great deal of experience in the Resource Management field. His evidence will assess the significance of the proposed flow regime in terms of the benefits claimed by TrustPower and, in particular,

undertake a costs and benefits analysis of the proposed flow regime having regard to the likely increase in risk of stopbank failure faced by the community if consent is granted to that regime.

(h) **Colin Meadowcroft** – Mr Meadowcroft is a civil engineer who specialises in water and environmental engineering and has experience in hydraulic modelling. He is the lead Flood Manager for the BOPRC and is responsible for providing adequate river flood warnings to the community and liaising with TrustPower in respect of the operation of the dam during floods.

(i) **Chris Dawson** – Mr Dawson is a planning consultant and senior planner at Bloxam Burnett and Olliver. He will consider the TrustPower application in the context of the relevant provisions of the regional plan and, where relevant, the operative and proposed regional policy statement. Mr Dawson will also propose conditions which would address the concerns raised by the EHG, including amendments to the proposed monitoring and review conditions which would provide for the involvement of a peer review panel in reviewing the information which is generated from the monitoring regime.

BOPRC officer's report

1.22 The Committee has before it a comprehensive officer's report ("BOPRC report") which assesses the TrustPower application in light of the matters of control in Rule 47C, other relevant provisions of the regional plan and the Resource Management Act 1991 ("RMA"). The report concludes that TrustPower has not made sufficient information available to fully assess the effects of the activity. EHG submits that, in particular, the TrustPower AEE and the evidence of Mr Levy, Dr Toan and Mr Tate significantly understates the impact of the proposed TrustPower flow regime on the river scheme.

1.23 As far as TrustPower's adverse impacts on erosion of river banks and stability of the river scheme, the BOPRC report defers to an independent assessment which has been undertaken by John Philpott. This report indicates a clear preference for the analysis undertaken by the EHG's expert, Mr Williams, over the analysis reflected in the AEE. In particular, he agrees with the EHG position that a fixed contribution by Trustpower is an inadequate approach to addressing the effects of the proposal. The Committee will hear from Mr Philpott but it is submitted that it is appropriate

for the Committee to place significant weight on this independent assessment.

Scope of submissions

1.24 Against that background, the purpose of these submissions is to put the EHG evidence into perspective by addressing contextual and legal issues relevant to the Committee's assessment of the Trustpower application. Specifically, it is proposed to address:

(a) The Rangitaiki-Tarawera Rivers Scheme, EHG's functions and responsibilities and concerns in relation to the TrustPower application (Section 2).

(b) The central technical issue – the impact of the TrustPower operation on erosion of the river banks and instability of the river scheme (Section 3).

(c) Legal issues relevant to the Committee's determination of the TrustPower application, including the proper application of the "existing environment" concept (Section 4).

(d) Comment on the potential role of the Matahina Dam in terms of flood management and the type of regime that the EHG is seeking via conditions in that regard (Section 5).

(e) Set out the EHG's submission as to the appropriate regulatory response and the relief which EHG seeks by reference to the conditions which are recommended in Mr Dawson's evidence (Section 6).

2. THE RANGITAIKI RIVER SCHEME AND THE BASIS FOR THE EHG'S CONCERNS

2.1 As noted in the BOPRC report, the Rangitaiki River flows in a northerly direction from its headwaters near Taupo to the river mouth at Thornton, passing in close proximity to the towns of Te Teko and Edgecumbe. Due to the geological history of the area downstream of the Matahina Dam, much of the land in this area is low lying and is prone to flooding. This is explained in Mr Crabbe's evidence.

2.2 In order to address the risks associated with the flooding of the River, the BOPRC set up a Rivers and Drainage Group which is now called the

Environmental Hazards Group. The functions of the EHG are addressed in Dr Tarboton's evidence but essentially relate to the management of the region's rivers and drainage schemes which seek to protect the community from the risk of flooding. This involves significant planning and analysis to identify flood risk and determine options to minimise those effects, including design and development of flood mitigation measures.

2.3 In fulfilment of these functions, the EHG has established an elaborate system of flood control which includes stopbanks and other protective works.[9] EHG is also responsible for reducing the potential for and repairing damage to the river banks resulting from erosion. As the Committee will have seen on its site visit, where a stretch of the River is particularly prone to erosion, the EHG places "rip rap" armouring to reduce erosion and consequent loss of productive land or potential hazards to property.

2.4 The damage to the river banks and flood protection works which the EHG seeks to prevent or repair is caused by normal fluvial processes and hydro-operations in river system that is in a constant state of change. The EHG seeks to strike a reasonable balance between allowing these processes to continue and undertaking works where necessary to protect valuable farm land and property.

2.5 The costs associated with the river scheme are substantial - in the region of $2.0M per annum.[10] These costs are borne by the ratepayers who are served by the scheme on an area based rate. Thus for a typical residential property the annual rate will be in the order of $170. For a dairy farm measuring 135 hectares, the annual rate will be $7,150.[11] In that regard, the river scheme represents a physical resource which must be sustainably managed in terms of section 5 of the RMA and in which the local community has invested significantly.

2.6 The river scheme would be necessary irrespective of the Matahina Dam and the flows associated with it. However, the modifications to the natural flow regime brought about by TrustPower's operations at Matahina, in particular the increased frequency of "peaking" and constant fluctuations in water levels associated with dam operations are different from a natural flow regime and, as a result, significantly exacerbates the damage caused to the banks of the River and to the foundations of the existing flood protection structures. The

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9 Evidence of Mr Crabbe.
10 Evidence of Mr Crabbe.
11 Evidence of Dr Tarboton.

range of those fluctuations (i.e. the difference between the high and low flows) also contributes to erosion and bank stability issues. The mechanisms by which this damage occurs will be addressed in the evidence of Dr O'Halloran and Mr Williams.

2.7 The fact that the TrustPower operation has impacts on the river scheme beyond the natural flows is recognised by an agreement between TrustPower (as successor to Electricorp) and BOPRC by which a sum in the vicinity of $15,000 is currently paid by TrustPower to BOPRC each year to compensate for TrustPower's adverse effects on river edge protection and rock works. To be fair, the agreement itself does not acknowledge liability but the fact of the agreement itself is significant. For the record, the EHG's position is that that contribution, which was arrived at following a particularly quiescent period of flood activity, is manifestly inadequate and does not provide any indication as to the adequacy of the financial contribution condition being offered by TrustPower.

2.8 The short point is: TrustPower is here to optimise profit; EHG is here to seek to reduce losses it is already suffering as a result of the impact of the Matahina Dam on the Rangitaiki River.

2.9 TrustPower and EHG have been in "without prejudice" discussions with a view to striking an appropriate contribution but agreement has not been reached. EHG acknowledges that the matters of control in Rule 47C of the Regional Plan may not provide scope for the Committee to impose a condition requiring a financial contribution, although TrustPower has proffered a condition under the principle in *Augier* which would require an annual payment of $50,000. EHG's position is that this sum does not come close to compensating the river scheme for the effects which the TrustPower flow regime is having under the current operating conditions, let alone the effects of the proposed regime.

3. THE CENTRAL TECHNICAL ISSUE – CAUSES OF EROSION / BANK INSTABILITY AND TRUSTPOWER CONTRIBUTION TO DAMAGE

3.1 Central to the EHG submission is the difference of opinion between TrustPower and the EHG as to the significance of TrustPower's operations in terms of the Rangitaiki River and the flood protection scheme.

3.2 In that regard, TrustPower accepts that the current operation of the Matahina Dam has some effect on erosion of the river banks. In that regard, the crux of

the evidence presented on behalf of TrustPower is that the operation of the Matahina Dam has little effect on the river banks and flood protection scheme but for small amounts of erosion of the river banks. Their case is that the erosion is not exacerbated by the proposed change to the operation.[12]

3.3 The evidence for TrustPower concludes that the river banks and stop banks are marginally stable in the context of the normal operation of the Matahina Dam and further reduced in a flood event. In other words, TrustPower's position is that the collapse of river banks and stop banks occur as a result of floods and has little, if anything, to do with the operation of the hydro scheme.

3.4 The EHG fundamentally disagrees with this characterisation of the cause of damage to the river scheme. The EHG's evidence is that the operation of the hydro scheme creates the preconditions which, during a flood event, exacerbate the damage which results. Mr Williams' evidence is that the unnatural fluctuations caused by the operation of the dam:

(a) Damage existing vegetation and preclude its re-establishment;

(b) Preclude the deposition of soils which "seal" the river banks and would otherwise protect the river banks against unfavourable preconditions; and

(c) Destabilise rock works and other protective measures.

3.5 Mr Williams' evidence is that the analysis presented by TrustPower is simplistic, does not acknowledge the dynamic nature of river processes, overstates the contribution of flood events in exposing raw banks and causing river and stop bank failure and understates the contribution of the dam operation to the preconditions for those events.

3.6 Dr O'Halloran's evidence is that the TrustPower analysis over simplifies the nature of the receiving environment and presents monitoring results which are not representative of the full length of the river. That analysis makes simple assumptions which, while they might ordinarily be acceptable "rule of thumb" assumptions to make, do not acknowledge the presence of silt cover, the natural variability of the soils of the Rangitaiki River or the three dimensional nature of the forces at work. In that regard, a fundamental aspect of EHG's case is that the Rangitaiki River is particularly complex and fragile

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[12] Levy evidence, paragraph 160.

and, to that extent, unusually vulnerable to the risks associated with the operation of the Matahina Dam.

3.7 In that regard, the Committee should have particular regard to the evidence of Dr O'Halloran who has undertaken significant investigations of the river banks and stop banks along the lower two reaches affected by the scheme over several years. Dr O'Halloran was engaged by the BOPRC after the 2004 floods to undertake a geotechnical analysis and recommend a programme of strengthening works. Based on technical analysis which represents the geological formation of the river and plains and the natural variability of the soils, Dr O'Halloran concludes that:[13]

(a) The soils on the river are particularly susceptible to erosion;

(b) Regular fluctuations cause ongoing erosion of river banks which, if not protected, could lead to the collapse of stopbanks;

(c) The over-steepening of river banks due to erosion has resulted in marginal stability at some sites which could be further affected as a result of reductions in water levels;

(d) The fragility of the flood mitigation scheme is such that further reduction in the security of the system, by even a small or unquantifiable amount, should be prevented; and

(e) In light of the above, her recommendation is that the dam should be operated as a run of river operation in order to enable the river banks to stabilise as far as practicable.

3.8 It is therefore submitted that the evidence of the EHG witnesses should be preferred over TrustPower's evidence because not only is it based on extensive experience of the river and the geotechnical issues which arise there, it recognises the dynamic nature of river processes and interprets the data in that context – which the EHG considers to be fundamental to understanding this river and Mr Williams will elaborate on that further in his evidence.

3.9 As noted at the outset, the EHG's position is that TrustPower should adequately compensate the EHG for the works which are required to be undertaken to address the additional effects created by the Trustpower scheme. In that regard, the EGH acknowledges that we are not dealing with

an exact science here and it is not possible to strictly quantify the additional effects created by the Trustpower regime. Nevertheless, Mr Williams' evidence offers an opinion in that regard and his findings can be compared to those of Mr Levy to calculate an appropriate level of compensation.

3.10 As noted, it is accepted that this Committee may not have jurisdiction to impose a condition requiring TrustPower to make a financial contribution to the EGH. Nevertheless, the order of magnitude of the costs which TrustPower's operations give rise to are worth considering in assessing the adequacy of the condition which TrustPower has volunteered.

3.11 Mr Burchett will give evidence as to the appropriate level of the contribution which Trustpower should be making if it wished to fairly compensate the EHG and not have its operations subsidised by local ratepayers.

3.12 A key aspect of EHG's evidence is that a "fixed" contribution, even tied to an index such as PPI, is inappropriate because the costs associated with the river scheme will change over time, both up and down (e.g., due to climate change and catchment changes), and a significant aspect of those costs relates to future maintenance and repairs which are required as a result of major flood events and are therefore unknown. Given the fundamentally different positions which Trustpower and EHG take with respect to the effects of the flow regime on the river scheme, it is EHG's submission that a condition requiring a contribution to future capital works (if Trustpower were to offer one) would only be appropriate if the basis for that contribution was made clear on the face of the consent. In other words, the EHG does not wish to be in a position where it is forced to negotiate an appropriate contribution in the future.

3.13 Assuming adequate compensation is not going to be volunteered, that raises the issue of how the Trustpower operation should be assessed and what measures are available to avoid, remedy or mitigate the adverse effects on the Rangitaiki River and river scheme. I turn to that issue now.

4. ISSUES RELEVANT TO THE COMMITTEE'S ASSESSMENT

4.1 Some issues arise in relation to the scope of Committee's jurisdiction and appropriate basis for assessment of effects. As the Committee will be aware, this matter has already been the subject of a decision by the Environment

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[13] Dr O'Halloran evidence, paragraph 10.8.

Court on a declaration application by BOPRC relating to the Trustpower applications[14] ("Declaration Decision").

Scope of the Committee's jurisdiction

4.2 This point can be dealt with briefly by reiterating that the EHG accepts that the matters of control contained in Rule 47C may not extend to the imposition of conditions requiring a financial contribution.

4.3 The EHG also accepts that it is open to the applicant to volunteer a condition under the principle in *Augier* and that, if imposed, the applicant would be precluded from raising any issues of lawfulness in complying with the condition. If the Committee accepts EHG's contention that the offer made is inadequate, it nevertheless lacks jurisdiction to impose a greater financial contribution than that offered.

4.4 Having said that, if the Committee was of the view that a greater contribution or different basis for contribution is appropriate, the EHG requests the Committee's guidance in that regard. The case of *Alexandra District Flood Action Society Inc v Otago Regional Council*[15] provides a good example of a case in which the Court created an incentive to an applicant for the renewal of dam consents to put an effective voluntary compensation regime in place where the ability to impose financial contributions was questionable – effectively, volunteer a regime for repair of property damage and you can have a 35 year consent; do not, and a 15 year consent will be granted[16]. Given that TrustPower have seen it appropriate to volunteer a condition, it is similarly appropriate that the Committee consider the effectiveness of that and, if necessary, create incentives for an appropriate compensation regime to be put in place.

Defining the "existing environment" for the purpose of assessing effects

4.5 In assessing the effects of the proposed TrustPower flow regime, it is appropriate for the Committee to consider the "existing environment" against which effects are to be assessed. In that regard, counsel for the Applicant has submitted that that the existing environment comprises the "operations

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14 *Bay of Plenty Regional Council v. Fonterra Co-Operative Dairy Limited* [2011] NZEnvC 73.

15 Environment Court (C 102/05).

16 See para [185] and [207] et seq.

legally permitted by the consent."[17] In doing so, TrustPower is effectively seeking a "discount" in terms of the Committee's assessment so that only adverse effects over and above those already being caused can be considered. Reference is also made to the Declaration Decision as being relevant to defining the existing environment.

4.6 The BOPRC report also says that the "existing environment" against which effects should be considered include the activities provided for under the existing resource consent.

4.7 It is submitted that these remarks need to be kept properly in perspective so that the concept is not skewed in favour of the Applicant in a manner which is not consistent with the relevant legal authorities. In particular, counsel for the Applicant has conflated the effects of an activity permitted by an existing consent which is being renewed, which is part of the existing environment, with the activities authorised by the existing consent itself, which is not, or only to a limited extent.

4.8 Counsel is aware that Commissioners van Voorthuysen and Bickers recently considered this issue in the context of applications by the EHG relating to the control of levels of and discharges from Lakes Rotorua and Rotoiti and that, in that regard, the Commissioners' decision from that case contains a useful review of the case law relevant to that issue. Consistent with that decision, it is submitted that the decision of the High Court in *Rodney District Council v Eyers Echo-Park Limited*[18] a useful recent enunciation of how to approach the "existing environment". The Court stated:

> *"[37] When considering the overall adverse effect of a proposed activity it is necessary first to consider the character of the receiving environment, as required under section 104(1)(a). The receiving environment of necessity includes activities conducted there pursuant to an existing use right as such activities may be carried on as of right. The adverse effects of a proposed activity, at this point of the analysis, will be those effects that are not already impacting upon the receiving environment. If, after this assessment, any additional adverse effects of the proposal remain for consideration, the permitted baseline will become relevant under section 104(2). The relevant authority at this point has a discretion to disregard any of the remaining adverse effects of the proposed activity on the environment if the plan permits an activity with that effect. If such adverse effects are excluded from consideration, the remaining effects of the proposed activity on the receiving environment must be assessed and may of course ultimately determine whether a resource consent is granted."*

17 Paragraph 40.
18 [2007] NZRMA 1

4.9 The identification of the relevant "environment" for the purposes of assessing effects under section 104 is ultimately a factual exercise based on the evidence available – "each case turns on its own facts and there is no invariable principle as to how to describe the environment".[19] However, there is a helpful line of authority which has clarified the application of the concept, starting with the important case of *Contact Energy Limited v Waikato Regional Council*[20] which was accepted as still providing useful guidance by Judge Whiting in *Rotokawa Joint Venture v. Waikato Regional Council*[21], in which the Court stated:[22]

> "[38] *We hold that consideration is to be given to the effects on the environment as it actually exists now, including the effects of past abstraction of geothermal fluid from the system, whether by [the applicant] or anyone else. In considering the effects in the future of allowing the proposed abstraction, we hold that we have to consider the environment as it is likely to be from time to time, taking into account further effects of past abstraction, and effects of further abstraction authorised by existing consents held by [the applicant] or by others ...*
>
> [40] *We accept that in practice there may be difficulty in distinguishing future effects on an environment that are caused by abstractions which are part of the baseline environment, from those which would be caused by the proposed abstractions that are the subject of the resource consent application now before the Court. However the difficulty of making the findings required should not affect the correct interpretation of the statutory provision.*"

4.10 The reference to further abstraction authorised by consents held by the applicant referred to existing consents held by Contact in the field, not the consents applied for. The significance of this and the distinction made in paragraph 40 is due to the Court's clear finding[23] "that it should be not be presumed that the present abstractions will continue to be authorised after the current consents expire".[24]

4.11 The case therefore makes clear that there is no presumption in favour of granting the consent sought and that, as a result, the future effects of the activities for which consent is sought or the consent which has expired is not included in the environment. In the context of a controlled activity this

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19 *Alexandra*, loc cit, para. [66].
20 (2000) 6 ELRNZ 12
21 A41/2007.
22 *Arrigato Investments v Rodney District Council* A115/99.
23 Paragraph [22].
24 The application of the Contact principles in defining the environmental baseline in the context of consent renewals for large dams in considered in detail in Berry, "*Resource Consent Renewals for Existing Dams – Defining an Appropriate "Environmental Baseline"*", NZSOLD/ANCOLD 2001 Conference on Dams.

translates to a principle that there is no presumption of any particular operating regime.

4.12 This principle was adopted by the Court in *Alexandra District Flood Action Society Inc v Otago Regional Council*[25] which involved applications to renew existing consents for existing dams on the Clutha River. In considering the existing environment and how to consider effects the Court made a number of observations which are helpful in the present context. The Court noted[26] that assessing effects normally involves four steps, the first two of which comprise:

> *"(1) to describe the existing environment;*
>
> *(2) to identify any likely, unfanciful future activities (other than that applied for) which are permitted, controlled or consented to on the relevant site...and/or neighbouring area...and then modifying the "environment" to be considered in light of these."* Emphasis mine.

4.13 The Court therefore disregarded the activities applied for the purpose of assessing effects. The rationale for that is clear in the Court's consideration of the environment. It said:

> *"[67] ...Renewing" a resource consent is like obtaining a lease where there is no right of renewal. The tenant, like the applicant for renewal of water permits, in effect has to ask for a new lease. If the landlord considers that the conditions of the last lease were disadvantageous to the landlord because they allowed the tenant to leave sand and stones on the landlord's land and/or to cause flooding on the neighbour's land then the landlord can write into a new lease a condition controlling these matters and even add a condition that past sediment be removed...*
>
> *[68] A regional council may look at "past effects" of the former activity and...add conditions to control future adverse effects, and in some cases to clean up the effects of past activities by the consent holder which were not covered before...*
>
> *[69] We hold that in these proceedings we are generally to consider the environment as it was during the hearings, but allowing for seasonal variations as they come and go.*
>
> *[70] The important point is, in our view, that a consent authority considering an application for resource consent does not usually compare "environments", it usually compares "effects" on one environment. That is because effects are effects* ***on*** *someone or something."*

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25 Environment Court (C 102/05).
26 Paragraph [54].

4.14 The Court considered Part 2 issues for the water permits in that case on the basis "that granting most of the water permits is inevitable, although the operating conditions are definitely not."[27]

4.15 It follows from these cases that it is appropriate to consider the existing dam as part of the existing environment and also the effects of the operating regime that has brought about the current physical environment (e.g., the colour in the Tarawera River in the *Marr* case, the damage to the river banks and stopbanks in this case) but not any particular operating regime associated with it. But, in terms of the rulings in the *Contact* and *Alexandra* cases, taking account of the effects of the existing flow regime does not make the flow regime itself part of the existing environment. That is because that consent has expired and only enures under section 124 until the application is determined – although consent needs to be granted as a controlled activity, there is no presumption one way or the other in terms of the operating regime which may result from the consent process; speculating about that involves consideration of future effects not the "existing environment".

4.16 It appears that confusion in this case may have arisen as a result of the following passage from the Declaration Decision citing the Court of Appeal's decision in the *Hawthorn*[28] case

> *The existing environment is the environment as it exists at the time of hearing including all operative consents and any consents operating under Section 124 of the Act, overlain by those future activities which are permitted activities and also unimplemented consents (which can be considered at the discretion of the authority).*

4.17 The *Hawthorn* case involved the extent to which the future environment needed to be considered in relation to an application for a new land use consent, not a renewal. The case is not authority for the proposition that a consent which is being renewed and which is protected by section 124 is part of the existing environment. In the Declaration Decision, the Court was referring to the existing Fonterra consent in this context, not the TrustPower consent – that the TrustPower consent is not part of the future environment is made clear in the following passage:

> *"[46] Arguably, controlled activities might be regarded as part of the future environment along with permitted activities...it is not necessary for us to address that issue as the only activity that is controlled is TrustPower's application for re-consent."*

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27 Paragraph [141].

28 *Queenstown-Lakes DC v. Hawthorn Estate Limited* [2006] NZRMA 424 (CA).

4.18 Thus, the Committee may in its discretion decide to take account of the effects of the operations authorised by the existing consent as part of the existing environment including the future effects of the increased vulnerability to erosion created by the TrustPower flow regime. This can include (on the basis of some authorities[29]), the current flow regime and its day to day effects until the new consent is granted and whatever flow regime the Committee opts for is implemented.

4.19 But it is important not to conflate the effects of the consent which is expiring with the activities permitted by the consent itself - the ongoing day to day operations of the consent itself cannot form part of the existing environment for the purpose of assessing future effects; whether those effects should continue is one of the key issues before the Commissioners given that there is no presumption as to a future regime. If that were not the case, the existing regime could presumably be renewed without any need to assess effects and without any opportunity to address any adverse effects associated with that flow regime. Based on the clear ruling in *Alexandra*, that cannot be the case.

4.20 Indeed, the role of the Committee in assessing the appropriate residual flow regime afresh and with a clean slate was specifically recognised by Judge Smith in the Declaration Decision when, in relation to whether a residual flow of $20m^3$ or $40m^3$ is required, His Honour observed:

> "[36] *We acknowledge that the question of residual flow will be directly before the Commissioners of the consent authority when the application proceeds to hearing. The previous consent was granted prior to the enactment of the Act and had a substantially different focus."*(Emphasis mine.)

4.21 The upshot is that this Committee has the jurisdiction to impose whatever requirements it sees fit in terms of flow having regard to the purpose and principles of the RMA given that this is the first time that this flow regime has been considered under that legislation. If that means that after considering the evidence the Committee decides that a flow regime that is less damaging than the current regime, e.g., run of river or a regime approximating the 1989 consent, that is entirely appropriate.

4.22 As is made clear in the *Eyres Echo-Park* decision, the Committee has a discretion as to the extent to which it places weight on the existing environment concept and it must also be borne in mind that the entire

29 *Sampson v. Waikato Regional Council* (A 178/02); *Tainui Hapu v Waikato Regional Council* (A 63/04).

assessment is subject to the overall broad judgment which the Committee is required to make under Part 2 of the RMA.

4.23 For these reasons, it is also submitted that it is incorrect to say that "it is impossible to talk about the existing environment in this case in isolation from the declaration decision".[30] The concept of the "existing environment" which was in issue in the context of the Declaration Decision was related to the status of the Fonterra consent, i.e. whether it was part of the existing environment for the purpose of determining the TrustPower application[31] and whether a review condition could be imposed on the TrustPower consent to take account of the "new state of affairs" or "new existing environment" should the separate resource consent which Fonterra has applied for be granted. The discussion of "existing environment" was in the context of that narrow issue and should not be seen as having broader application or suggesting that the Commissioners' assessment of effects is restricted to only considering effects over and above the operating regime permitted by a consent which has expired.

4.24 In summary, the law is that the "existing environment" comprises all features and characteristics which exist at the present time, whether as a result of natural processes or the actions of TrustPower or other third parties, including irreversible changes to the environment arising as a result of the implementation of existing or past consents.

4.25 The existing environment in the present context therefore comprises:

(a) The dam and associated infrastructure and the impact that the existence of that infrastructure has on flows.

(b) The existing river scheme as it currently stands, including any damage caused by both normal fluvial processes and the Trustpower flow regime. This also includes any ongoing effects of past and existing operations which have already increased the susceptibility of the banks and stopbanks to further erosion.

(c) Credible variations to the environment likely to result from the implementation of existing resource consents including any consents protected under section 124. In that regard, it is appropriate to consider the existing flow regime up until whatever new conditions

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30 Legal submissions of counsel for the Applicant, paragraph 29.
31 Paragraph 47.

that the Committee imposes as regards flow regime are implemented, but not to assume the existing regime into the future as a basis for assessing effects given that that regime is not applied for as there is no presumption as to the terms upon which the consent will be granted.

(d) Permitted activities (but not hypothetical or fanciful activities) in terms of the permitted baseline having regard to regional or district plan rules. It would not appear that that is a relevant consideration.

4.26 The Committee should therefore not feel constrained to consider only effects which arise over and above that authorised by the current conditions of consent. Thus, if, in light of the EHG's evidence, the Committee considers that a flow regime that has less fluctuations than that proposed or as permitted by the current (expired) consent, you are entitled to pursue that issue with a view to developing appropriate conditions which limit damage to the flood scheme.

Significance of the NPS on Renewable Energy

4.27 The submissions of counsel and evidence of the planning consultant for the Applicant appropriately refer to the National Policy Statement for Renewable Electricity Generation 2011 ("REG NPS") as being relevant in this case, because the Committee is required to have regard to the NPS in terms of section 104.

4.28 It is important not to overplay the significance of the REG NPS in the context of this application, particularly insofar as the Applicant relies upon it to justify amendments to the current operating regime which would enable a small percentage of additional generation but at a significant cost to communities downstream.

4.29 In that regard, the matters identified in section 104 are expressed to be subject to Part 2. Thus the Renewable Energy NPS is not determinative; the Committee is still required to make an overall judgement as to the appropriateness of the proposal having regard to the purpose of the RMA, informed by Part 2. In that regard, Mr Kemble's evidence specifically recognises that the reversibility of adverse effects on the environment is not a

benefit that can be claimed in respect of the EHG's case with respect to erosion effects of the proposal in terms of Policy A.[32]

4.30 The EHG does not seek that the consent be declined, indeed it cannot, but simply seeks that the operational regime that is granted is one which strikes an appropriate balance between the need for renewable electricity generation and the environmental effects of that operation in the context of an already sensitive environment. In that regard, the evidence of Mr Burchett is that the flow regime proposed by EHG would not result in an overall reduction of generation of renewable energy. Mr Dawson will address the REG NPS in his evidence.

5. FLOOD MANAGEMENT

5.1 The other key concern which arises for the EHG relates to the management of the Matahina Dam in times of flood. In that regard, EHG is responsible for managing the safe passage of flood water in accordance with the levels of risk agreed with the community and the Matahina Dam can be utilised to some extent to mitigate the potential effects of a flood. This is addressed in the evidence to be presented by Mr Meadowcroft, who has been in constructive discussions with TrustPower representatives and will be able to advise the Committee on any areas in which agreement has been reached in relation to flood management.

5.2 The evidence will demonstrate that the EHG has developed sophisticated flood prediction tools some of which enable the prediction of floods up to six days in advance. The accuracy of predictions increase closer to the event. In contrast, TrustPower's flood prediction tools consist of inflow recorders located in the upstream catchment which measure flow levels from which a prediction is then made.

5.3 TrustPower's evidence is that it is able to predict a flood several hours in advance. EHG's position is that this is more in the nature of "flood measurement" than flood prediction and that better outcomes in terms of the safe passage of flood waters can be achieved with the type of flood prediction model which EHG maintains.

5.4 Given the BOPRC's capacity to predict floods and the EHG's responsibility for managing the impact of floods on the community under the Soil Conservation and Rivers Control Act 1941, it is submitted that it may be

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[32] Kemble evidence, paragraph 3.18.

appropriate in some circumstances for the EHG to have the ability to require TrustPower to provide storage in the dam to assist in the attenuation of floods. The appropriateness of that approach has always been recognised by TrustPower and is reflected in the conditions of the expiring consent which provides for BOPRC to require storage in the dam when floods with inflows of over 500 cumecs are expected.

5.5 The recent flood events (particularly the 2004 flood event) have caused the EHG to consider whether the current conditions are sufficient to optimise the potential of the dam to attenuate floods. Against that background, the key issues in contention between TrustPower and EHG are:

(a) The minimum level to which the Matahina Dam can be reduced when a flood is predicted. EHG's position is that a lower minimum level would provide additional capacity for flood attenuation.

(b) The level of control which BOPRC has in terms of requiring TrustPower to lower the dam when a flood is expected and the trigger point for BOPRC's involvement in that regard. EHG's position is that it would be appropriate for BOPRC to be able to require TrustPower to lower the dam to an identified level and at an identified rate once it predicts that a flood of 300 cumecs or greater will occur.

5.6 The crux of TrustPower's concern is that it wishes to avoid what they see as "wasted energy" which would result if TrustPower is either required to spill water or is unable to promptly refill the dam. Counsel understands that, in response to questions from the Commissioners, Trustpower has advised that if it were required to spill water to the minimum lake level, it would forgo 1.4GWh of electricity in the worst case scenario. Mr Burchett has estimated the likelihood of such an event and quantified the opportunity cost to TrustPower of such an event and concluded that that value at risk is in the vicinity of $10,000 per annum.

5.7 EHG's submission is that avoiding or minimising the potential adverse effects of a large flood event to the community downstream is of fundamental importance and more important than avoiding any financial loss for TrustPower. Dr Wheeler's evidence addresses the cost of increased risk of failure in the context of the relative benefit to TrustPower.

5.8 TrustPower has proposed conditions relating to flood management which largely reserve the detail as to how floods will be managed to a Flood

Management Plan, including the trigger point for BOPRC involvement in management of the Matahina Dam to attenuate the effects of a flood. Trustpower propose that the Flood Management Plan, while submitted in a "final" form for approval by the Hearing Committee and attached to the consent, can be amended by TrustPower as it sees fit and the only discretion which BOPRC retains over those changes is in a certifying capacity in terms of the Building Act and Building (Dam Safety) Regulations. It is submitted that it would be appropriate in the circumstances for any amendments to the Flood Management Plan to be required to be approved to the satisfaction of the EHG, having regard to whether those changes will achieve the best use of the dam in terms of flood management.

5.9 These matters will be further addressed in Mr Meadowcroft and Mr Dawson's evidence.

6. THE APPROPRIATE RESOURCE MANAGEMENT RESPONSE – CONDITIONS REQUESTED BY THE EHG

6.1 Once it has assessed all of the evidence for and against the flow regime proposed by TrustPower, the Committee needs to make an "overall broad judgment" in relation to the application. In terms of the classic enunciation in the *North Shore City Council*[33] case:

> *"The method of applying s5 then involves an overall broad judgment of whether a proposal would promote the sustainable management of natural and physical resources. That recognises that the Act has a single purpose. Such a judgment allows for comparison of conflicting considerations and the scale or degree of them, and their relative significance or proportion in the final outcome."*

6.2 As noted, the EHG acknowledges that the Matahina Dam is a "physical resource" which needs to be sustainably managed in terms of section 5 of the RMA (as is the river scheme) and that the consent sought, as a controlled activity, must be granted. However, for the reasons outlined above, the Committee has a blank canvas in terms of the flow regime it authorises and in doing so is entitled to have regard to the broad range of matters of control contained in Rule 47C of the Regional Plan. In that regard, Rule 47C reserves control over a wide range of matters relevant to the EHG's submission, including:

> *(e) Measures to manage erosion effects (including destabilisation of beds and banks or river);*

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33 *North Shore City Council v Auckland Regional Council* [1997] NZRMA 39, at 94.

(m) Techniques for ensuring the safe passage of flood water;

(p) Measures to avoid, remedy or mitigate adverse effects of the operation on downstream sediment transport processes;

(q) Measures to avoid, remedy or mitigate adverse effects on lawfully established downstream infrastructure.

(r) The range, rate of change of levels or flows of water;

6.3 It is also clear that the Rangitaiki River Scheme is also a physical resource which needs to be sustainably managed and it is relevant for the Committee to consider the adverse effects which Trustpower's operation have on this scheme in deciding on the regime of conditions which it imposes on the Trustpower consent.

6.4 Other factors which are relevant in terms of your overall broad judgement are, in our submission, as follows:

(a) There is no presumption, one way or the other, in terms of the flow regime sought by TrustPower or even in terms of continuation of the current flow regime which the EHG's evidence clearly demonstrates has been causing damage which the EHG is not being adequately compensated for. To that extent, there are externalities of the TrustPower operation which TrustPower is not being required to address – to that extent TrustPower's operations are being subsidised by BOP ratepayers.

(b) This is the first time the effects of the overall Matahina operation have been considered in terms of the purpose and principles of the RMA with the result that careful consideration of the resource management issues is warranted.

(c) Despite evidence from TrustPower as to the broader benefits of the Matahina scheme, the evidence of the EHG's expert electricity industry and economic witnesses make it clear that the primary benefit to be derived from the altered flow regime derive to TrustPower's shareholders and not to the broader environment. It is submitted that this is relevant in balancing the benefits claimed for the proposed flow regime against the damage which is acknowledged to arise as a result of the Matahina Dam operation.

(d) The compensation which TrustPower is prepared to offer is not adequate to compensate the EHG for the work it needs to do in order to address that damage. The Committee has no jurisdiction to require a larger annual contribution although the EHG remains hopeful that in light of the evidence presented and in order to achieve finality, TrustPower might revise its proposed contribution to reflect the more sophisticated approach explored in the evidence of Mr Philpott and Mr Burchett.

6.5 Another factor which is relevant to the Committee's decision making relates to the uncertainty which exists as to the impact of the TrustPower proposed flow regime on the Rangitaiki River system and river scheme. This is clearly demonstrated by the different positions held by highly qualified independent experts and for the reasons outlined above, we submit that the evidence of Dr O'Halloran is to be preferred due to her far greater practical experience on the Rangitaiki scheme and Mr Williams due to his superior experience of rivers throughout New Zealand.

6.6 TrustPower are essentially framing their case in a manner in which they derive the benefit of the doubt created by this uncertainty and we have already made the submission that it is more appropriate that the Committee adopt a conservative view by which this uncertainty is resolved in favour of the EHG. This approach would represent an appropriate application of the precautionary approach inherent in the RMA for the Committee to resolve this doubt in favour of the EHG – *McIntyre v. Christchurch City Council.*[34]

6.7 Against that background, the Committee has a range of options open to it in terms of the conditions it is able to impose. I turn to those now.

Imposition of restrictive flow regime which avoids or limits damage

6.8 Given that the benefits of the proposed flow regime derive entirely (or at least predominantly) to TrustPower shareholders with the adverse effects on ratepayers who fund the river scheme, the Committee could theoretically decide that the adverse effects of the Matahina operation should be avoided altogether. It would thus be possible to achieve that outcome by imposing conditions which require a flow regime which emulate a "run of river" situation such that the Committee would be satisfied that the TrustPower operations would not have any incremental effect on the river itself. In this circumstance,

34 [1996] NZRMA 289.

it would not be necessary for TrustPower to make a contribution and the EHG would be satisfied that the matter is resolved.

6.9 The EHG acknowledges that it is unlikely that the Committee may ~~not~~ be minded to take such a step. That said, given that the $50,000 contribution offered by TrustPower would not even compensate for the existing flow regime let alone that which is proposed, the Committee may wish to explore the development of conditions which would more closely reflect the impact of TrustPower operations. This is addressed in the evidence of Mr Dawson but the EHG request conditions so that:

(a) When inflows are equal to or less than 40 cumecs, outflows should equal inflow.

(b) When inflows are more than 40 cumecs, outflows should be equal to or more than 40 cumecs.

(c) TrustPower are only permitted a single peak per day, with the amplitude of that peak limited to twice the average inflow of the previous day.

(d) No change to the ramp up and ramp down rates permitted beyond those authorised by the existing consent.

6.10 The rationale for this request is addressed in Mr Williams' and Dr O'Halloran's evidence.

Flood management

6.11 In terms of flood management, the EHG seeks:

(a) Provision for the BOPRC to require TrustPower to lower the level of the dam to 71.6m when the BOPRC predicts a flood of 300 cumecs or more (as opposed to 500 cumecs as sought by TrustPower) at a rate specified by BOPRC.

(b) Provision for the BOPRC to require TrustPower to lower the level of the dam to 70.0m (as opposed to 71.6m as proposed by TrustPower) when the BOPRC predicts a flood of 500 cumecs or more at a rate specified by BOPRC.

(c) Inclusion of these trigger points as conditions of consent, rather than provisions in the Flood Management Plan which may be amended without a variation to the conditions of consent.

(d) Amendments to the conditions to enable the BOPRC to approve amendments to the Flood Management Plan against relevant criteria.

(e) Other amendments to the Flood Management Plan which will be addressed in the evidence of Mr Meadowcroft.

Adaptive management regime

6.12 As already noted, the difference of expert opinion in relation to the impact of TrustPower's operations on the Rangitaiki River Scheme clearly reflect that there is uncertainty, perhaps created by a shortfall of information in relation to the impact of TrustPower's operations. It is submitted that in these circumstances an adaptive management approach to conditions should be adopted – in essence this is a precautionary approach for managing risks "where potential adverse effects are unable to be fully assessed by reference to the primary or adjudicative facts."[35] In this case, given that doubt exists as to the level of effect or potential future effect, it is appropriate to impose conditions which provide for the "adaptive management" of TrustPower's activities through the imposition of monitoring and reporting conditions which will facilitate the production of high quality information which enables management decisions to be made as to how effects should best be avoided, remedied or mitigated.

6.13 Counsel for the Applicant has made the submission that the monitoring and reporting conditions which are volunteered by TrustPower are adequate and appropriate. It is acknowledged that the bare bones of a robust monitoring and reporting regime are in place. However, we submit that the monitoring proposed is somewhat unsophisticated and that the conditions lack any real ability to "adaptively manage" TrustPower's activities, with the only redress or mechanism being the ability to review consent conditions pursuant to section 128. The Committee will be well aware that such conditions are rarely utilised, but even if it were, it imposes significant process risk and cost on the EHG given the likelihood that it would end up with exactly the same difference of opinion in relation to technical issues as has been demonstrated in the context of this hearing.

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35 *Minister of Conservation v. Tasman District Council* (CIV 2003-485-1072).

6.14 It is therefore submitted that if the Committee is minded to grant TrustPower a long term (i.e. 20 years plus) consent for the flow regime which it seeks, the consent should be subject to conditions which establish an adaptive management regime for both generating the type of information which will enable better decisions to be made in relation to the measures to be adopted to avoid, remedy or mitigate the adverse effects created by the TrustPower operation, provision of information generated to be independently reviewed, and an ability to address effects during the life of the consent without the need for undertaking section 128 reviews.

6.15 Key elements of such an adaptive management strategy would comprise:

(a) A requirement for TrustPower to develop, for BOPRC approval, a monitoring plan which is specifically designed to identify and, to the extent feasible, quantify the effects of TrustPower's operations. There should be an ability to revisit the monitoring plan in light of information which is derived from the monitoring, on the recommendation of an independent peer review panel.

(b) Following on from (a), it is submitted that the conditions should provide for the establishment of an independent peer review panel comprising experts in river and geotechnical processes who receive the information generated from the monitoring undertaken, interpret that information and report on a periodic basis to BOPRC. The peer review panel should have powers of recommendation to the BOPRC that amendments should be made to the monitoring plan or that other conditions of the consent should be revisited in light of monitoring information. The use of such panels is commonplace in the context of geothermal resource consents in which uncertainty often exists and flexibility needs to be maintained to take account of changing circumstances and new information - the BOPRC consent for the Kawerau Geothermal Power Station provides a good example of how a peer review panel concept is intended to operate.

(c) The Peer Review Panel should have powers of recommendation to BOPRC in relation to fine tuning the monitoring plan, reporting to BOPRC as to the mechanisms and causes of damage to the river scheme, and recommendations as to amendments to the flow regime, potential remedial action or appropriate compensation (particularly if the Regional Plan is amended to make clear that financial contributions can be required).

(d) Review conditions should be included which are tailored specifically to respond to the Panel's recommendations – including amendments to the flow regime or the undertaking by TrustPower of specific work in the event that the monitoring indicates that such a response is necessary or appropriate. (In that regard a separate review condition should also be specifically included that enables the imposition of a financial contribution condition in the event that the regional plan is amended so that all 47C or its equivalent ultimately contains a matter control which enables the imposition of a financial contribution condition.)

6.16 Mr Dawson's evidence contains some conditions along these lines. However, if the Committee is attracted to the development of this type of regime, it may be appropriate to issue an interim decision and seek further input on the detailed drafting of such provisions.

Short term consent

6.17 If the Committee is not minded to impose conditions requiring a reduced peaking regime (or similar) or the type of adaptive management regime just described, it is submitted that a relatively short term consent (not exceeding ten years), would be appropriate. That would enable the effects of the TrustPower operation to be observed over a substantial time frame and would provide an opportunity for the consent to be revisited to take account of this further knowledge or changes to the regional plan. The dam is in place and protected by existing use rights and a long term consent to protect that infrastructure is not required. Having regard to the uncertainty of the effectiveness of the conditions to address effects[36], a short to medium term consent (ten years) would be appropriate to enable uncertainties to be revisited on a substantive and comprehensive basis.

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36 *Huntly Quarries Ltd v Waikato Regional Council* A 010/2008

Jurisdiction

6.18 The Committee can be satisfied that the conditions sought by the EHG can be imposed in terms of section 47C of the Regional Plan.

6.19 The EHG is grateful for the Committee's attention to their submission.

DATED at Whakatane this 5th day of July 2011

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S J Berry / J Vella

Counsel for Environmental Hazards Group, BOPRC

65750 - 65753
A762435.

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of an application by **TRUSTPOWER LTD** to the **BAY OF PLENTY REGIONAL COUNCIL** for water permits associated with the operation of the Matahina Hydroelectric Power Scheme

STATEMENT OF EVIDENCE OF KENNETH CRAIG TARBOTON

1. INTRODUCTION

Qualifications and experience

1.1 My name is Kenneth Craig Tarboton. I am the Environmental Hazards Group Manager at the Bay of Plenty Regional Council ("BOPRC") and was appointed to this position in July 2007. I hold a PhD in Engineering in the field of Agricultural Engineering from the University California, Davis (1997).

1.2 I am a Member of the New Zealand Institute of Professional Engineers and registered as a Professional Engineer in the State of Florida.

1.3 I have 26 years experience in water resources engineering and hydrological modelling, including modelling to develop and consult on options analysis for environmental restoration.

1.4 As Environmental Hazards Group Manager, I am responsible for the management of the Bay of Plenty Region's rivers and drainage schemes including the Rangitāiki-Tarawera Rivers Scheme that provides flood protection and erosion control on the Rangitāiki and Tarawera Rivers.

Expert Witness Code of Conduct

1.5 While I am not giving my evidence as an expert witness, I have been provided with a copy of the Code of Conduct for Expert Witnesses contained

in the Environment Court's Consolidated Practice Notes 2006. I have read and agree to comply with that Code. This evidence is within my area of expertise, except where I state that I am relying upon the specified evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Purpose and scope of evidence

1.6 The purpose of my evidence is to put the evidence which follows into context by providing an overview of the Environmental Hazards Group ("EHG"), its role and responsibilities with respect to management of the rivers and drainage schemes, the strategic importance of these schemes, their governance and funding, and the key reasons for this submission.

1.7 Specifically, I will:

(a) Provide an overview of the Environmental Hazards Group ("EHG") and its responsibility for rivers and drainage scheme management (Section 2);

(b) Address the importance of the Regional Council's river scheme assets in the context of the Bay of Plenty Region (Section 3);

(c) Provide an overview of the governance and funding of the Bay of Plenty's rivers and drainage schemes including the mandate for the EHG to make this submission (Section 4); and,

(d) Describe the EHG concerns with the TrustPower proposal (Section 5).

1.8 I have referred to the documents which I have relied upon in preparing this evidence in **Appendix A**.

2. OVERVIEW OF EHG AND RIVERS AND DRAINAGE SCHEMES

2.1 This section describes the role and responsibility of the EHG in the management of the Bay of Plenty's rivers and drainage schemes.

Environmental Hazards Group overview

2.2 The EHG (formerly known as Rivers and Drainage Group) is one of six groups within the Bay of Plenty Regional Council responsible for undertaking the functions and responsibilities of the Regional Council under the Local Government Act 2002 ("LGA 02").

2.3 The primary functions of the EHG include managing risks posed by our major rivers including the region's major flood control schemes, ensuring safe use of our region's waters and undertaking civil defence and emergency management.

2.4 Due to its operational nature, the EHG holds numerous RMA resource consents. Maintenance of River Schemes are permitted under the Bay of Plenty Regional Water and Land Plan (Rule 79).

2.5 It is the responsibility of the Consents Section of the Water Management Group, one of the other six groups within the Bay of Plenty Regional Council, to administer and grant resource consents and ensure compliance with their conditions.

2.6 When the EHG acts as an applicant on its own consents or submits on consents related to the group's area of responsibility, as in this case, there is total separation between the Consents Section and the EHG with respect to the consent process, and the EHG is treated in the same way that any other consent applicant or submitter would be treated.

Rivers and drainage scheme management responsibility

2.7 The EHG manages the Bay of Plenty's six rivers and drainage schemes, shown in **Appendix B**. These include the:

(a) Kaituna Catchment Control Scheme;

(b) Whakatane-Waimana Rivers Scheme;

(c) Rangitaiki-Tarawera Rivers Scheme;

(d) Waioeke-Otara Rivers Scheme;

(e) Rangitaiki Drainage Scheme; and a group of

(f) Minor Rivers and Drainage Schemes.

2.8 These are whole of catchment schemes, with the Rangitaiki-Tarawera Rivers Scheme being relevant to the TrustPower application.

2.9 The EHG provides river scheme management in two parts: the first part undertaking the necessary planning, and analysis; and the second part managing the operations maintenance and capital improvements of the schemes themselves.

2.10 River scheme planning and analysis includes:

(a) Floodplain management planning to ascertain flood risk, and determine physical and planning options to minimise the effect of flood risk;

(b) Maintenance of the Rivers and Drainage Asset Management Plan ("AMP"), which specifies lifecycle management of the rivers and drainage scheme assets, risk, and levels of service;

(c) River engineering analysis to ensure that community agreed levels of service are provided for in the rivers and drainage schemes;

(d) Civil and environmental design of flood protection measures, including hydraulic analysis and hydrologic modelling for this design; and

(e) Real time flood management (e.g. coordinating pre-flood drawdown of Matahina Dam) and providing flood warnings in accordance with our flood manual.

2.11 Managing the operations, maintenance and capital improvements of the schemes themselves includes:

(a) Supervision and oversight of new capital works such as stopbanks, pump stations and drainage ditches;

(b) Stopbank maintenance which includes providing river edge protection in stopbanked areas and provision of measures to protect stopbank integrity (e.g toe loading and cut-off trenches);

(c) Stopbank renewal which includes topping up stopbanks to required design levels;

(d) Riverbank inspection and erosion protection in non-stopbanked portions of river schemes. Vegetative protection such as willow trenching is used where possible and rock protection elsewhere;

(e) Pump and structure maintenance;

(f) Drain and channel weed control;

(g) Fence maintenance and repair.

3. STRATEGIC IMPORTANCE OF THE RIVERS AND DRAINAGE SCHEMES

3.1 This section addresses the strategic importance of the rivers and drainage schemes to the Bay of Plenty Region and its ratepayers.

Significance in terms of LGA 02

3.2 The Regional Council has determined the rivers and drainage schemes to be strategic in nature, in terms of the LGA 02, so that decisions with respect to ownership or control of the schemes or to construct, replace or abandon a scheme cannot be made unless it has first been included in the Ten Year Plan (TYP).

3.3 Any such decisions with respect to the rivers and drainage schemes are automatically considered to be significant in terms of the LGA 02.

Community outcomes and levels of service

3.4 Regional Council has identified a range of community outcomes[1] to which rivers and drainage schemes contribute directly including:

(a) A clean and protected environment;

(b) Healthy and safe communities;

(c) Quality affordable infrastructure;

(d) A prosperous and sustainable economy.

3.5 The work that EHG undertakes with respect to the rivers and drainage schemes contribute to those community outcomes insofar as it:

(a) Formulates mitigation measures to protect people, property and the environment from floods;

(b) Manages the effects of development on the existing rivers and drainage schemes;

(c) Provides sustainable, safe, ongoing and cost effective rivers and drainage schemes;

(d) Provide robust maintenance, renewal and capital programmes; and

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[1] 2008/09 Rivers and Drainage Asset Management Plan

(e) Creates safe conditions for new business through the management of potential rivers and drainage hazards.

3.6 The Rivers and Drainage AMP also sets out levels of service for the rivers and drainage works (in accordance with the requirements of the LGA 02), which are linked to these community outcomes.[2]

4. GOVERNANCE AND FUNDING OF RIVERS AND DRAINAGE SCHEMES

4.1 This section provides an overview of the governance of the rivers and drainage schemes and describes how the schemes are funded.

Governance of rivers and drainage schemes

4.2 Regional Council took over from the Catchment Boards and Commissions in 1989 to manage the soil conservation and river control for the rivers and drainage schemes.

4.3 The Bay of Plenty's six rivers and drainage schemes are managed in accordance with the Soil Conservation and Rivers Control Act 1941 which allows the establishment of separately rated river schemes on a catchment-by-catchment basis.

4.4 The rivers and drainage schemes are managed in accordance with floodplain management strategies, the Rivers and Drainage Asset Management Plan, the Council's Ten Year Plan and Annual Plans.

4.5 River scheme related decisions are taken to Regional Council's Operations Management and Regulation ("OMR") Committee. Typically decisions include budget transfers and carry forwards, accessing five year flood reserves and approving progress.

4.6 Regular (at least twice yearly) meetings are held with each River Scheme Liaison Group ("RLG") in order to get representative community input, report on scheme maintenance and capital works and discuss other issues related to the management of the specific rivers and drainage scheme. The evidence of Mr Holmes will specifically address the Rangitaiki-Tarawera Rivers Scheme River Liaison Group.

4.7 In its capacity as Rangitāiki-Tarawera Rivers Scheme manager, the EHG has a mandate to promote the best interests of the rivers scheme. It is in this

role, representing the Rangitāiki-Tarawera Rives Scheme, that the EHG has made a submission on the TrustPower proposal for the operation of the Matahina Dam.

4.8 The EHG submission is supported by the River Liaison Group. Council, through the OMR Committee has been informed of the submission.

Funding of rivers and drainage schemes

4.9 The rivers and drainage schemes in the region are funded via Regional Council general funds and targeted rates. In that regard:

(a) 80% of the funding for the rivers and drainage schemes comes from an area based targeted rate with differential payments based on the benefit a landowner directly receives from the scheme or the contribution of the landowner to scheme runoff.

(b) 20% of the funding comes from general funds which recognises the regional benefits which arise from the rivers and drainage schemes (such as protection of regionally significant infrastructure, economic benefits, etc).

4.10 There are some circumstances in which funding is obtained from central government. Central government contributed towards recovery costs following the 2004 Floods and has committed to contributing one third of the Edgecumbe flood mitigation works (estimated to cost $10.1 million).

4.11 The overall annual 2011/2012 operating budget for the six rivers and drainage schemes is $7.1 million, of which $1.9 million is for the Rangitāiki-Tarawera Rivers Scheme. The Capital works budget for the six rivers and drainage schemes is $11.1 million, of which $4.7 million is for the Rangitāiki-Tarawera Scheme (Annual Plan 2011/2012).

4.12 Damage from the August 2010 and January 2011 flood events was estimated at $10.5 million across the region's river schemes. Of this $2.97 million (28%) was in the Rangitāiki-Tarawera Rivers Scheme. The portion of damage downstream of the Matahina Dam was 40% of the overall Rangitāiki-Tarawera Rivers Scheme at $1.19 million.

4.13 2011/2012 targeted rates for the Rangitāiki-Tarawera Rivers Scheme are $1.5 million. A 135 ha land owner in the A1 targeted rate category will pay $7,150 in the upcoming year, while an Edgecumbe landowner in the U1

targeted rate category with a 1000 m^2 property will pay \$168. By comparison, the rate for the Matahina Dam is \$578.

4.14 Mr Crabbe will address the specific costs and funding arrangements for the Rangitaiki-Tarawera Rivers Scheme.

5. EHG CONCERNS WITH TRUSTPOWER PROPOSAL

5.1 This section sets out the EHG's concerns with respect to the TrustPower proposal in order to provide context for the evidence which follows. Those concerns fall into two categories:

(a) Impact of the Matahina Dam operations on the river scheme; and

(b) Appropriate flood management of the Matahina Dam.

Impact on the rivers scheme

5.2 The position of the Rangitāiki-Tarawera Rivers Scheme ("Rivers Scheme") is that the current Matahina Dam operations have a significant detrimental effect on the downstream river processes, the security of the flood protection system, and the effectiveness of the river edge protection works that are maintained by the EHG on behalf of the Rivers Scheme.

5.3 In recognition of downstream impacts, an agreement between TrustPower and the Rivers Scheme was made in 1998. TrustPower has been honouring this agreement and making an annually adjusted financial contribution to the scheme. The amount of this contribution was \$15,646 + GST for the 2008/2009 financial year.

5.4 The 1998 agreement was made prior to the large flood event of July 1998, at a time when maintenance expenditure was relatively low, following a quiescent period for floods. The Environmental Hazards Group's position is that this contribution is totally inadequate given the effects of the dam's current operations on the Rivers Scheme and costs to the Rivers Scheme for asset maintenance.

5.5 The proposed operations for Matahina Dam will have a further detrimental effect on the downstream rivers scheme assets as a result of increased peaking, quicker ramping and lower flows. The reasons for this are fully covered in the technical evidence. The proposed new operating regime is untested in terms of the effects on the downstream river system.

5.6 Following the 1998 and 2004 floods, the Rivers Scheme has made considerable investment in flood mitigation including geotechnical strengthening works that have put the river bank flood protection system in a more robust condition to better withstand both the stresses of flood events in the future but also stress imposed by increased peaking and quicker ramping.

5.7 This extraordinary works programme has not received any contribution from Trustpower; however, it will enable the river to better cope with the high frequency low magnitude fluctuations created by proposed dam operations in the future. Essentially, Trustpower, through its applications, is seeking to capitalise on the works and expenditures of the scheme in order to justify approval for on-demand multiple peak generation profiles under a varied operating regime.

5.8 The upshot is that downstream stakeholders are effectively being asked to accept (and indeed subsidise) a regime that has unknown consequences. This is a concern as the soil profile is known to be complex and vulnerable and vegetation establishment is compromised by frequent river level variations. For this reason, as well as concerns about the multiple peaking proposal discussed above, Environmental Hazards Group (in its role as Rivers Scheme manager) consider that there are wide ranging and significant variables that Trustpower has not been able to quantify, control or mitigate.

5.9 The Environmental Hazards Group has been involved in good faith "without prejudice" negotiations with Trustpower with a view to negotiating an appropriate contribution to recognise that company's impact on the river and flood. We put a significant effort into that initiative, including the development of a sophisticated "live model" that would enable Trustpower's contribution to be specifically tailored to meet the circumstances applying. Unfortunately, Trustpower take a fundamentally different view of the impact of their operations downstream and this ultimately meant that no model for compensation could be agreed.

5.10 As a consequence, the Environmental Hazards Group has requested conditions that mitigate the downstream effects of the proposed operations and that any application granted be subject to a review

condition. The specific conditions sought by the EHG will be addressed by Mr Dawson.

Flood management

5.11 Since 2004 Environment Bay of Plenty has been engaged with Trustpower to review the flood management operation of Matahina Dam which had not been reviewed since 1989.

5.12 The EHG takes the view that the Matahina Dam can be used for attenuation of floods (even large floods) if the appropriate mechanisms are in place which enable the dam to be used as a flood management device to its fullest potential.

5.13 On that basis, the EHG submission is targeted at achieving specific conditions to ensure that when floods are forecast above a certain trigger level, a set of pre-determined operations are implemented by the Matahina Dam operators under the direction of the Bay of Plenty Regional Council Flood Manager to ensure flood pending lowering of the dam, and return to normal operations once the flood or threat of flood has passed.

Summary of concerns

5.14 Current Matahina Dam operations contribute towards the increased risk of downstream flooding and riverbank slumping and erosion through effects of peaking fluctuations on the riverbanks and stopbank foundations as will be shown by our expert witnesses.

5.15 These effects can be seen in the photographs in **Appendix C** from our on river observations of erosion effects on the riverbank, which were taken on Sunday 3 July 2011. Mr Williams will address our observations from this site visit in more detail. While these photos were taken only a couple of days after the Commissioner's site visit, it appears from the hydrograph in **Appendix C1** that river levels were significantly higher during the Commissioner site visit on July 1 than on July 3, so similar effects may not have been observed.

5.16 EHG's fundamental concern is that the Rangitāiki River and plains are a particularly sensitive environment. There is considerable uncertainty as to the long term effects of the proposed operating regime, with any

increased risk from this uncertainty showing up as additional cost which must be borne by the river scheme ratepayers.

5.17 Quite simply EHG's position is, this is not the right river for this type of operation. Our preference is for run of river operations. The details of EHG's relief will be addressed by the witnesses that follow.

Kenneth Craig Tarboton
June 2011

Attachments:

Annexure A: Documents considered in preparation of evidence
Annexure B: Map of Rivers and Drainage Scheme Areas
Annexure C: Photos of river banks erosion and collapse mechanisms

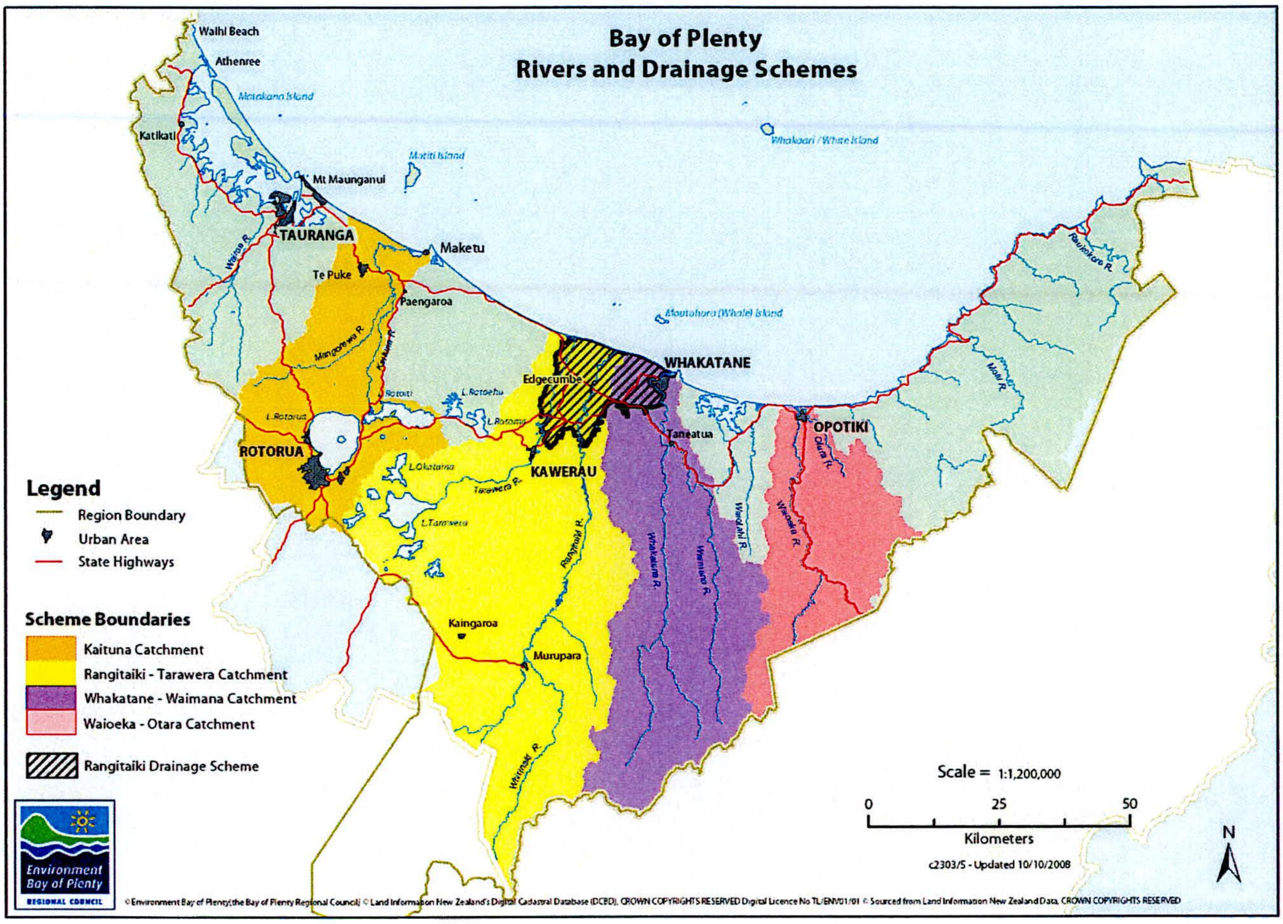
Annexure A

Documents used in preparation of this evidence

1. EBOP. 2009. 2008/09 Rivers and Drainage Asset Management Plan
2. BOPRC. 2011. Bay of Plenty Regional Council's Annual Plan 2011/2012
3. EBOP. 2009. Environment Bay of Plenty's Ten Year Plan 2009-2019.
4. Britton, R. 2008. Rangitāiki Tarawera Floodplain Management Strategy. Stage 1.

Annexure B

Map of Rivers and Drainage Scheme Areas

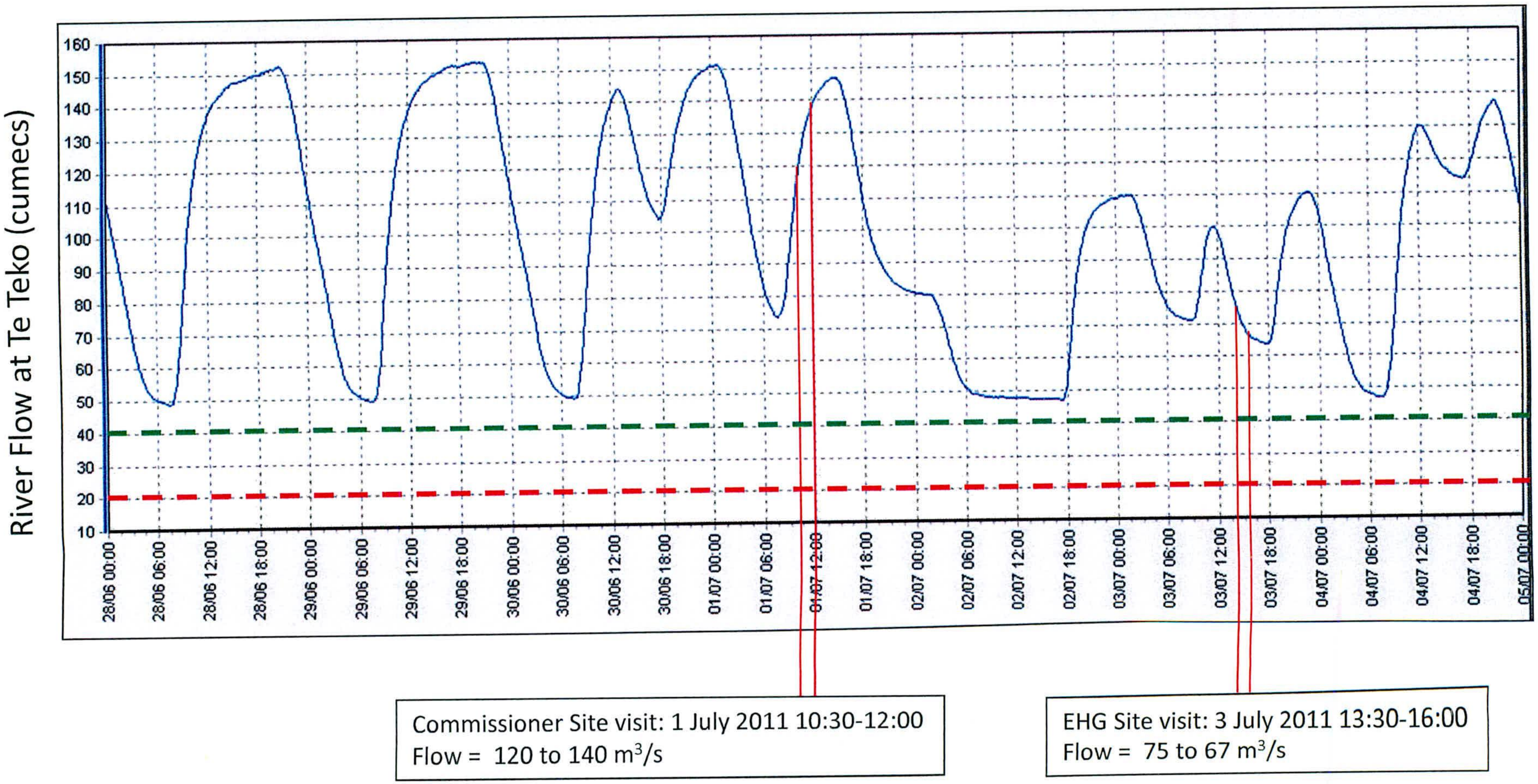


Appendix C

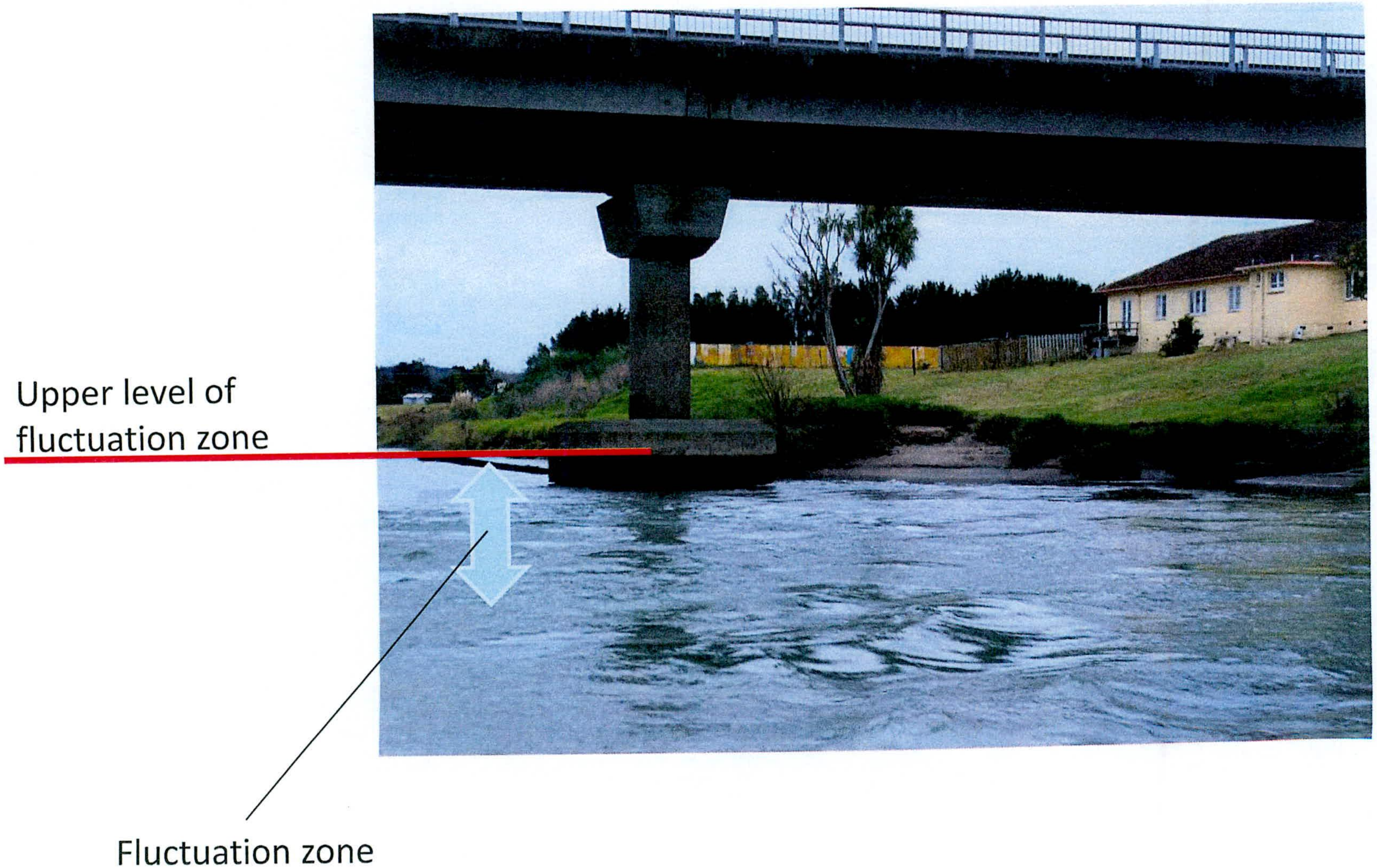
Riverbanks Erosion and Collapse Mechanism
Observations: 3 July 2011

Rangitāiki River from Thornton to Matahina Dam

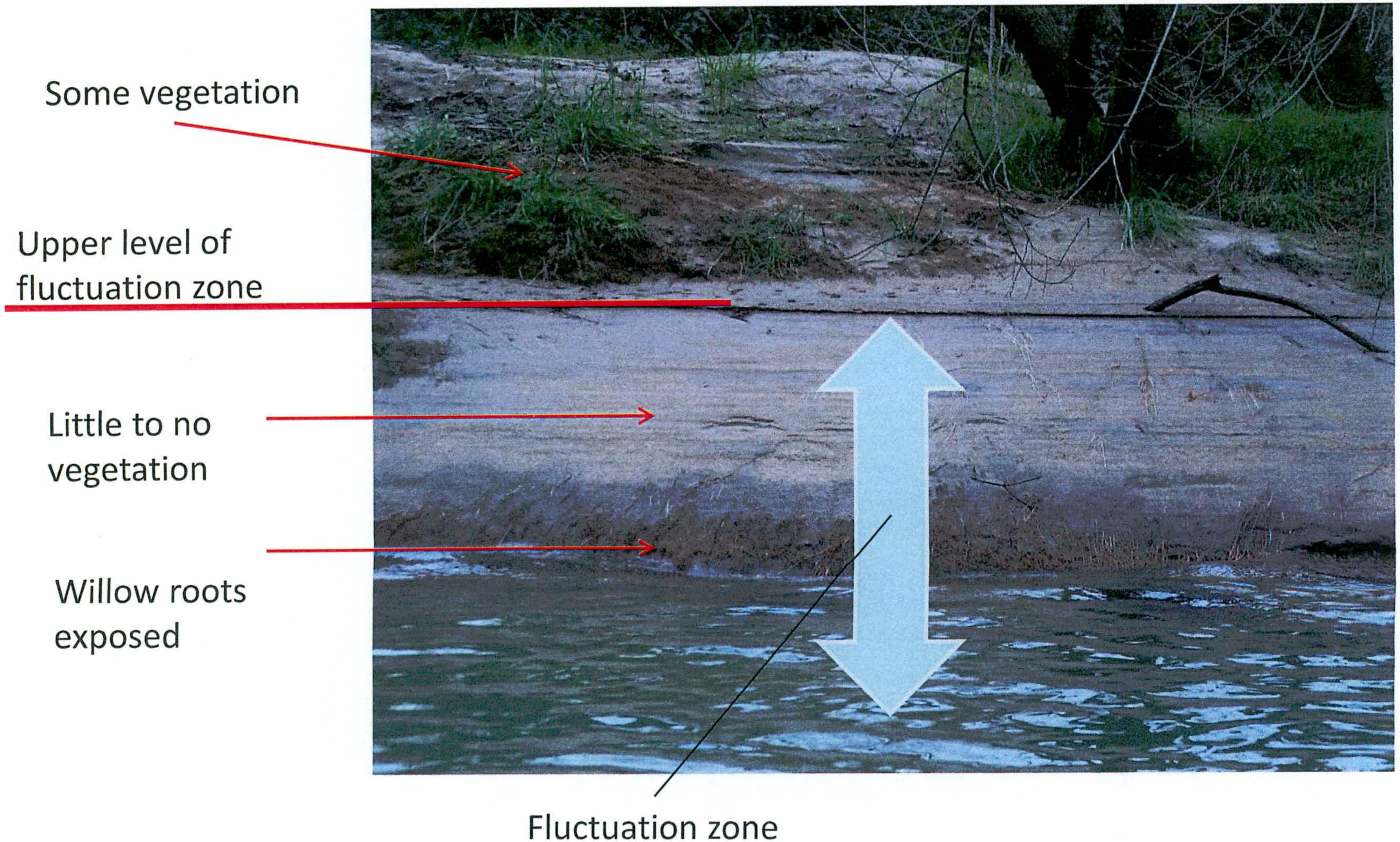
C1. River fluctuations for river site visits



C2. Extent of river fluctuation at Te Teko



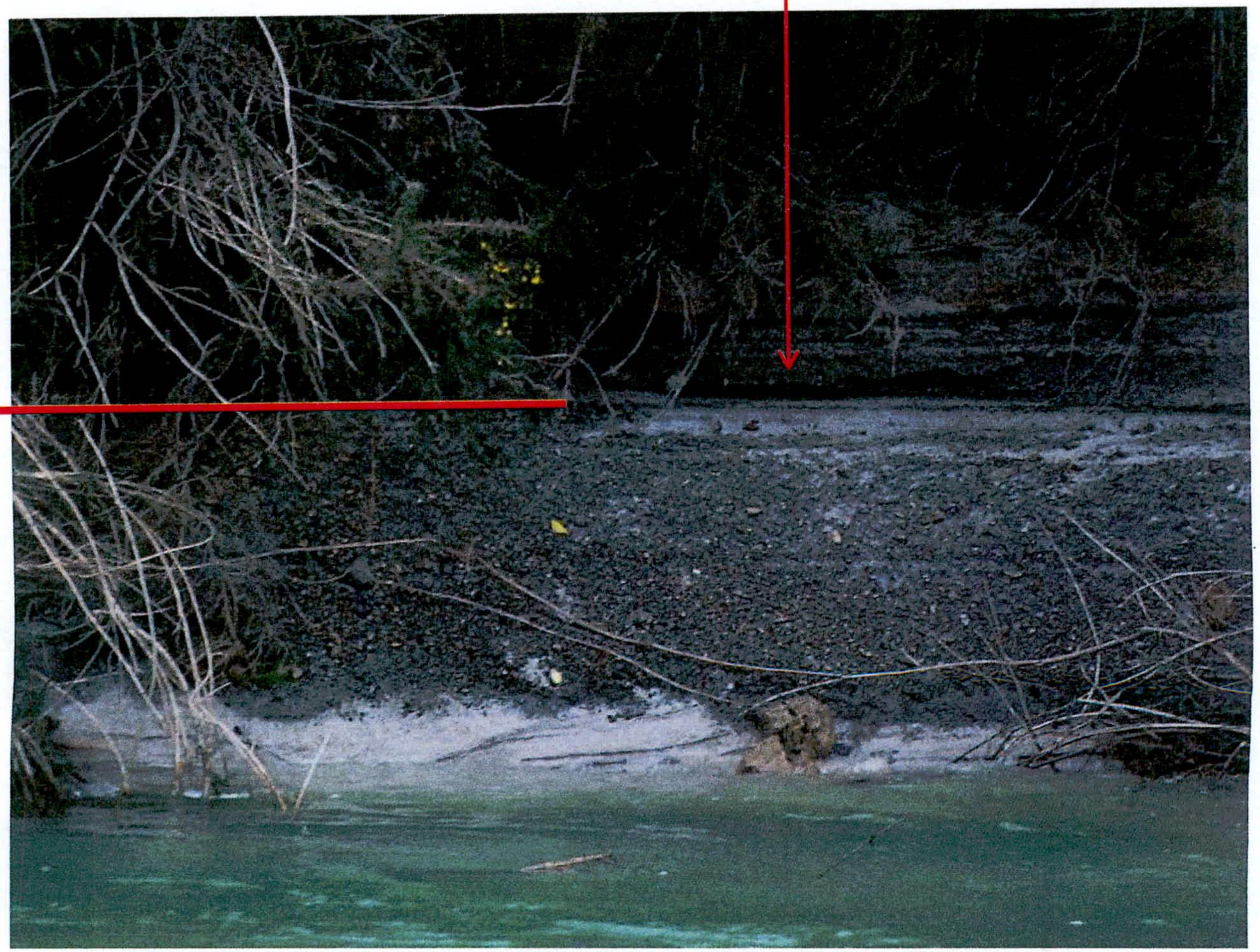
C3. Fluctuation zone illustrating de-vegetation



C4. Riverbank undercut and slump – example 1

Undercut erosion

Upper level of fluctuation zone



C5. Riverbank undercut and slump – example 2

Upper level of
fluctuation zone

C6. Erosion and collapse of rock lining

Upper level of fluctuation zone

C7. Undercut, collapse and erosion into sandy layers

IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of an application by **TRUSTPOWER LTD** to the **BAY OF PLENTY REGIONAL COUNCIL** for water permits associated with the operation of the Matahina Hydroelectric Power Scheme

STATEMENT OF EVIDENCE OF COLIN GEORGE HOLMES

1 INTRODUCTION

1.1 My name is COLIN GEORGE HOLMES

1.2 I hold a Bachelor's degree in Economics (University of Canterbury) and a MBA (Otago University).

1.3 I have lived and farmed in the Galatea Valley for most of my life. My farm adjoins the Rangitāiki River about 5 km upstream of Lake Aniwhenua.

1.4 I was a founding director of Bay of Plenty Electricity following the reforms of 1989 and Chairman from 1992 until 1999. Following the asset split in 1999 I was chairman of the succeeding company Horizon Energy until 2007.

1.5 I was Mayor of Whakatāne District Council from 2004 until 2010.

1.6 I have been a member of the River Liaison Group for many years and have taken an active interest in all aspects of the management and health of the river and its catchments.

1.7 I am the Chairman of the Galatea Murupara Irrigation Society which has an MOU with TrustPower to pursue the investigation of a combined irrigation/generation scheme for approximately 8,000 ha.

2 OVERVIEW OF RIVER LIAISON GROUPS

2.1 There are four river schemes administered by the Bay of Plenty Regional Council which are 80% funded by targeted rates with 20% Regional Council contribution.

2.2 Each scheme has a Liaison Group which fulfils a number of functions. These include:

- A forum for discussion of strategies and long term plans
- A forum for prioritisation of expenditure and discussion of rating levels and sustainability
- Monitoring of operations and expenditure

2.3 The Liaison Groups have no statutory standing or delegated authority. They can make recommendation to Council staff and/or submission to Annual Plans and other Council processes.

2.4 Membership of the Liaison Groups is not formalised nor members fixed. They are chaired by a Councillor from the appropriate constituency and meet twice per year with extra meetings as extraordinary issues arise. Members are ratepayers and/or represent interest groups e.g. Iwi.

2.5 In my opinion, the Liaison Groups provide a valuable link with ratepayers and the community at large and enjoy respect from staff and Council for their feedback and recommendations.

3 THE RANGITĀIKI-TARAWERA RIVER SCHEME – A LOCAL ECONOMY PERSPECTIVE

3.1 I refer to the evidence of Bruce Crabbe and Kenneth Tarboton for details on physical and financial characteristics of the scheme.

3.2 The economy of the Eastern Bay of Plenty is dominated by agriculture, horticulture and forestry/wood processing and the servicing of these industries.

3.3 Of the five major local processing facilities:

- Whakatāne Board Mills
- Fonterra Edgecumbe
- EastpackEdgecumbe
- SCA Kawerau

- Norske Skog Kawerau

3.4 Four are located in the area of the scheme and on the banks of the Rangitāiki or Tarawera Rivers. The Edgecumbe and KawerauTranspower facilities are also located nearby.

3.5 The agricultural and horticultural production is intensive and dominates the land area of the Plains which is bisected by the Rangitāiki River. A unique feature is the proportion of the land which is below or only marginally above sea level. There are extensive drainage and canal systems, many of which require pumping to function effectively. In conditions of inundation they can be completely overwhelmed and often rendered inoperative. This leads to prolonged inundation damage to infrastructure, relocation of stock and severe damage to pastures.

3.6 The Eastpack, Fonterra and Transpower facilities at Edgecumbe have all had extensive flood protection upgrades post 2004 as has the residential area. These were funded by either the Bay of Plenty Regional Council or Whakatāne District Council.

3.7 All road access to the East Coast - Gisborne areas from either Rotorua or Tauranga and the Port of Tauranga is across the Plains via bridges at TeTeko, Edgecumbe or Thornton. All of these highways were severed during the 2004 flood event.

3.8 In summary, our local economy is land based, very intensive in nature and concentrated in area, and extremely vulnerable to both short duration and prolonged inundation in the case of failure of our scheme infrastructure. The 2004 flood demonstrated this vulnerability quite clearly.

3.9 Expert evidence is unanimous in that our soils and parent materials are far from ideal for the construction, maintenance and integrity of flood defences.

4 RECENT HISTORY

4.1 The context in which the ratepayers of the River Scheme view any increased risk of failure is important.

4.2 The history of physical disasters over the last 25 years includes: 1989 Edgecumbe earthquake, 1998 floods, 2004 flood, 2005 Matatā landslip and a host of minor but cumulatively significant flood and saturation induced civil infrastructure failures over the last three years.

4.3 It should also be noted that in flood events the Whakatane River can also produce similar results. In 2004, for example, flooding in urban Whakatane led to evacuation of over 300 homes with many of them uninhabitable for many months. This occurred simultaneously with 17,000 ha of the RangitāikiPlains being inundated, some of it for up to three weeks.

4.4 Despite Government assistance the financial impact on our community both through rates and individual costs is large and ongoing. The remediation and mitigation work impacts well after the events.

4.5 The index of socio-economic deprivation for the Whakatāne District is sixth highest out of 75 New Zealand Territorial Authorities.

5 RIVER LIAISON GROUP AND THE APPLICATION

5.1 The River Liaison Group (RLG) became aware of the TrustPower application in early 2010 and considered our position against the backdrop of a number of factors which included:

(i) The 2004 flood repair expenses
(ii) A trend to much higher maintenance costs
(iii) A trend to more frequent and severe damage for mid-level and smaller flood events
(iv) A growing belief that the TrustPower contribution towards scheme costs was quite inadequate when compared to the costs incurred by its operation. This belief was of at that stage relatively uninformed.
(v) A growing belief that if nothing changed we would ultimately have to rock all of Reaches 2 and 3.
(vi) Growing disappointment with the lack of progress on best practice flood forecasting capability and realistic protocols for reservoir flood management at Matahina.

5.2 We sought more information on all these aspects and a view began to form that we needed to treat the application very seriously.

5.3 The scheme managers accepted our direction and at several key points have sought re-confirmation. Budget considerations have been to the forefront.

5.4 At all times our motivation has only been to pursue fair compensation. More latterly there has been a shift to the view that our scheme, the

community and the environment would be better served by pursuing conditions as close to run of the river as possible.

6 FLOOD MANAGEMENT

6.1 I believe it is important to comment on a community/ratepayer view of flood management at Matahina. It attracts a great deal of public interest albeit some of it quite uninformed.

6.2 The Liaison Group has been very focussed on the need to have the best possible arrangements to attenuate large floods via management of the reservoir. Criticism has been directed at the lack of progress since 2004.

6.3 TPL's concerns about lost revenue are understandable. Our position is that we (RLG) are confident that improved information about weather and catchment conditions coupled with good communication and procedures should minimise those losses. Reaction and adaption to changing circumstances should both minimise needless loss and maximise flood attenuation.

6.4 We believe responsibilities and roles should be very clear and unambiguous and the operating parameters should be wide enough to cope with extreme situations.

6.5 The community expect nothing less than arrangements which are effective, transparent and fair to all parties.

Colin Holmes
July 2011

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IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of an application by **TRUSTPOWER LTD** to the **BAY OF PLENTY REGIONAL COUNCIL** for water permits associated with the operation of the Matahina Hydroelectric Power Scheme

STATEMENT OF EVIDENCE OF BRUCE KELVIN CRABBE

1. INTRODUCTION

Qualifications and experience

1.1 My name is Bruce Kelvin Crabbe. I am the Rivers and Drainage Operations Manager for the Environmental Hazards Group ("EHG") of the Bay of Plenty Regional Council ("BOPRC"). I have held this role for approximately 15 years.

1.2 My qualifications are NZ Certificate in Engineering (Civil) completed in 1981 at the Central Institute of Technology at Upper Hutt and I am a Registered Engineering Associate.

1.3 For the last 21 years I have worked for BOPRC mainly on management of the flood protection, rivers control and drainage schemes managed by the council. This involves managing operational and capital work programmes, targeted rating systems, ratepayer and stakeholder liaison and most aspects of administering these schemes. My first involvement with the Rangitāiki River flood protection system was as a Project Engineer rebuilding the stopbanks following the 1987 Edgecumbe Earthquake and my involvement with the scheme has continued since that time.

1.4 The team I manage consists of 18 staff that carry out the operational roles including maintenance/construction of the river edge protection works, capital

works projects, drainage maintenance and pumping scheme operations. Several of these key people have in excess of 25 years practical experience with BOP rivers including the Rangitāiki River.

1.5 Prior to that I had 15 years' experience involving a wide variety of civil engineering contract management works on large scale construction projects including the Clutha Valley Power Development and the Arapuni Dam Headrace Refurbishment Project.

1.6 The other role I fill is as duty Flood Manager carrying out flood management functions in accordance with council's Flood Manual. This involves, among other duties, liaison with TrustPower staff relating to management of the dam reservoir during flood events in order to minimise impacts of flooding downstream.

Involvement in TrustPower application

1.7 My involvement with the TrustPower application is in the context of my role described above. In particular, I represent the Rangitāiki-Tarawera Rivers Scheme ratepayers, insofar as the BOPRC Environmental Hazard's Group manages the scheme on behalf of those ratepayers.

1.8 This involvement included engaging experts to review the TrustPower application and AEE and advise the EHG in relation to the proposal. Based upon that advice and the EHG experience, I prepared the submission on the application on behalf of the EHG.

1.9 I have been involved in discussions with TrustPower regarding an appropriate annual financial contribution to the Rangitaiki-Tarawera Rivers Scheme to mitigate the adverse effects of operation of the Matahina Power Station. Unfortunately we have not managed to reach an agreement with TrustPower as to an appropriate contribution toward the scheme.

1.10 I have also assisted with revising the proposed Flood Management Plan for operating the dam reservoir during a river flood events.

Purpose and scope of evidence

1.11 The purpose of my evidence is to put the TrustPower application and the EHG evidence into context by providing relevant background to the Rangitaiki-Tarawera River Scheme and the EHG's role and responsibilities

with respect to that scheme, particularly in relation to the ongoing management of the scheme's operations and maintenance programmes.

1.12 Specifically, I will:

(a) Provide an overview of the Rangitaiki – Tarawera Flood Protection Scheme, including the history of and need for the Scheme, the aspects of the Scheme relevant to the TrustPower application and the protection which those aspects of the Scheme provide to the local and regional community. (Section 2).

(b) Provide an overview of the components of the Scheme below Matahina Dam and the value of those components (Section 3).

(c) Outline the works that the EHG undertakes in relation to the relevant aspects of the scheme, the costs of those works and funding (Section 4).

(d) Comment on the impact of recent flood events on the Scheme and costs of those events (Section 5).

(e) The key aspects of the TrustPower proposal with which the EHG is concerned and our position on those aspects of the proposal (Section 6).

(f) Address the monitoring which the EHG undertakes and its concerns with respect to the TrustPower monitoring (Section 7).

1.13 My evidence needs to be considered alongside the evidence of:

(a) Dr Ken Tarboton;

(b) Dr Marianne O'Halloran;

(c) Mr Gary Williams;

(d) Mr Roger Burchett.

2. RANGITAIKI–TARAWERA RIVERS SCHEME

2.1 This section will address the Rangitāiki-Tarawera Rivers Scheme as a whole for the purposes of providing relevant context, identify aspects of that scheme relevant to the TrustPower application and provide an overview of the area which the relevant aspects of the Scheme protect.

Overview of the Rangitāiki-Tarawera Rivers Scheme

2.2 The Rangitāiki-Tarawera Rivers Scheme is a comprehensive river control scheme, providing benefits of flood protection and channel edge stability to much of the land within the Rangitāiki and Tarawera catchments.

2.3 It also comprises flood protection on the tributary canals, including Awakaponga, Old Rangitāiki Channel, Omeheu-Awaiti and Reid's Central. The scheme has substantial physical assets including stopbanks, concrete floodwalls, a bypass floodway, floodgate structures, a flood pumping station, rockwork and other edge protection measures and vegetative plantings.

2.4 The Rangitaiki-Tarawera Rivers Scheme has the largest catchment area of all the schemes managed by BOPRC's EHG. A map showing the location of the scheme is attached to Dr Tarboton's evidence.

History of and need for the Scheme

2.5 The Rangitaiki-Tarawera flood plains were historically an extensive area of wetlands with very few areas of higher inhabitable land. The Rangitaiki River in particular was a meandering river which did not have a direct outlet to the sea, but split a few kilometres from the coast with one branch (Orini Stream) flowing to the Whakatāne River mouth and the other (Old Rangitāiki Channel) flowing to the Tarawera River mouth.

2.6 Early transportation was largely by canoe using the many waterways as overland travel was so unreliable. The waterborne mode of transport continued in early European times as the inland waterways were plied by scows for transporting people and goods across the plains. Throughout early development of the plains the naturally raised levee landforms along the waterways were the favoured locations for land based transport and for dwellings and building etc. These areas were the most reliable (highest level) protection against flooding and lack of drainage. This pattern of development, although counter-intuitive, has continued to this day as most public and private infrastructure is still located along these raised levee areas.

2.7 The LIDAR elevation map in **Appendix A** shows these raised river/stream levees well. This pattern of development is important in context of the location of the flood protection stopbanks as these same naturally elevated levee systems were the logical location to also establish the stopbanks. Several of the Applicant's expert witnesses have commented on the close

proximity of the stopbanks to the river. This is the reason for the location of those stopbanks and it is still valid today.

2.8 The lowland basin areas located toward the northern portion of the Plains are typically lower than mean sea level. Note that the basins adjacent to Thornton and Robbins Road on the LIDAR map are up to 1.0 metres below mean sea level. This low level of these areas creates significant problems with seepage and piping risk as they can be 4 to 5 metres lower than the 1% AEP flood level in the river. Dr O'Halloran will discuss this issue in more detail.

2.9 Early drainage works involving excavation of drainage ditches and canals across the plains in order to develop farmland commenced as early as the late 1800's, however no real progress was made until a new outlet for the Rangitāiki River was excavated to the sea at Thornton in 1914. Development of the plains for farming and settlements progressed significantly from that point on but periodic flooding from the river still occurred, resulting in large areas being under water for extended periods until the drainage systems discharged the floodwaters.

2.10 Many sections of private informal stopbanks were constructed along the river levees in the interim, however a series of large flood events in the period from 1944 to 1964 caused overtopping and/or geotechnical failures of many of these stopbanks and the community rallied to get the problem addressed in a comprehensive manner.

2.11 Aside from the flooding and inundation problems in the lower reaches, there had also been extensive river erosion and realignment problems in the middle and upper reaches, including the Waiohau and Galatea Plains.

2.12 By this time the Soil Conservation and Rivers Control Act 1941 had been enacted, provided for the establishment of Catchment Boards with appropriate powers to establish river schemes. The Bay Of Plenty Catchment Commission was thus initiated and river scheme works on the Rangitāiki and Tarawera Rivers (along with other river schemes) were established from 1971 through to early 1980's.

2.13 In 1987 the scheme was badly damaged by the Edgecumbe Earthquake and required a significant amount of rebuilding and raising of the stopbank system to mitigate subsidence of over 2 metres centred near Edgecumbe, which affected most of the scheme's flood protection system.

2.14 The earthquake exacerbated the integrity of the flood protection system significantly. Aside from the significant expense the scheme incurred to raise and repair the stopbanks following the earthquake, the ongoing legacy of heightened stopbanks creating larger head differences from the designed flood level to the surrounding land; the lightweight permeable soil layers, combined with earthquake damaged soils structures is still being addressed today. Ms O'Halloran will address these issues in more detail in her evidence.

2.15 The levels of service provided by the stopbank systems are largely unchanged from that adopted by the original scheme design. The level of protection adopted for the main river channel is 1% AEP ('100 year' flood event) with most of the tributary canals being constructed to 20% to 10% AEP ('5 year' to '10 year' standard). Gradients across the Rangitāiki Plains are extremely flat and the poor foundation soils make it unsafe to construct systems in excess of these levels of service because of the high risk of seepage/piping failures.

2.16 The history and nature of the Rangitaiki River, the surrounding plains and the Rangitāiki-Tarawera Rivers Scheme is very important because the nature of the existing natural environment means that it is sensitive to any further aggravation. Given the sensitive nature of that environment, management of this river is an ongoing and reactive process and any exacerbation of that existing situation makes our job more difficult and increases the costs of managing the scheme. I will come back to this point shortly.

Aspects of scheme relevant to TrustPower application

2.17 The TrustPower application relates to the Rangitaiki River aspect of the broader Rangitaiki-Tarawera Rivers Scheme, and particularly the 3 river reaches downstream of the dam. A map of the Rangitaiki Catchment, (**Appendix B** based on Attachment 1 of Mr Levy's evidence), shows the river scheme maintenance works area extends well upstream of the Matahina Dam to Murupara and includes the lower reaches of the Whirinaki River and many tributary rivers and streams on Galatea and Waiohau Plains.

2.18 The Rangitāiki-Tarawera River Scheme comprises nine river reaches with 7 on the Rangitāiki and 2 on the Tarawera River. The dam operation affects a downstream length of the Rangitāiki River of 37km which is sectioned approximately into thirds with Edgecumbe and Te Teko being 11km and

24km from the river mouth respectively. These three reaches have been shown in previous evidence and are known as:

(a) Reach 1 – River mouth to Edgecumbe.

(b) Reach 2 – Edgecumbe to Te Teko.

(c) Reach 3 – Te Teko to Matahina Dam.

2.19 I will describe the components of the scheme in these reaches and the works undertaken by EHG in these reaches in Sections 3 and 4.

Benefits of Scheme

2.20 The three reaches of the River Scheme which lie below Matahina Dam protect land which lies within the potential inundation zone shown on the map attached at **Appendix C**. The area at risk of inundation from a stopbank breach or overtopping event comprises approximately 7,400 hectares and is largely rural land.

2.21 The rural land is used predominantly for dairy farming, but kiwifruit and cropping (largely maize) is also a common land use. The townships of Edgecumbe, Thornton and Te Teko are also located within the potential inundation zone.

2.22 The Scheme also protects significant local and regional infrastructure. As noted above, much of that infrastructure has historically been located on natural levees which have formed adjacent to the river channel. Therefore much of the infrastructure in the area is located close to the river.

2.23 In particular, State Highways 2 and 30 and the Thornton Highway cross the floodplain and these were all severed for varying periods during/following the 2004 flood event. Other locally and regionally significant infrastructure which is protected by the flood protection works include:

(a) The Transpower substation at Edgecumbe (this substation controls all electricity reticulation from Edgecumbe to the East Coast);

(b) The Fonterra factory at Edgecumbe;

(c) The Eastpack Kiwifruit processing facility at Edgecumbe, and;

(d) Many other District Council managed roads.

3. **OVERVIEW OF COMPONENTS OF RIVER SCHEME BELOW MATAHINA DAM**

3.1 This section of my evidence provides an overview of the key components of the River Scheme below Matahina Dam and addresses the value of those assets.

Key components – river edge protection and flood protection

3.2 There are two components to the River Scheme below Matahina Dam and the works which EHG undertakes, being:

(a) River edge protection; and

(b) Flood protection.

3.3 These components and works overlap significantly but they nevertheless need to be distinguished in the context of this hearing because TrustPower takes the view that it would be appropriate for the company to contribute to river edge protection but not to other aspects of the flood protection scheme, i.e. stopbanks. EHG does not accept that the TrustPower operation has no effect on the stability of stopbanks (which are located from Te Teko to the mouth) but we do accept that TrustPower is not responsible for any upgrades to the stopbanks, including to meet revised levels of service, etc. We have taken this into account in assessing TrustPower's proposed mitigation of its proposal.

3.4 I will address each of these components below.

River edge protection

3.5 River edge protection generally comprises works along the river banks themselves and are generally designed to counter erosion which arises as a result of freshes/floods in the river or other causes.

3.6 River edge protection works includes planted trees, willow tree groynes, rope and rail river training groynes and rock edge protection works. The scheme has installed and maintains an extensive length of river edge protection works that extend intermittently from the Rangitāiki Mouth some 95km up to the township of Murupara (located well above the Matahina Dam), including various tributaries upstream of the dam.

3.7 Historically, the Rangitaiki River was managed by means of rockworks (used at high energy erosion sites) and a variety of willow-based soft engineering works. The willow works involved the installation of willow tree groynes and planting of willows on battered (sloped) banks. A typical trenched willow groyne layout is shown in **Appendix D1**. Over approximately the last decade, EHG has moved away from these soft engineering works because we have found that they are not adapting to the fluctuating river levels and tend to slowly sicken and die. Now, more often than not, our options are limited to using rock edge protection works which are more robust but also considerably more expensive (shown in **Appendix D2**).

3.8 This change in management method is important because EHG's view is that the unnatural fluctuations in river levels has had an impact on the ability for vegetation to establish on the river banks within the fluctuation zone. The hard engineering solutions which we are now forced to adopt are more expensive in terms of capital expenditure and in terms of ongoing maintenance. Our costs have therefore risen significantly in the last decade and, in particular, since the agreement which BOPRC entered into with the Electricity Corporation of New Zealand in 1998 with respect to a financial contribution towards the scheme as mitigation for the effects of the Matahina operation.

3.9 The increase in Scheme costs over the last decade, as compared with the contribution from TrustPower are shown in the table below:

Rangitāiki-Tarawera River Scheme Rate and TrustPower Contribution Information Table

Financial Year Ended 30 June	Targeted Rate Collected[1]	Targeted plus Regional Rate[2]	TrustPower Contribution
2001	656,000	756,000	
2002	747,000	841,000	
2003	764,000	846,000	8,940
2004	755,000	813,000	11,381
2005	707,000	1,393,000	12,931
2006	1,058,000	1,182,000	13,032
2007	1,160,000	1,463,000	13,594
2008	1,279,000	1,615,000	15,103
2009	1,453,000	1,888,000	15,647
2010	1,134,348	1,419,000	15,376
2011	1,377,121	1,715,000	12,245
2012	1,499,995	1,874,994	
2013 Forecast	1,679,994	2,099,993	

Notes:
1. The targeted rate is colllected from landowners within the scheme catchment area.
2. The Regional funds contribution toward the scheme operating cost has increased from 5% up to 20% over this period with 20% commencing in 2006-2007 financial year.

Flood protection works

3.10 Along the Rangitāiki River the scheme provides flood protection from approximately Te Teko to the river mouth. Flood protection works which form part of the Scheme include stopbanks, concrete floodwalls, and a bypass floodway to reduce the flow down the main river channel. The layout of the flood protection system and the level of service provided by the stopbanks is shown on **Appendix E**.

Value of Scheme assets

3.11 The Rivers and Drainage Asset Management Plan identifies the Scheme asset valuations (Optimised Replacement Cost). They are summarised as follows for the whole scheme:

River edge protection works:	$11.1M
Pump station:	$0.7M
Stopbanks:	$45.4M
Structures:	$1.3M
Total:	$58.5M

3.12 Asset value data for the 3 reaches below Matahina Dam is included in the table below:

Rangitāiki River Mouth to Matahina Dam River and Flood Protection Assets		
Asset Type	Length (m)	Replacement Value
Concrete Floodwall	665	$367,694
Edge Planting	31,496	$133,858
Rockwork & Rubble	17,089	$7,649,529
Stopbanks	36,117	$14,412,773
Trenched Willows	2,533	$178,565
Total Asset Value below Matahina Dam	-	$22,742,418

3.13 Thus the River Scheme below Matahina represents a significant investment in infrastructure from the local community.

4. WORKS UNDERTAKEN BY THE EHG AND ASSOCIATED COSTS AND FUNDING

4.1 This section of my evidence outlines the types of works undertaken by the EHG and the costs of those works, particularly in order to in order to inform the Committee as to the adequacy of the proposed TrustPower contribution, and funding arrangements.

Overview of Asset Management Plan

4.2 The Asset Management Plan ("AMP"), and the public consultative procedure for its adoption through Council's Ten Year Plan, is the procedure which the EHG uses to manage the physical assets of the scheme, set appropriate performance standards, establish appropriate maintenance programmes and forecast long term expenditure on the schemes.

4.3 Ongoing consultation with scheme stakeholders is achieved via the AMP and Annual Plan/Ten Year Plan adoption processes. Each of the schemes managed by the EHG also has an elected Liaison Committee and

consultation meetings are held twice per year and when extra-ordinary issues arise.

4.4 Levels of service for the river scheme are addressed through the AMP, Annual Plan/Ten Year Plan and the Floodplain Management Plan processes.

4.5 The AMP maintenance costs budget for the Rangitāiki-Tarawera Scheme is shown in **Appendix F**. This is the same spreadsheet which has formed the basis for the analysis of an appropriate contribution by TrustPower to the Scheme by Mr Levy, Mr Philpott, Mr Williams and Mr Burchett. The maintenance plan budget covers the whole of the scheme and of particular interest to this resource consent renewal is the first three river reaches that comprise the Rangitāiki River from the Mouth upstream to Matahina Dam.

4.6 The routine operating and maintenance costs of the Scheme are addressed below. I have also provided an overview of other costs which the Scheme incurs (i.e. future unknown costs associated with flood repairs and capital improvements) in order to demonstrate the nature and scale of costs which may arise as a result of erosion and flood events. I also considered it necessary to address how the EHG accounts for flood reserves, which appears to have been misunderstood by both Mr Levy and Mr Philpott in undertaking their assessments of an appropriate contribution to the Scheme by TrustPower.

Routine maintenance works and operating / maintenance costs

4.7 Ongoing maintenance programmes are established via the AMP. The existing 2008-2009 AMP was adopted as part of the 2009-2019 Ten Year Plan.

4.8 Routine maintenance involves works such as:

(a) Layering of willows - encourages compact growth close to the river bank and strengthens the riverbank by the layered limbs setting roots. This also assists during flood events by reducing water velocity close the river bank;

(b) Tree clearing and burning – Willows which are unstable and/or sick or dying need to be cleared and burned;

(c) Planting – i.e., replacement of willows where vegetation is able to be established.

(d) Rock maintenance – The AMP maintenance frequency includes replacement of 25% of existing rock works every 15 years.

(e) Rubble maintenance – The AMP maintenance frequency includes replacement of approximately 10% each year as concrete rubble is available.

(f) Fencing – River banks which are planted to protect the vegetation from stock require ongoing maintenance.

4.9 The operating and maintenance cost for the whole Rangitaiki-Tarawera River Scheme for 2011-2012 financial year is $1.875M (excluding GST). This is funded 80% by the scheme targeted ratepayers ($1.5M) and 20% by the wider Regional Funds ($0.4M), which is explained below.

4.10 The routine maintenance costs are set out in **Appendix F**. They are divided into general costs and costs associated with the maintenance of each of the Scheme's reaches.

4.11 The general costs relate to the Scheme as a whole and involve:

(a) Management/administration of the Scheme including liaison with stakeholders, TYP, Audit and Local Government Act requirements, managing ratepayer enquiries etc.

(b) Inspections and annual inspections of river scheme assets for condition monitoring and planning maintenance programs;

(c) Recording of rainfall and river gauge data, etc.

(d) LAPP and transfer to flood reserves (I will address flood reserves later).

(e) Updating asset valuations and Asset Management Plan (including auditing, etc);

(f) Repairs associated with minor flood and freshes, i.e. ongoing erosion repairs from small frequent floods.

(g) Surveying river cross sections, etc.

4.12 The maintenance costs of each of the three relevant reaches are:

(a) Reach 1 – $71,421;

(b) Reach 2 – $76,510;

(c) Reach 3 - $53,743.

4.13 Preparation for the next Ten Year Plan (2012-2022) is currently underway involving reviewing the AMP. Significant increases in the scheme operating costs are inevitable particularly with managing flood repairs as existing flood reserves have been completely depleted resulting from the August and January flood events. Large increases in LAPP insurance (of up to 400-500%) have been also been advised as a consequence of the Christchurch earthquake events.

Flood repairs / flood reserves

4.14 Repair of flood damages is a common activity on any river scheme and is an expected challenge. Erosion repair works are effectively just another maintenance activity; the difficulty being when forecasting maintenance programmes in the AMP the actual sites and severity of the damages are unknown so the repair costs are included similar to a contingency. Flood repair work is primarily maintenance that we undertake in order to remedy damage from floods of any size. This work primarily relates to river banks, but can include works with severe erosion of the adjacent river bank (shown in the **Photo 3 at Appendix M**) or catastrophic failure. Flood repairs are particularly important because if they are not repaired immediately, the fluctuations from the TrustPower operation aggravate the damaged sites.

4.15 The work involved in these reaches is almost always rock works, but is essentially no different to the works we do in routine maintenance or geotechnical works.

4.16 The Scheme's Asset Management Plan accommodates for responding to flood repairs at a hierarchy of levels as follows.

Annual flood damages

4.17 Minor erosion repairs are an ongoing maintenance work activity and it is important to keep this activity as a high priority to avoid the risk of small repair works escalating into much larger and more costly repairs. The AMP budget currently allows $80,000 per annum for carrying out these minor erosion repairs. This is shown in the **Appendix F** AMP maintenance schedule, General category, as "Flood Damage Freshes (<20%AEP)". As

noted above, the only reason it isn't included as a task within the reaches is that we don't know where the work is going to occur.

Floods exceeding 'five year' events

4.18 This mid-range of damages is managed by accumulation of funds in the Flood Reserve (shown in **Appendix F** as "Transfer to Reserves – (Flood Damage) (>20%AEP)". This annual contribution had been included in the 2008-09 AMP as $26,000pa but this has proved to completely inadequate with the recent frequency and severity of events and new flood risk modelling is planned for the next revision of the AMP. Withdrawal from this Reserve to fund flood repair works requires Council approval.

Major flood events

4.19 Major flood events are intended to be covered by membership of the Local Authority Protection Programme ("LAPP") infrastructural asset insurance programme and Government financial assistance. It is assumed that a major flood event will attract a Government contribution via the National Disaster Recovery Plan although this contribution is discretionary. In general terms it is planned that the LAPP cover funds the 40% local share of repair costs and the Government share is 60%. In practice, repair costs are not totally covered because there are deductibles and items not covered by the insurance (e.g., creation new assets are not covered by LAPP).

4.20 When the funding options above are depleted or drawn down the scheme is obliged to raise loans to fund the repair works. The Rangitāiki-Tarawera Rivers Scheme has a high level of debt (currently $7.3M) and this is largely due to the frequency and severity of flood damages incurred particularly since 2004 and the geotechnical strengthening works programme.

Geotechnical works

4.21 Typically geotechnical works involve either toe-loading, seepage pressure relief systems (either pressure relief trenches or wells) or rock edge strengthening works. **Attachment G** shows diagrammatically how the geotechnical strengthening works function. This process is explained more fully in Dr O'Halloran's evidence. The rock work component is generally no different to flood damage repair works, but for accounting purposes geotechnical works are treated as a capital work because they result in a new asset.

4.22 For example, we have a geotechnical strengthening works programme which was initiated follow the seepage/piping failure of the stopbank foundation at Sullivan's Bend in July 2004 and other geotechnical difficulties prompted by the 1998 flood event. The purpose of the works is to improve the factor of safety against a stopbank foundation failure caused by weak and/or damaged soil conditions. This project involves investigation of areas of potential geotechnical weakness and implementation of remedial works to strengthen them.

4.23 The overall cost of this project is expected to be approximately $4.5M and the project is loan funded, therefore expenditure to date is included in the existing scheme debt figure of $7.3M.

Capital improvements

4.24 A capital improvement is essentially creating a new or enhanced asset. They can involve major maintenance works, such as erosion repairs, but even where they do, we account for these works differently because they represent a new asset in terms of our AMP.

4.25 Capital improvements can also include raising stopbanks or improvement to the flood protection system to make it more robust or meet a higher level of service. Typically, we would not regard these works as something that TrustPower should contribute toward. However, some of capital works, particularly those which might arise from a major flood or geotechnical works such as those described above, could involve works which arise at least in part as a result of a precondition to which TrustPower's operation has contributed.

4.26 Considerable capital improvements have been made to the Scheme throughout its history. The more recent capital projects have included:

(a) Post-Earthquake Restoration Project;

(b) 2004 Flood Recovery Works; and

(c) The Edgecumbe/Rangitāiki River Flood Mitigation Project.

4.27 The 2004 and 2010 / 2011 floods will be addressed in more detail in Section 6 for the purposes of illustrating the level of damage that can occur and the scale of future unknown costs which the Scheme can face.

Funding of scheme

4.28 As addressed above, the Scheme is primarily funded via targeted and general rates. The targeted rates are collected from landowners within the Rangitāiki-Tarawera catchment area and form 80% of the funding for the Scheme. In other words, the people who are protected by the Scheme pay for the Scheme.

4.29 The existing targeted rating system for the scheme is a 'land area, whole-of-catchment, differential' rating system. Therefore rates are based upon the property area, all landowners within the catchment are levied some rate, and the level of rate per hectare is based on the amount of benefit the scheme provides them (the higher the benefit the higher the rate per hectare). Dr Tarboton's evidence has addressed the typical urban and rural rates, particularly as compared with the rate paid by TrustPower.

4.30 The Scheme is also partly funded by general regional funds (20%) in order to recognise the wider regional benefits provided by the Scheme (for example SH route security, economic and environmental benefits).

4.31 From time to time, projects undertaken by the Scheme attracted Government subsidy funding. For example the 2004 flood recovery attracted a 60& government contribution and the Edgecumbe-Rangitāiki River Flood mitigation project is attracting a 33% subsidy from Government under the hazard mitigation policy.

4.32 The TrustPower contribution per the 1998 agreement varies in minor way each year given that it is adjusted by the construction index. For the 2009-2010 year, that contribution was $15,646 +GST; for the 2010-2011 year, that contribution was $13,776 + GST because the construction index reduced in that year. This is addressed in more detail by Mr Burchett. Based on current flood repair works costs the TrustPower contribution under the 1998 agreement represents approximately 15 - 20 lineal metres of rock works per annum.

5. COSTS OF RECENT FLOOD EVENTS

5.1 The Rangitāiki-Tarawera Scheme has been adversely impacted by several flood events over the past decade which have given rise to significant costs which need to be funded by the ratepayers. This section briefly addresses the 2004 and 2010/11 flood events and associated costs in order to demonstrate the uncertainty which arises for those ratepayers in terms of

future unknown costs of the flood protection scheme and the sensitive nature of the Scheme.

2004 Flood Events

5.2 The scheme experienced a 1% AEP ('100 year') flood during July 2004 followed by another large flood in December the same year. The July event resulted in a breach of the Rangitāiki River at Sullivan's Bend located on the right bank upstream of Edgecumbe Township. It has been estimated that approximately one third of the river flow diverted through the breached stopbank resulting in widespread inundation of the Rangitāiki Plains. Edgecumbe Township was badly affected with approximately 129 homes being damaged by floodwaters, flooding of the Fonterra offices and manufacturing plant and narrowly missed inundating the Transpower electricity substation that supplies all of the area from Edgecumbe to East Cape.

5.3 The cost impact of this event was extensive. Central Government contributed $29M toward the recovery works covering mainly transport, public infrastructure and contribution toward the flood scheme works. It is estimated that private losses resulting from the flood event were in the order of $150 million.

5.4 Resulting flood repair costs for the Rangitāiki-Tarawera Rivers Scheme totalled approximately $8.5M. $5.6M of this was spent along the three river reaches downstream of Matahina Dam summarised as follows:

Reach 1: Mouth to Edgecumbe;	$1.556M
Reach 2: Edgecumbe to Te Teko:	$2.979M
Reach 3: Te Teko to Matahina:	$1.059M
Total:	$5.594M

5.5 The scheme received disaster recovery funding from the Government that amounted to 51% after deductibles. The scheme residual share was therefore 49% i.e. approximately $4.2M in total.

2010-2011 Flood Events

5.6 The Rangitāiki River (along with other rivers in Bay of Plenty) experienced further flood events in August 2010 and again, twice, during January 2011.

These flood events were intermediate flood events of approximately 10% AEP.

5.7 These were not particularly major events and despite the 2004 rock works being in place, the Scheme still experienced very significant damage. While the EHG acknowledges that the dam has some beneficial effect in attenuating floods, the damage caused by the 2010/ 2011 floods translates into approximately $1.1M in costs for the three reaches below Matahina Dam.

6. **EFFECTS OF GENERATION FLUCTUATIONS**

6.1 This section of my evidence will briefly address the aspects of the TrustPower operation which give rise to concern for the EHG and provide an overview of our experience of the effects of that operation.

Relevant aspects of TrustPower operation

6.2 The key issues which arise in relation to the management of the River Scheme and effects on the Scheme are:

(a) The fluctuations in river level which arise as a result of the peaking. The key issue which arises here is the effect on vegetation, the ability for vegetation to re-establish and consequent erosion of bare banks.

(b) The seasonal range of those fluctuations. When seasonal variations in fluctuation over a period of time are combined, the overall range of levels is very large.

(c) Peaking during low flows. Peaking during low flows extends the range of fluctuations below the natural range and increases the range of overall fluctuation.

(d) Ramping rates. The key issue with respect to ramping rates is the rate at which river levels are ramped down and the effect that this has on stability of the river banks. This is further addressed by Mr Williams and Dr O'Halloran.

6.3 Based on the modelling data provided by Beca, recorded data from the Te Teko river level recording site and from modelling of a worst case scenario peaking regime, EHG have deduced a range of information to show historic and proposed water level fluctuations. This is addressed below. I have also commented on the effects of these fluctuations on the river scheme and river

bank stability as experienced by my staff who spend extended periods of time working on the river and observing the regular fluctuations.

Historic river level recording at Te Teko and level at time of site visit

6.4 Existing data from the Te Teko river level recorder for the period 2007 to 2009 is attached as **Appendix I**. This includes the period when the "informal agreement" or rough running regime was in place and has been referred to by the Applicant's experts as being "similar" to the proposed operating regime. The data shows periods of fairly regular fluctuations from 0.3m to 2.0m (approximately 35 cumecs to 130 cumecs) during the period July 2007 to October 2008. During that period, the fluctuations at Te Teko varied over a range of approximately 1.7 vertical metres. Mr Williams will address the effects of such fluctuations on river banks and river bank stability in detail, but it is worth noting here that this is a significant deviation from a natural flow environment.

6.5 It is important to point out here that the site inspection which the Commissioners undertook on Friday, 1 July 2011 occurred at a time when the Te Teko recorder was at approximately 2.1 metres (refer **Appendix J1**) or, in terms of flow, 130 -140 cumecs (**Appendix J2**). In other words, during the site visit, the river level was toward the upper water level associated with a normal generating regime. **Appendix I** shows that during 2007 to 2009, the water level was lower than that for the majority of the time. The minimum flow level shown on the graph at **Appendix I** is approximately 1.7m lower than the level experienced during the site visit. It would therefore have been reasonably difficult for the Commissioners to fully appreciate the extent of impact on the river banks because they were largely inundated. It should be noted that the proposed 20 cumec low flow condition would show up on the Te Teko recorder as 0.0 metres, i.e., 2.1m below the river level observed on the site visit.

6.6 I undertook a site visit along with Dr Tarboton, Mr Williams and Dr O'Halloran on Sunday, 3 July 2011 at 1.30pm – 4.00pm. At that time, the river level was ranging from 0.9m to 1.0m as shown in **Appendix J1** and **Appendix J2**. This is significantly lower than the levels and flows at the time of the Commissioners' site visit and Mr Williams' evidence will address photographs which show the extent of existing damage to the river banks within the fluctuation zone in order to fully appraise the Commissioners of that situation.

6.7 I note that I have also attached a map at **Appendix Q** showing the location along the river of the key sites which were visited by the Commissioners.

Attenuation modelling by Beca

6.8 "Figure 5" from the Beca 2009 River Hydrology, Hydraulics and Bank Erosion report is attached as **Appendix K**. The general profile of the flow peaks shows that there is some attenuation down the river but that the height of the peaks at Edgecumbe and Thornton is still quite significant. Analysis of the first peak on Figure 5 (circled on the Appendix) indicates flows in cumecs of approximately 84, 79 and 76 respectively at Te Teko, Edgecumbe and Thornton as follows:

Location	Flow Rate (cumecs)	Percentage of Te Teko Flow Rate
Te Teko	84	N/a
Edgecumbe	79	94%
Thornton	76	90%

6.9 From this information it can be deduced that attenuation of the flow peak down the river is relatively small and that the flow peak continues well down the river and through Reach 1. This indicates that the dam operation will have impacts into Reach 1. EHG acknowledges that the tidal influence will also be significant in this reach, but Mr Williams view is that the tidal influence does not entirely cancel out the influence from the dam operation and he will address this in more detail.

Worst case scenario peaking regime

6.10 Mr Burchett has undertaken modelling which demonstrates that daily fluctuations in flow ranging from 20 to 150 cumecs is possible as a worst case scenario, which his addressed in his evidence. This flow range at the Te Teko recorder site represents a river level fluctuation between zero (gauge height) and 2.3 metres (shown in the graph attached at **Appendix N**). A regular fluctuation of this magnitude (up to 2.3 metres) would have a serious adverse effect on the vulnerable banks on the river.

Observed impacts of fluctuations

6.11 EHG staff have significant experience working with and on the river over decades and, based on that experience and observations during the course of that work, have formed the view that the daily fluctuations of river level below the dam, created by the peaking regime, detrimentally impacts the river bank in the following ways:

(a) Weakened precondition of river bank: EHG observation and experience with this river indicates that the regular fluctuation of flow levels in the order of 1.5 metres daily or twice daily creates a weakened zone on the river bank where suitable edge vegetation and silts are lacking. This precondition creates a relatively weak area of river bank so that damage and erosion of the banks during flood events is more severe. Some of the Applicant's expert witnesses have stated that the scheme is in a more robust condition now that the 2004 flood repair works have been installed. This is correct to an extent however the extensive damages caused by the January 2011 event demonstrates that the edge protection system is still vulnerable to these events and tends to lend support to the EHG's concern about the weakened precondition of the river banks.

(b) Eroding of river banks already exposed: It is common for exposed areas of damaged river bank to remain unrepaired for some time following from significant floods simply due to the extent of work to be carried out and also due to the priority order applied. Flood repair works are always prioritised by EHG to be carried out where flood protection assets are at risk first. This means that repair works in Reach 3 (no stopbanks) particularly will remain unrepaired for some time. The 2004 flood repair works programme for example continued for up to 3 years so inevitably many sites remained in a damaged state for considerable periods. During this time these vulnerable sites inevitably incur more damage due to subsequent floods but also due to the regular fluctuations caused by the dam. Several of the "before" photos of flood repairs contained in **Appendix M** show the 'tidal' effect of the regular generation fluctuations. **Photograph 2c** shows a large section of exposed riverbank subsiding into the river whilst awaiting repair. The EHG's view is that this ongoing impact causes extra costs to the scheme ratepayers and our jet boat inspection on 3 July 2011 reinforced this view.

(c) Preventing the natural healing process: In some situations where erosion occurs and the site is not critical in terms of proximity of a stopbank or other valuable asset, they may be left and monitored to allow a self-healing process to occur. If the eroded bank has slumped to a reasonable angle of repose (slope) and there is reasonable amount of soil and/or grasses the areas may revegetate and stabilise naturally. This results in a cost saving for the scheme ratepayers. In the reaches below Matahina this option rarely works as the frequent fluctuations fritter away the soil and grasses before they can re-establish.

(d) Low cost soft engineering works are unsuitable: As I have already explained above, establishing willow tree groyne works is a less costly method of edge protection works but is generally unsuccessful in the reaches below the dam. EHG is therefore forced to use higher cost rock protection works. Typical lineal metre rates for trenched willow groyne works varies from $150 - $200, compared with rock protection works that can range from $500 - $1500 per lineal metre.

(e) Increased requirement for rock maintenance works: The frequent fluctuations caused by the dam operation are having an adverse effect on the installed rockworks. Close inspection of the rockworks on 3 July 2011 has revealed that many of the rockworks constructed as part of the 2004 flood repair works are already requiring replenishment at the river level where the fluctuations occur. This will be address in the photographs contained in Mr Williams' evidence. The AMP maintenance schedule assumes rock replenishment (i.e. replacing of lost rock and strengthening of existing rockwork edge protection works) will occur on a 15 year cycle with 25% of the rock being replaced. The 2004 repair works that were completed between 2004 and 2006 are in need of strengthening at many locations now, which is well ahead of of the frequency assumed in the AMP maintenance program.

7. MONITORING UNDERTAKEN BY BOPRC AND CONCERNS WITH TRUSTPOWER MONITORING

7.1 This section of my evidence provides a brief overview of the monitoring which is undertaken by EHG and the purpose of that monitoring, as requested by the Commissioners, and also addresses the EHG's concerns with respect to the monitoring undertaken and reported on by TrustPower.

EHG monitoring

7.2 The EHG undertakes monitoring for the BOPRC for the purposes of river management and the planning of maintenance works.

7.3 That monitoring involves a comprehensive system of river cross sections which are regularly resurveyed. In the lower Rangitāiki River (mouth to Matahina) 67 cross sections are spaced 300m to 700m apart which are resurveyed at a 3 – 5 year frequency and following significant flood events. These are shown on the map at **Appendix O**.

7.4 These cross sections are used for river management purposes including hydraulic capacity modelling and fluvial processes analysis. The results of the analysis of these surveys are compared against any gravel extraction records to develop an understanding of the movement of gravel and bank erosion in the river systems of the Bay of Plenty.

7.5 We also undertake condition monitoring of the river banks and stop banks annually (as a requirement of the AMP) to identify problem areas and to assist in planning the annual maintenance works programme.

7.6 Other forms of ground water monitoring have also been carried out and are being established to monitor effectiveness of the geotechnical strengthening works.

7.7 The short point is, the EHG does not monitor for the purposes of ascertaining the cause of erosion and bank instability – our primary focus is to identify areas at risk and stabilise them as soon as we can within our financial constraints and according to identified priorities based on level of risk.

TrustPower monitoring

7.8 TrustPower was required to undertake monitoring of a range of sites pursuant to its existing consent, which primarily involved jet boat inspections and cross sections. Mr Williams will address the adequacy of the monitoring which has been undertaken, but the purpose of my comments is to provide some background in terms of EHG's concerns with respect to the monitoring results produced by TrustPower.

7.9 I am aware from my lengthy involvement with the River Scheme and from observations of my staff that the EHG (and the ratepayers which are protected by the Scheme) have long held concerns that the monitoring which

has been undertaken in the past has not correlated to our experience of the river and ongoing erosion damage of the river banks.

7.10 The effects of the operation of the dam have been recognised for several decades. The memorandum from BOPRC staff dated 9 February 1998 (Wallace/ Dunlop) attached at **Appendix P1** (which formed the basis for the 1998 agreement, which is attached at **Appendix P2**) signals that the very issues which EHG raises today (in terms of bank instability and inability to establish vegetation) were at issue when that memorandum was drafted in 1998 (and, indeed, before then). Key aspects of that memorandum include:

(a) Reference to the twin peaking trials in 1980, which caused damage to river banks such that the power station was returned to a mixture of one peak per day and run of river operation after just ten weeks.

(b) Little reporting of monitoring of the effects of a trial of a second intermediate peak, inconclusive results of monitoring of those changes and that monitoring appeared to have been halted.

(c) Acknowledgement that fluctuations could be a contributing factor to erosion and weakening of banks, including the possibility of a greater influence on bank instability of a twin peaking regime.

7.11 In terms of the variation to the consent to allow twin peaking, I raised these issues again (see memorandum dated 9 June 2005, attached at **Appendix L**) with BOPRC's Manager of Consents and Compliance. In particular, I noted that the 2004 flood events caused such significant damage that any conclusions that could be drawn from monitoring results after that event are fairly meaningless.

7.12 I also made the point that sites which were noted as being subject to erosion had that trend truncated because once we identify a problem site, we fix it as soon as we are able to. This is a real concern insofar as interpretation of the monitoring results can be affected by the EHG doing its job.

7.13 These issues raised by the EHG have repeatedly been refuted by Beca and the issue has never been resolved.

7.14 More recently, Beca has provided information in support of Mr Levy's assessment of an appropriate contribution from TrustPower (refer 16 June 2011 File Note attached to Levy evidence) which includes a table of vegetation cover indicating that the areas of bare bank at near water level

ranges from 1% to 16% over the three reaches below the dam. EHG has not been able to review the analysis as the report is "unpublished".

7.15 However this form of monitoring is difficult to assess without having a close inspection of the river bank to assess the type and strength of vegetation cover. The reason for this is that some types of vegetative cover, particularly vegetation like blackberry and trailing grasses can give the impression of good vegetative cover but can be disguising bare river bank beneath. Similarly, areas of river bank with established trees or other vegetation can appear stable from the water but can be partly undermined beneath the water level and have significant tension cracking behind it making it quite unstable. If this inspection has been carried out from a jet boat without closely inspecting the banks from close proximity the information provided is likely to be misleading.

7.16 The results of this monitoring report don't reconcile with EHG observation of the banks which have been carried out as recently as 3 July 2011 (and which will be illustrated in the evidence of Mr Williams). When closely inspected there are quite significant areas where the river bank is bare and very unstable as well as a large number of rock protected sites that require premature replenishment.

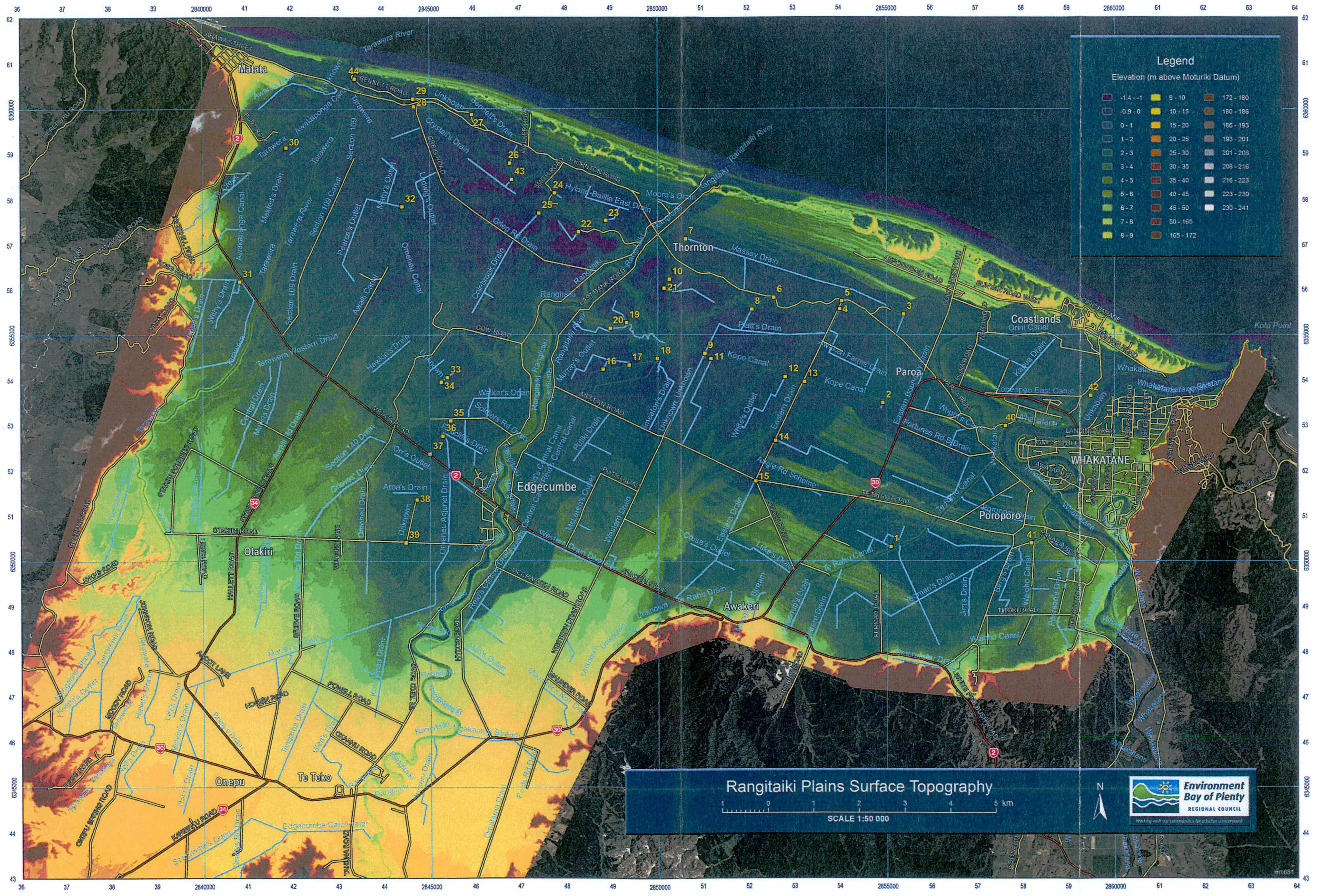
7.17 For this reason, EHG strongly urges the Committee to include conditions of consent which incorporate robust monitoring and review conditions with provision for an independent review panel which can assess the monitoring being undertaken but also take into account concerns raised by the EHG as a result of its experiences on an ongoing basis.

Bruce Crabbe
July 2011

Statement of Evidence of Bruce Crabbe, Operations Manager for Bay of Plenty Regional Council

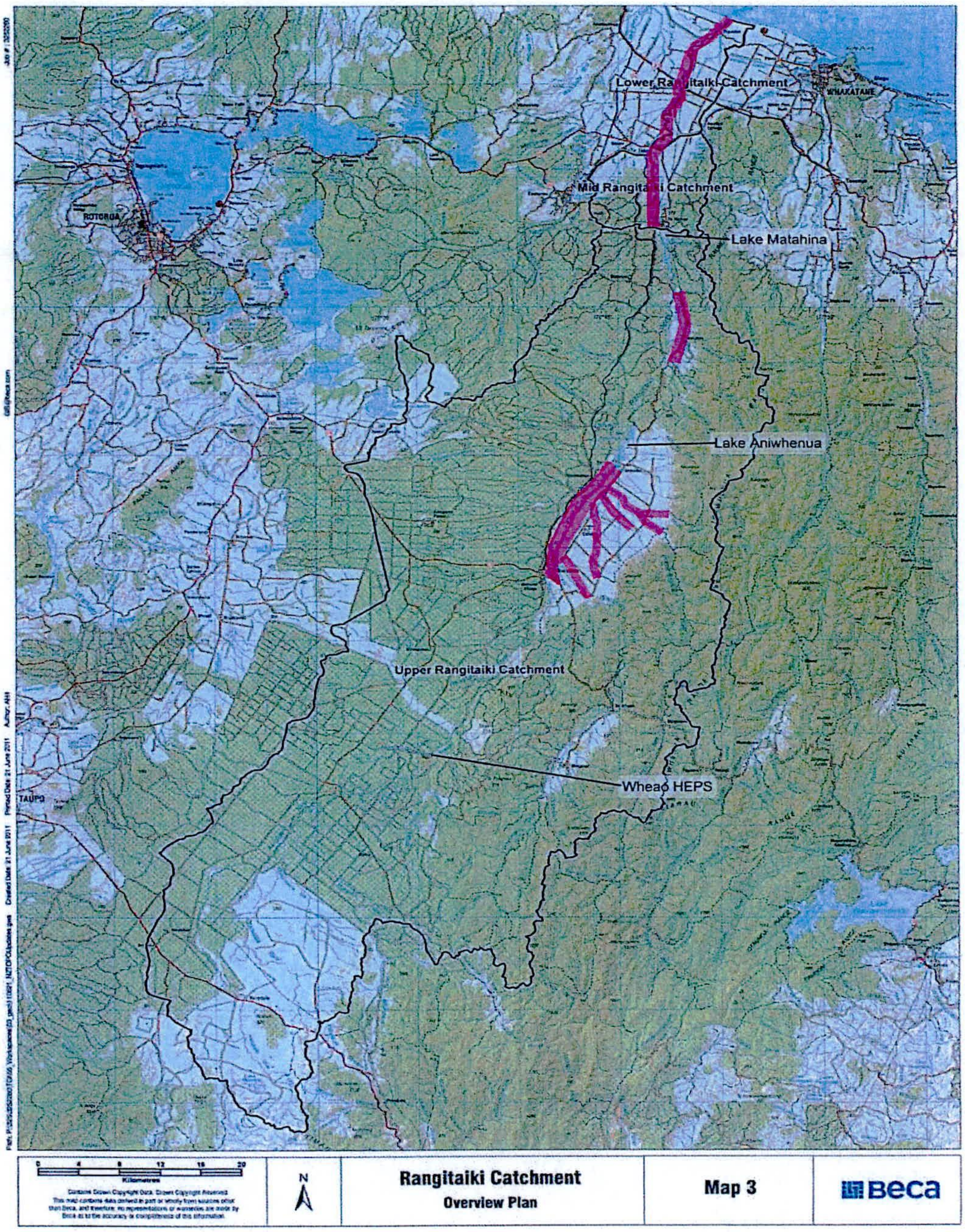
Table of Appendices

Appendix A: LIDAR Elevation Plan of Rangitāiki Plains



Appendix B

Attachment 1 Rangitaiki Catchment plan

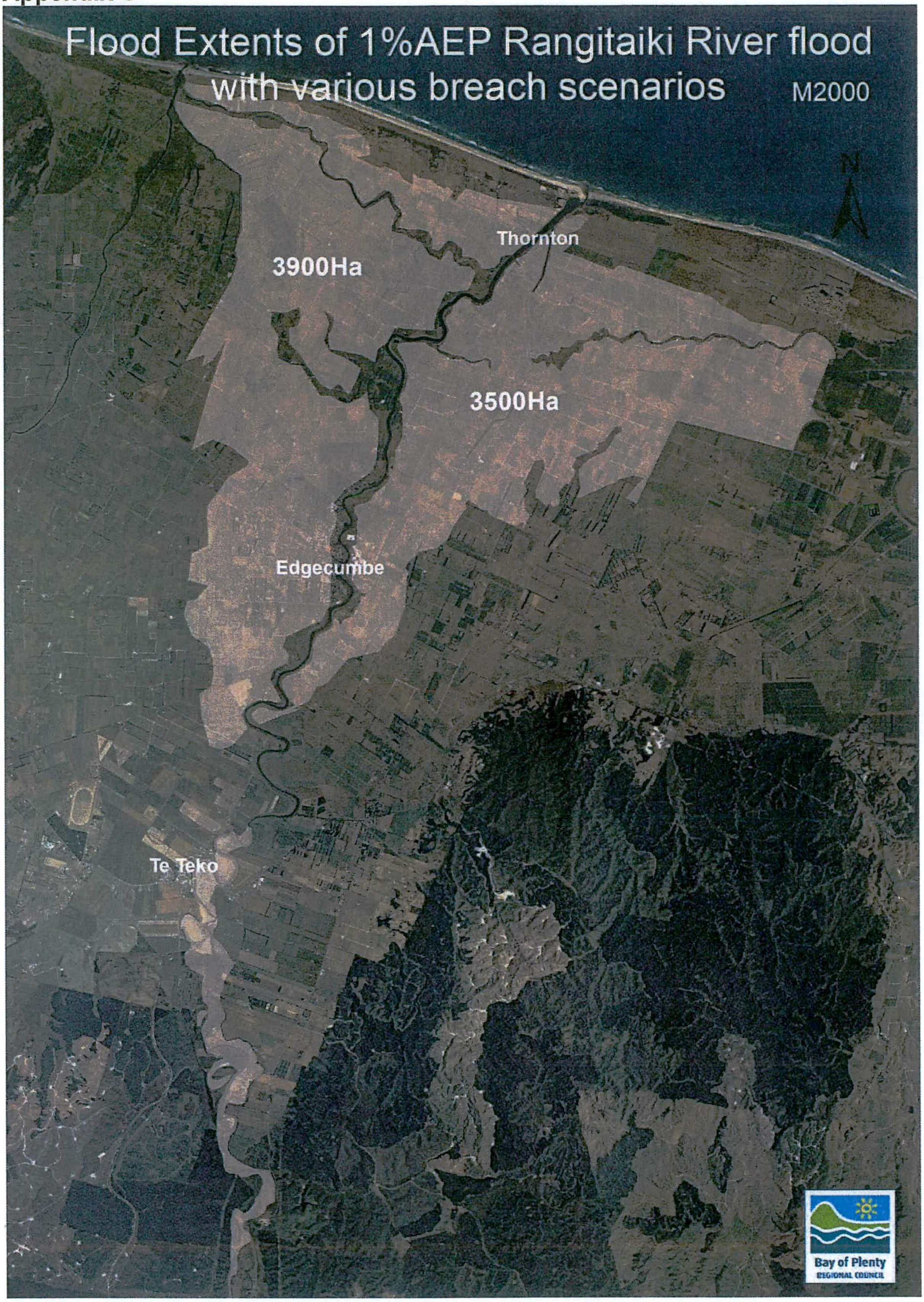


Rangitaiki River Maintenance Area

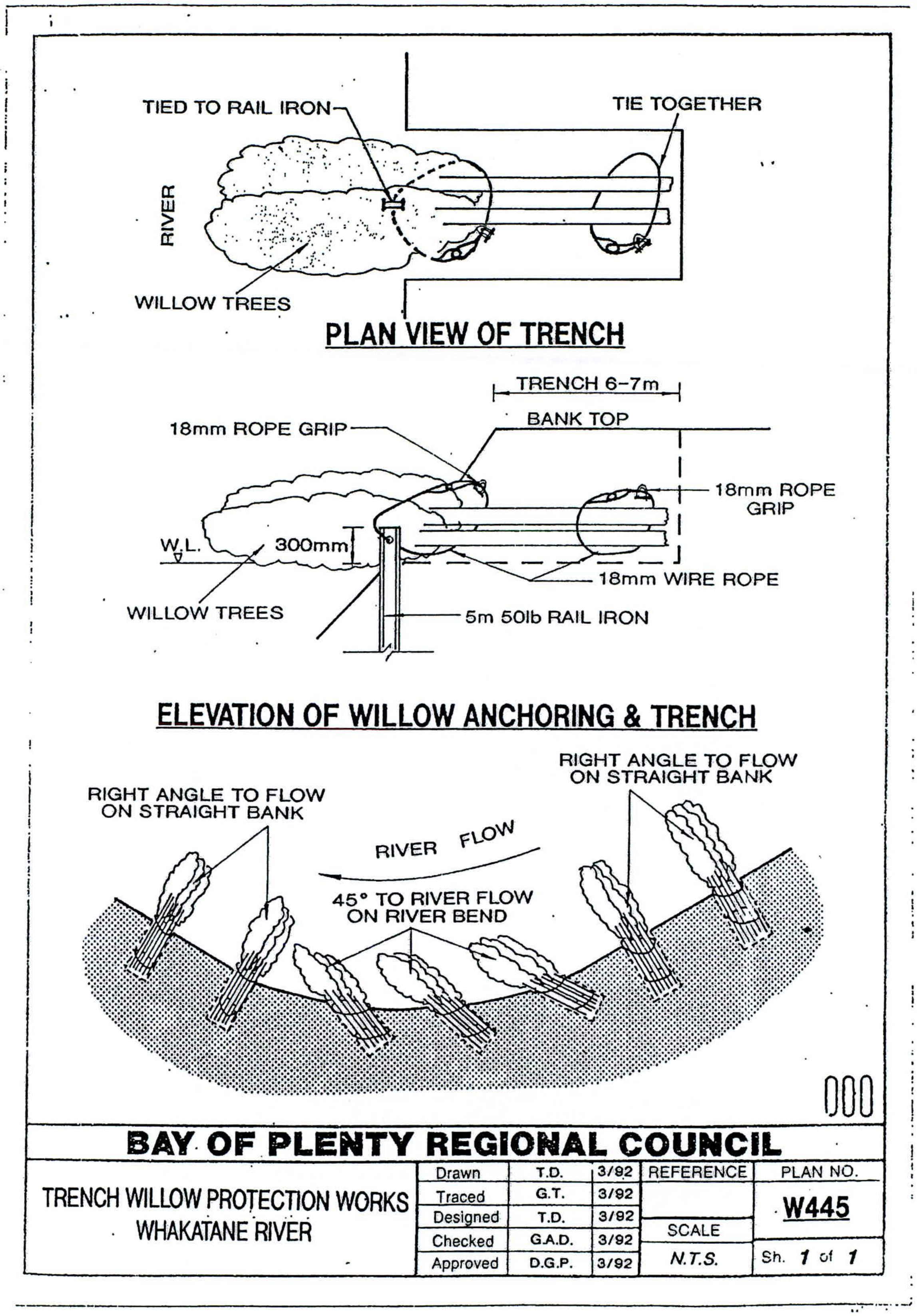
Graham Levy

Base map reproduced from Graham Levy evidence

Appendix C


Flood Extents of 1%AEP Rangitaiki River flood
with various breach scenarios
M2000
N
Thornton
3900Ha
3500Ha
Edgecumbe
Te Teko
Bay of Plenty
REGIONAL COUNCIL

Appendix D1: Trenched Willow Edge Protection Works



Appendix D2: Rock Edge Protection Works Diagram

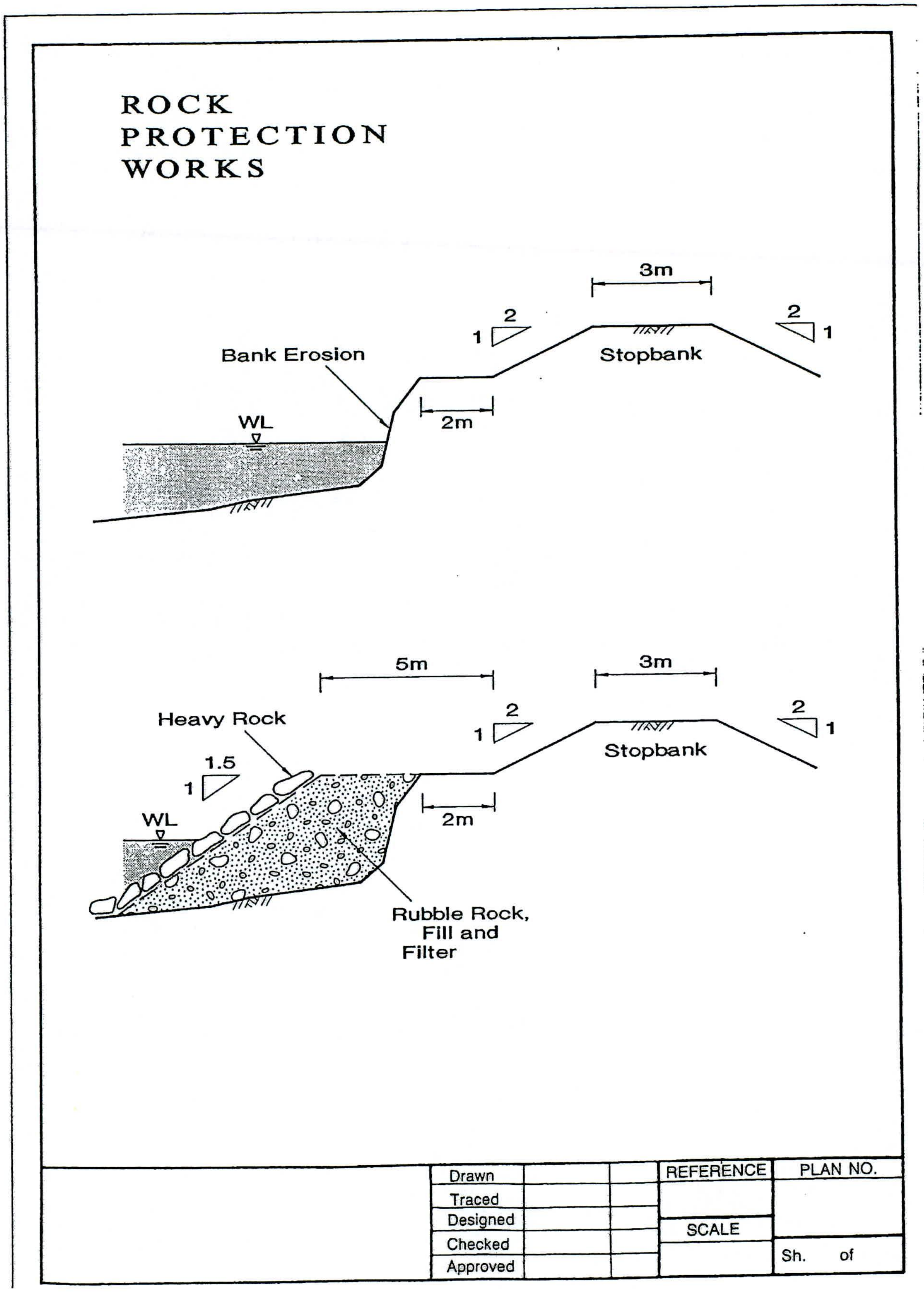
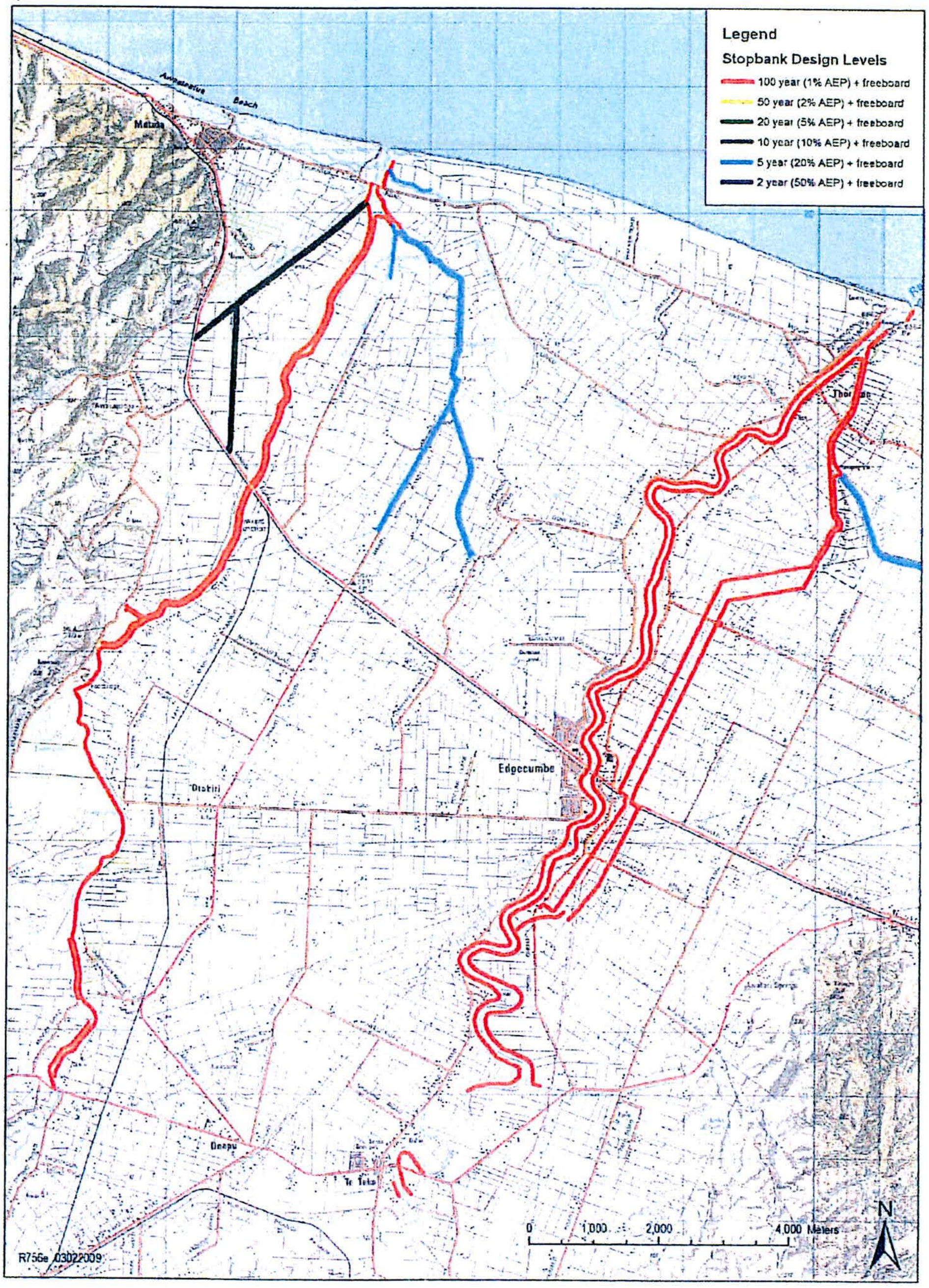


Figure 7: Stopbank and Return Period Plan for Rangitaiki Tarawera Rivers Scheme



Appendix F:

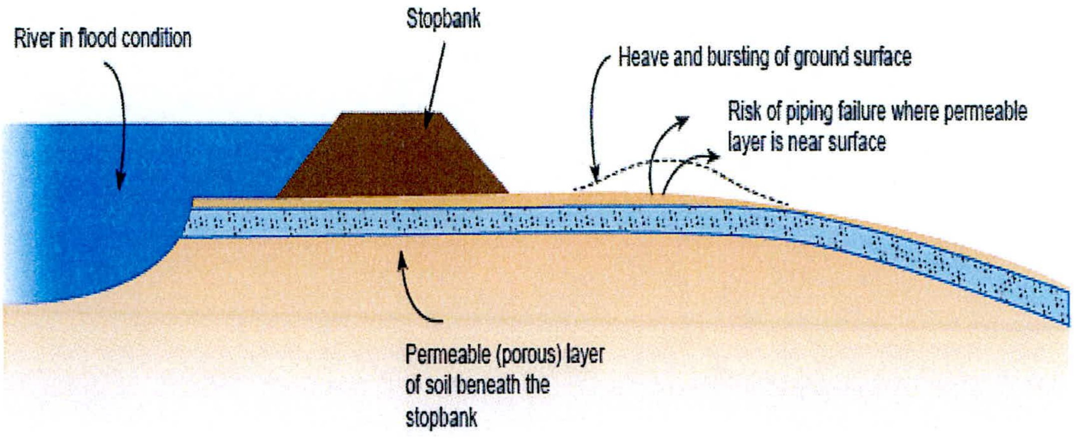
Cropped from the 2008-2009 Rangitāiki-Tarawera Asset Management Plan Maintenance Schedule

Rangitāiki - Tarawera Rivers Scheme Routine Maintenance Activities

Reach	Works Description	Work Type	Total Quantity	Annual Quantity		Rate	Works Frequency Yearly	Annual Cost
General								
	Management	Management				$76,000.00	1	$76,000
	General Overview Inspection	General Overview				$3,710.00	1	$3,710
	Visual Inspection of Riverbanks	Inspection Riverbank				$4,100.00	1	$4,100
	General Inspection of Stopbanks	Inspection Stopbank				$1,384.00	1	$1,384
	Data Services Charges (rain/river info)	EDS Charges				$5,900.00	1	$5,900
	Rate Commission	Rate Commission				$39,400.00	1	$39,400
	Rate Remission	Rate Remission				$4,300.00	1	$4,300
	Electricity	Electricity				$1,200.00	1	$1,200
	Insurance (structures)	Insurance				$5,000.00	1	$5,000
	Disaster Recovery Insurance (LAPP)	LAPP				$44,600.00	1	$44,600
	Transfer to Reserves (Flood Damage) (>20% AEP)	Flood Damage Reserve				$26,000.00	1	$26,000
	CTS Service Charges	CTS Charges				$11,700.00	1	$11,700
	Information Service Charges	IS Charges				$2,700.00	1	$2,700
	Asset Valuation	Asset Valuation				$2,500.00	1	$2,500
	Asset Management Plan Update	AMP Update				$11,200.00	3	$3,733
	Flood Damage Fresh's (< 20%AEP)	Flood Damage				$80,000.00	1	$80,000
	Flood Monitoring							-
	- Annual	Annual Flood Monitoring				$2,500.00	1	$2,500
	- Significant	Significant Flood Monitoring				$0.00	10	$0
	- Major	Major Flood Monitoring				$36,350.00	50	$727
	Survey - stopbank, longitudinal	Stopbank Longsection Surv	117.9	24	km per annum	$315.00	5	$7,428
	Survey - Cross sections	Cross Section Survey				$32,625.00	5	$6,525
	Renew Resource Consent for gravel extraction.	Gravel Consent				$11,500.00	10	$1,150
	Misc (eg legal fees, newsletter etc)	Misc				$4,000.00	1	$4,000
							Subtotal	$270,695
Reach 1								
Rangitaiki								
Mouth to Edgecumbe								
	Weed spraying, Channel	Channel Weed Spraying	0	0	km	$245.00	1	$0
	Weed spraying Riverbank	Riverbank Weed spraying	22.4	22	km	$15.00	1	$336
	Layering 1/6 of the reach	Layering	7868	1311	m per annum	$1.70	1	$2,229
	Tree clearing 1/15 of the reach	Tree Clearing	7868	525	m per annum	$6.50	1	$3,409
	Tree burning 1/15 of the reach	Burning	7868	525	m per annum	$2.25	1	$1,180
	Replace 1/15 of trees in reach per annum	Planting	7868	525	m per annum	$8.80	1	$4,616
	Rock maintenance 25% every 15 years	Rock	37894	632	tonne per an	$56.00	1	$35,368
	Rubble maintenance 1/10 of reach	Rubble	1851	185	m per annum	$79.85	1	$14,780
	Fence maintenance. Replace 10% per reach	Fencing	16968	1697	m per annum	$5.60	1	$9,502
	Beach shaping. 20% of reach requiring work	Beach Shaping	0	0	m per annum	$20.00	1	$0
							Subtotal	$71,421
Stopbanks	Minor floodgates. Inspect all.	Minor floodgates Inspection				$60.00	0.08	$720
	Miscellaneous maintenance eg culverts, fences etc	Stopbank Miscellaneous Maintenance				$600.00	1	$600
RENEWAL	Stopbank reconstruction	Depreciation			Depreciation	$17,515.00	20	$17,515
RENEWAL	Concrete walls	Depreciation			Depreciation	$7,279.00	50	$7,279
Reach 2								
Rangitaiki								
Edgecumbe to Te Teko								
	Weed spraying, Channel	Channel Weed Spraying	0	0	km	$245.00	1	$0
	Weed spraying Riverbank	Riverbank Weed spraying	25.2	25	km	$110.00	1	$2,772
	Layering 1/6 of the reach	Layering	9116	1519	m per annum	$1.70	1	$2,583
	Tree clearing 1/15 of the reach	Tree Clearing	9116	608	m per annum	$6.50	1	$3,950
	Tree burning 1/15 of the reach	Burning	9116	608	m per annum	$2.25	1	$1,367
	Replace 1/15 of trees in reach per annum	Planting	9116	608	m per annum	$8.80	1	$5,348
	Rock maintenance 25% every 15 years	Rock	55330	922	tonne per an	$56.00	1	$51,641
	Rubble maintenance 1/10 of reach	Rubble	0	0	m per annum	$79.85	1	$0
	Fence maintenance. Replace 10% per reach	Fencing	15800	1580	m per annum	$5.60	1	$8,848
	Beach shaping. 20% of reach requiring work	Beach Shaping	0	0	m per annum	$20.00	1	$0
							Subtotal	$76,510
Stopbanks	Minor floodgates. Inspect all.	Minor floodgates Inspection				$60.00	0.08	$720
	Miscellaneous maintenance eg culverts, fences etc	Stopbank Miscellaneous Maintenance				$1,550.00	1	$1,550
RENEWAL	Stopbank reconstruction	Depreciation			Depreciation	$23,200.00	20	$23,200
Reach 3								
Rangitaiki								
Te Teko to Matahina								
	Weed spraying, Channel	Channel Weed Spraying	0	0	km	$245.00	1	$0
	Weed spraying Riverbank	Riverbank Weed spraying	25.2	25	km	$110.00	1	$2,772
	Layering 1/6 of the reach	Layering	14511	2419	m per annum	$1.70	1	$4,111
	Tree clearing 1/15 of the reach	Tree Clearing	14511	967	m per annum	$6.50	1	$6,288
	Tree burning 1/15 of the reach	Burning	14511	967	m per annum	$2.25	1	$2,177
	Replace 1/15 of trees in reach per annum	Planting	14511	967	m per annum	$8.80	1	$8,513
	Rock maintenance 25% every 15 years	Rock	30112	502	tonne per an	$56.00	1	$28,105
	Rubble maintenance 1/10 of reach	Rubble	0	0	m per annum	$79.85	1	$0
	Fence maintenance. Replace 10% per reach	Fencing	3173	317	m per annum	$5.60	1	$1,777
	Beach shaping. 20% of reach requiring work	Beach Shaping	0	0	m per annum	$20.00	1	$0
							Subtotal	$53,743
Stopbanks	Minor floodgates. Inspect all.	Minor floodgates Inspection				$0.00	0.08	$0
	Miscellaneous maintenance eg culverts, fences etc	Stopbank Miscellaneous Maintenance				$0.00	1	$0
Reach 4	**Not applicable**							
Rangitaiki								
Waiohau Valley								
Reach 5	**Not applicable**							
Rangitaiki								
Aniw henua to Murupara								
Reach 6	**Not applicable**							
Galatea Plains								
Horomanga, Ohutu, etc								
Reach 7	**Not applicable**							
Whirinaki								
Reach 8	**Not applicable**							
Taraw era								
Mouth to SH 30								
Reach 9	**Not applicable**							
Taraw era								
Upstream SH 30								
Reach 10	**Not applicable**							
Canals, Awaiti, etc								
Sum of Maintenance Items Impacted by Matahina Dam Operations =>								**$472,369**

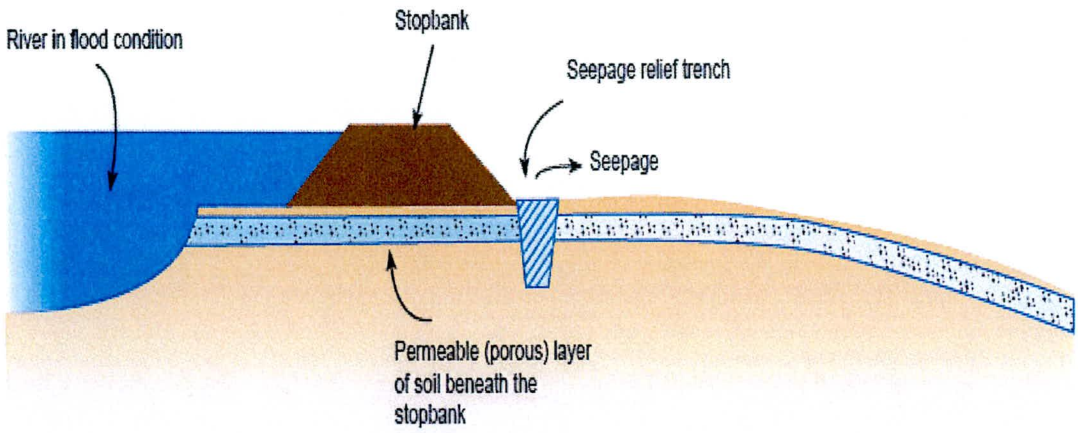
Note: All details exclude GST

1 Existing situation



Potential Piping Failure: If the permeable layer has seepage water flowing through it under pressure from the high river water level, the pressure may cause the surface soil layers to burst open allowing a greater velocity of water flow that leads to erosion of the soil and formation of a pipe. Eventually the pipe grows so large the stop bank collapses and the floodwaters breach through the stop bank.

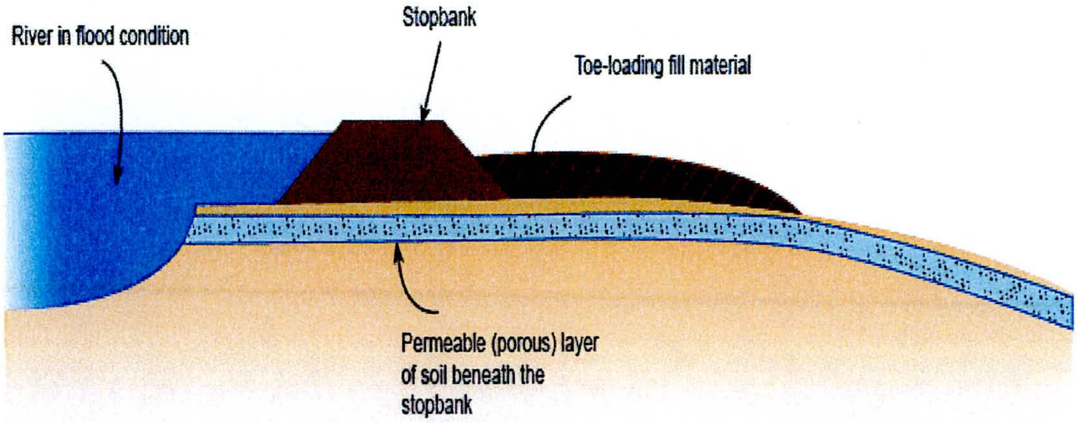
2 Seepage pressure relief trench option



Seepage Relief Trench: A seepage relief trench is installed to intercept the permeable layer. The trench collects the seepage water over a wide area and allows the water to seep out of the trench so that less pressure is developed in the permeable layer, thus reducing the risk of creating a piping failure.

This option is suitable where there is limited space, i.e. house or buildings close by.

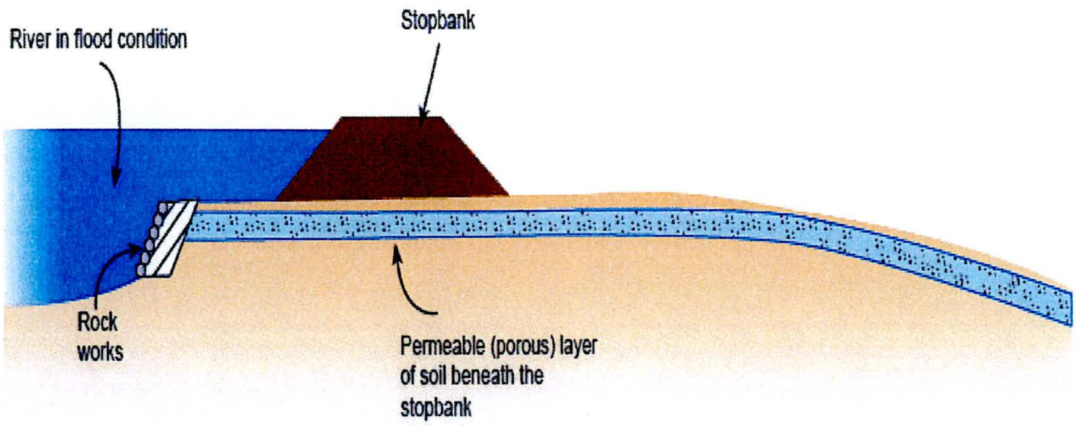
3 Toe-loading option



Toe-Loading: Toe-loading involves placing fill over the top of the permeable layer to prevent it heaving up. The toe-loading puts additional weight of fill over the permeable layer to counter balance the water pressure. The toe-loading layer will still allow seepage water to flow through it to the surface, but it spreads the seepage over a wide area and reduces seepage pressure and velocity.

This option is only suitable where there is space available near the stop bank as the toe-loading may need to extend up to 60 to 100 metre from the stop bank.

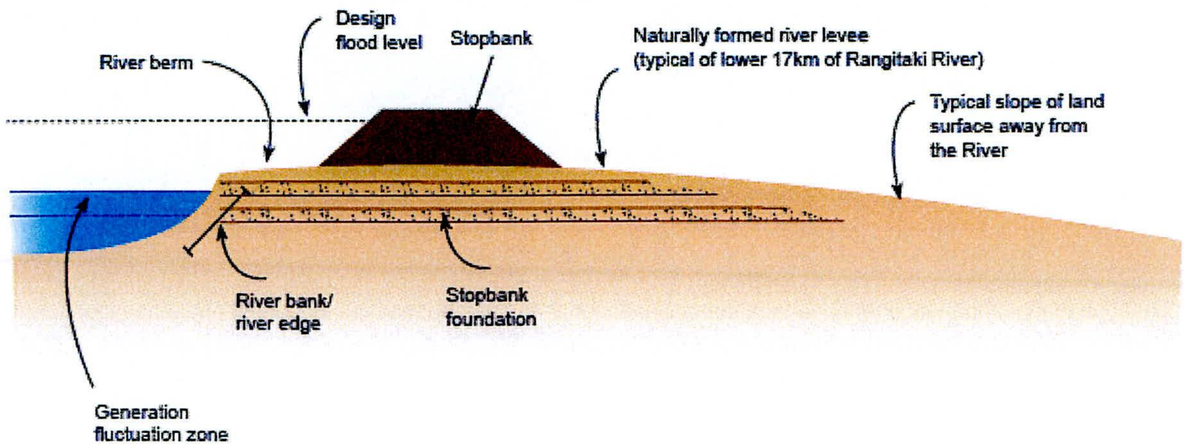
4 Rock edge protection



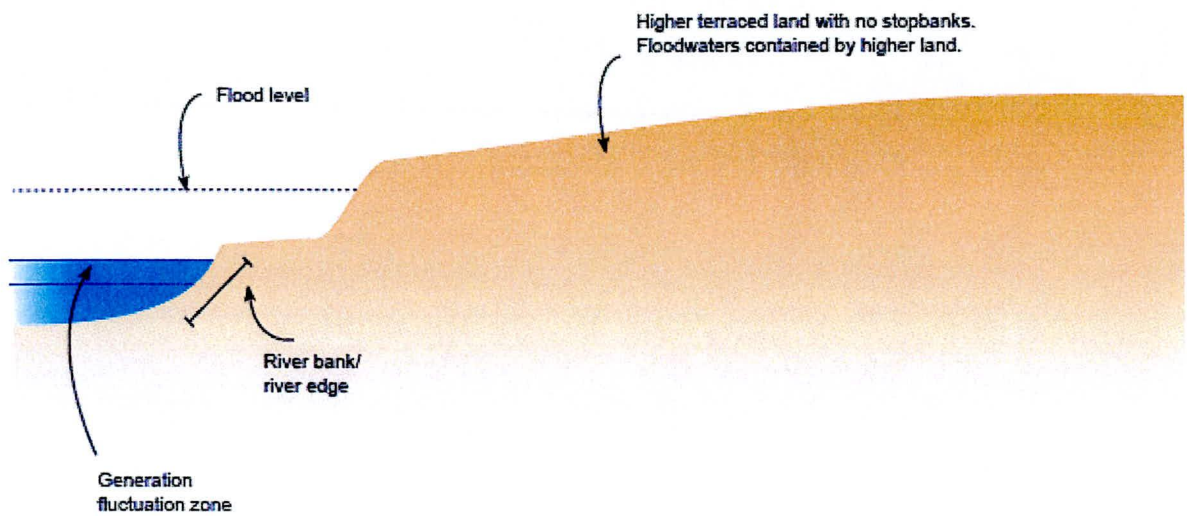
Rock works and cut-off layer: This is used to strengthen the river bank against erosion. The rock may trap sufficient sediment to reduce the seepage flows in the permeable layer. Sometimes used in conjunction with other treatments above.

Appendix H

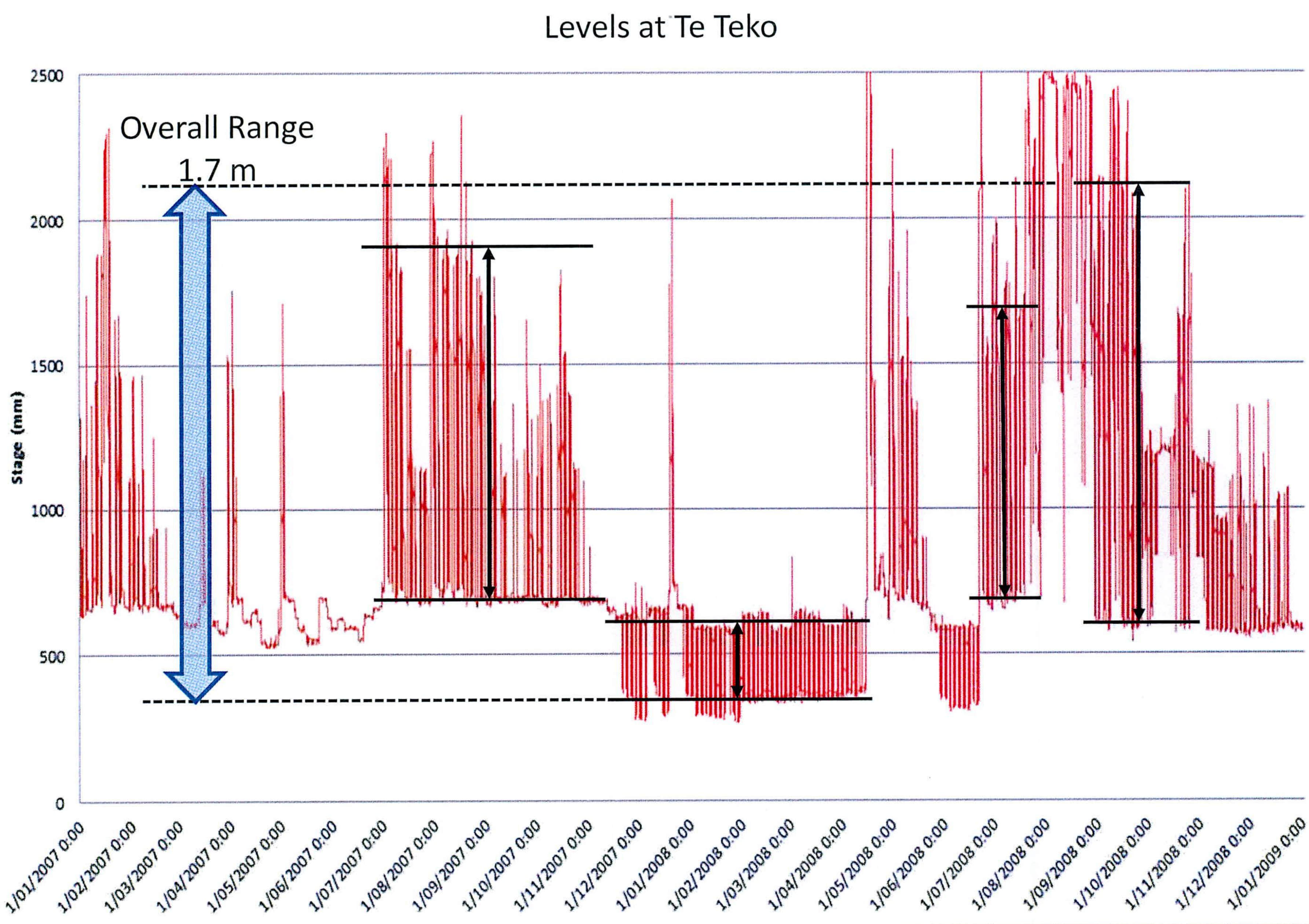
Typical cross-section in stopbanked reach

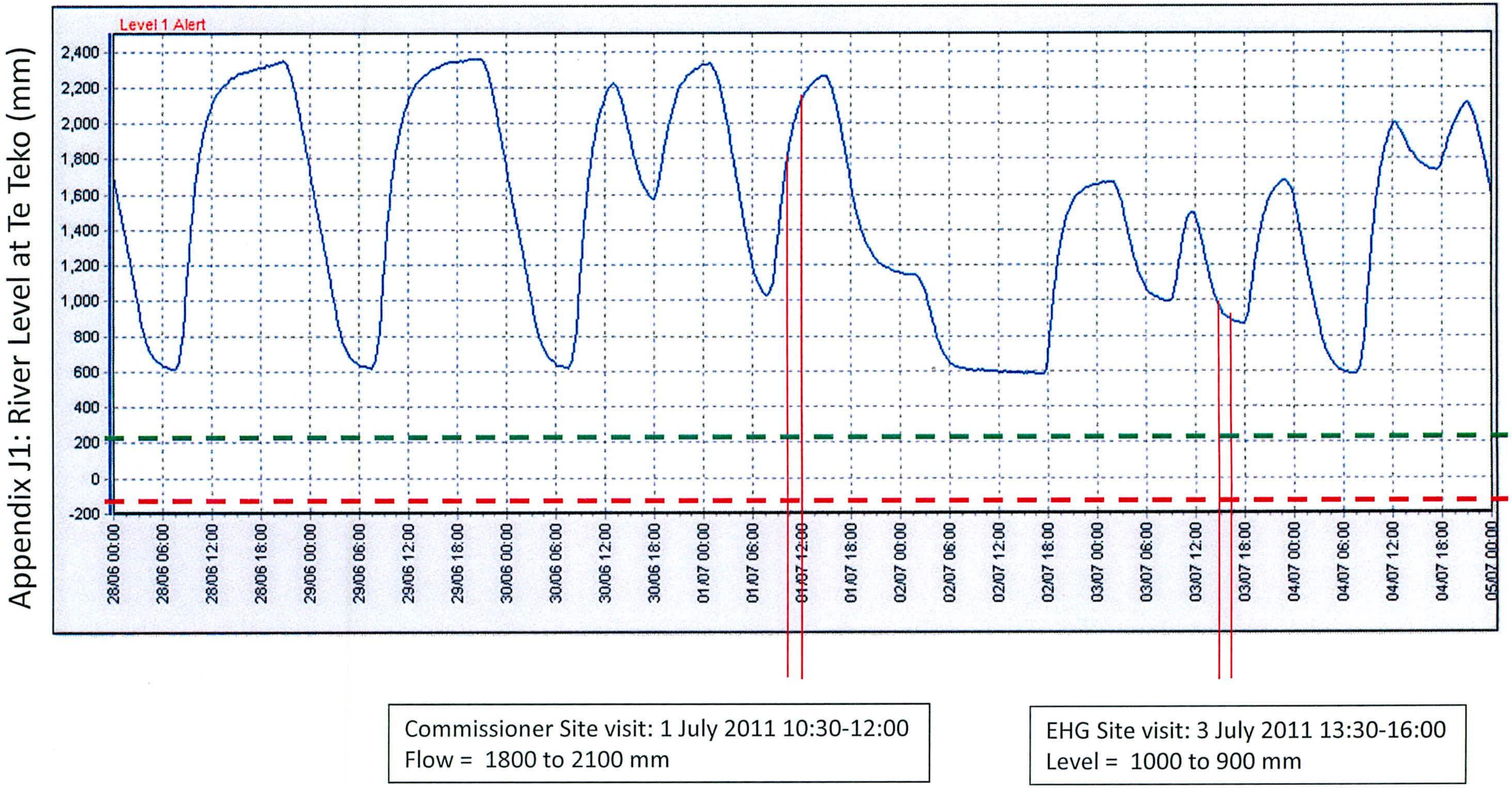


Typical cross-section through upper reaches



Appendix I: Sample of daily maximum and minimum level fluctuations at Te Teko





Appendix J1: River Level at Te Teko (mm)
Level 1 Alert
2,400
2,200
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
-200
28/06 00:00
28/06 06:00
28/06 12:00
28/06 18:00
29/06 00:00
29/06 06:00
29/06 12:00
29/06 18:00
30/06 00:00
30/06 06:00
30/06 12:00
30/06 18:00
01/07 00:00
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01/07 12:00
01/07 18:00
02/07 00:00
02/07 06:00
02/07 12:00
02/07 18:00
03/07 00:00
03/07 06:00
03/07 12:00
03/07 18:00
04/07 00:00
04/07 06:00
04/07 12:00
04/07 18:00
05/07 00:00
Commissioner Site visit: 1 July 2011 10:30-12:00
Flow = 1800 to 2100 mm
EHG Site visit: 3 July 2011 13:30-16:00
Level = 1000 to 900 mm

Appendix J2: River Flow at Te Teko (cumecs)

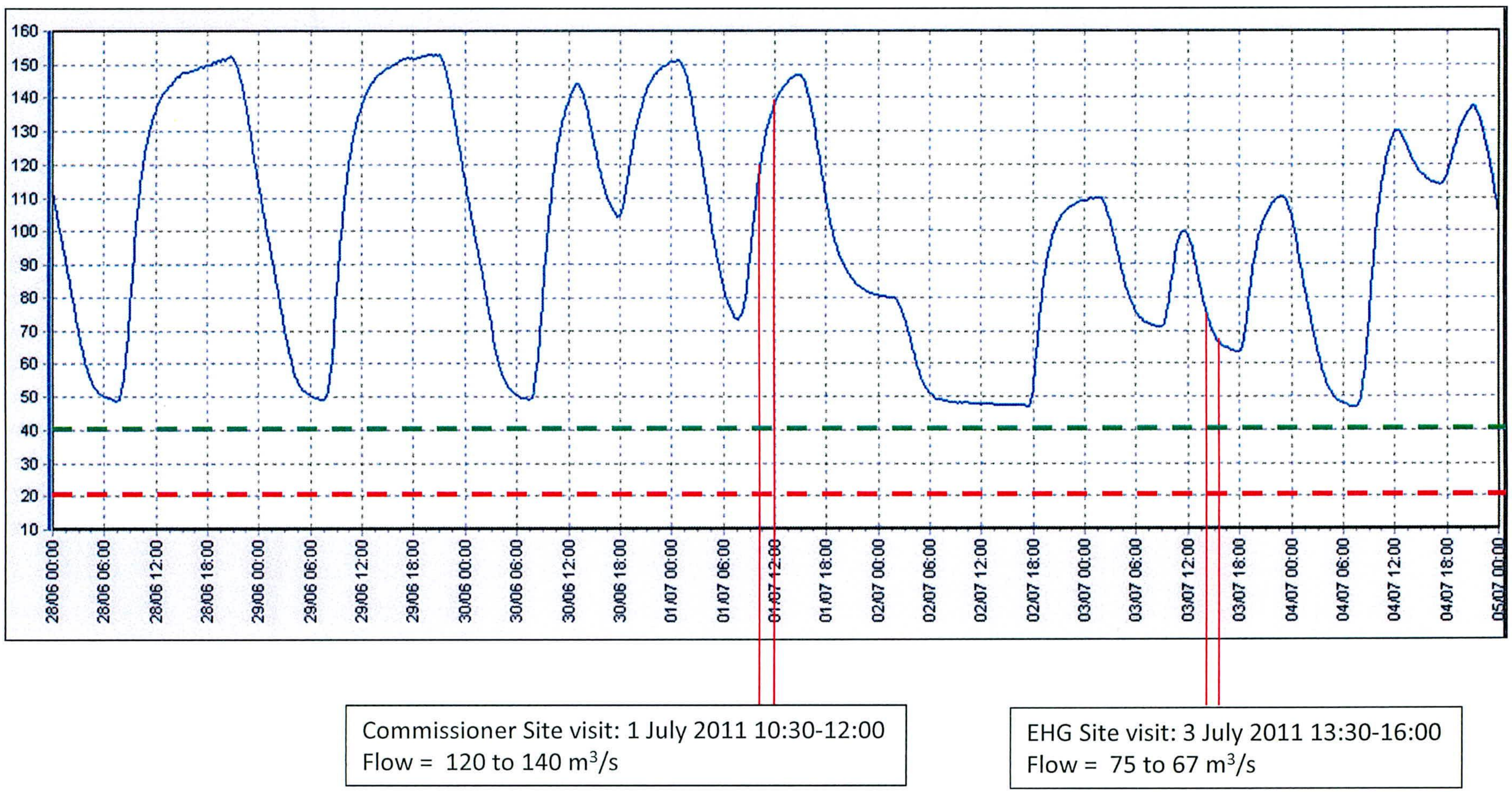
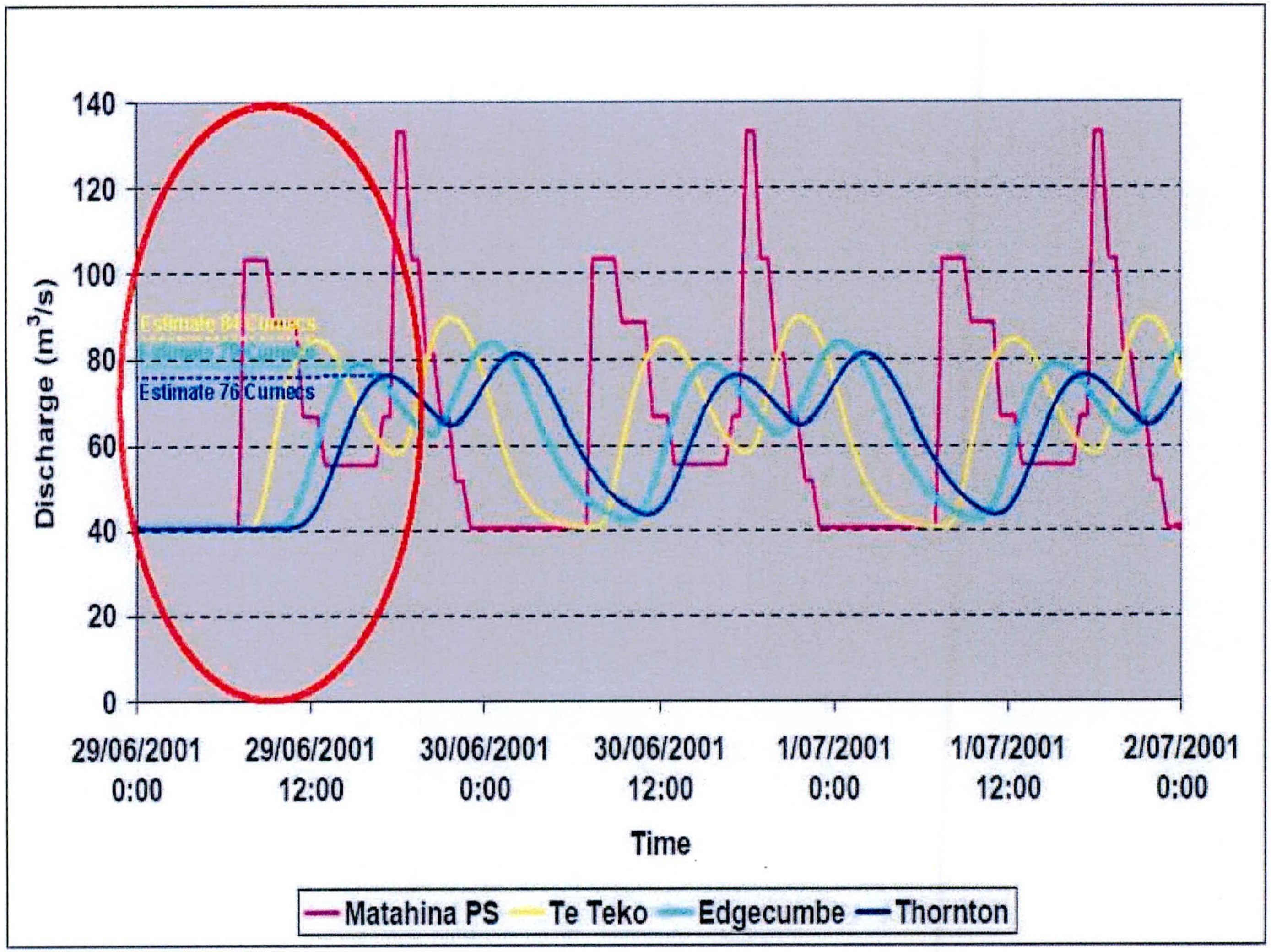


Figure 5

Twin Peak Flow Attenuation Down the River (35 MW inflow)



Example of modelled river level fluctuations below Matahina Dam. Note the relatively small attenuation of flow from Matahina to Thornton.

Figure reproduced from the Beca River Hydrology, Hydraulics and Bank Erosion Report. Page 22

Appendix L

MEMORANDUM

Environment Bay of Plenty
REGIONAL COUNCIL
Working with our communities for a better environment

To: Andy Bruere
Manager Consents and Compliance

From: Bruce Crabbe
Manager Rivers & Drainage

Date: 9 June 2005

File Ref: 1370 22195, 5680 06

Copy To: Peter Blackwood & Tony Dunlop

Subject: **Twin Peak Trial Monitoring Final Report**

Andy,

The following comments are made regarding the March 2005 "Twin Peak Trial Monitoring – Final Report" produced by Beca Carter Hollings & Ferner Ltd. on behalf of TrustPower:

General Comments:

1. The July 2004 flood was an extreme event and as a result I believe any observations and assumptions about erosion and/or the rivers response to erosion that has occurred after that time are fairly meaningless as the situation is atypical.

2. The issue of whether twin peaking is worse than single peaking is a lesser concern to us. The main issue is that the level fluctuations cause significant problems for establishing and maintaining vegetative river edge protection works. Whilst the BCHF report is only dealing with the twin peaking issue, we want to give notice that we experience difficulties with the level fluctuations (irrespective of whether it's once or twice per day) and that we will be seeking redress to this situation when the Matahina Dam consent is renewed in 2009 (approximately).

Specific Comments:

1. The comment (under section 8.1) that the erosion at sites 3.0 RB, E11, and 13.0 LB "were directly attributable to willow clearance" is incorrect. Repair works were undertaken at these sites because erosion was occurring. The only time willow tree removal is carried out is when the willows become overgrown and 'top heavy' and threaten to topple in to the river (creating bare vulnerable patches on the river bank), or when we have to cut down trees from higher up the bank in order to gain access to an erosion site at the toe of the bank. On other occasions willows are 'layered' over the river bank to bring about a vegetative repair to erosion that is occurring. In all three of the sites referred to erosion was occurring prior to the trees being removed.

2. Rock stabilisation works. The comment (also under section 8.1) that "... previously eroding sites have become stabilised through ... , or rock stabilisation." appears to be concluding that the twin peaking regime has somehow enabled the stabilisation to occur. The sites concerned were stabilised by Environment Bay of Plenty installing the rockworks.

3. The number of sites where erosion is occurring appears to be under-reported due to the underlying erosion being discounted for various reasons. For example, "sediment from adjacent fields being bulldozed to the river bank", at 3 sites where the photos appear to show erosion occurring; and "rock protection installed" at 4 sites where clearly there would be ongoing erosion if the protection works had not been carried out. I believe the analysis of the number of eroded sites should be recalculated to account for the sites mentioned above. The analysis should also be limited to the pre-flood period as anything after that event has minimal relevance.

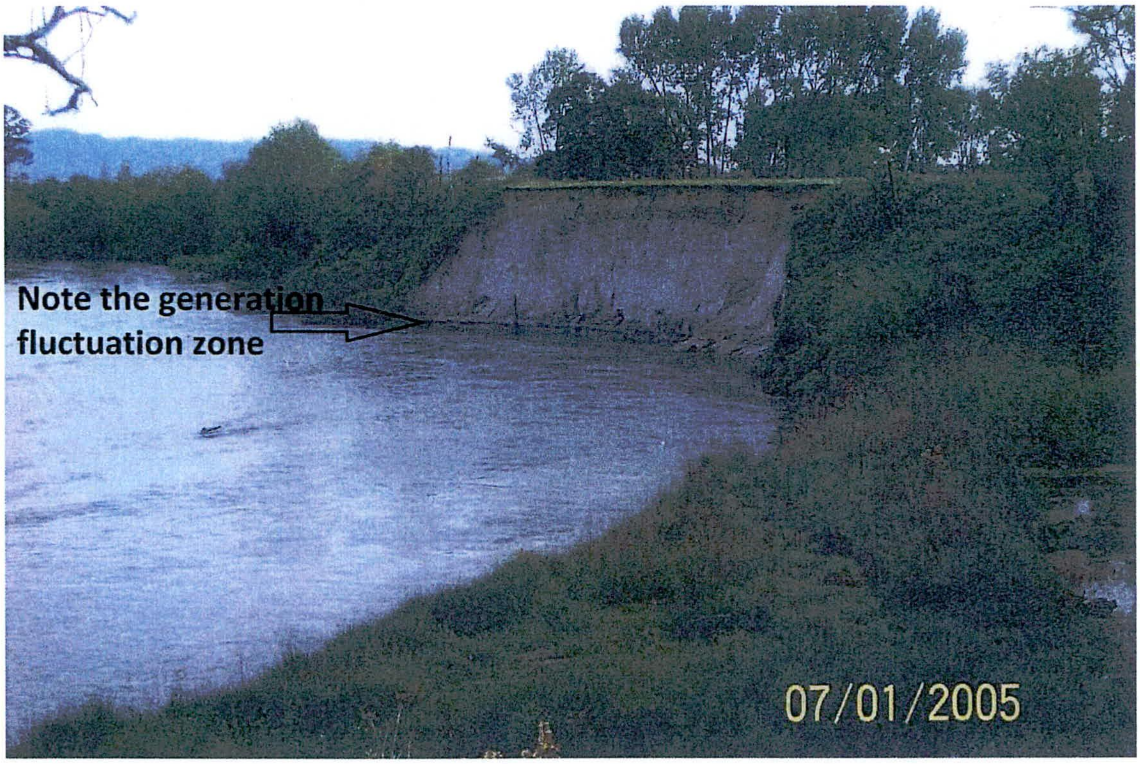
4. The final paragraph in section 8.1: "We therefore conclude that observed erosion is primarily triggered *(underline added by me)* by flood events or riparian activity, and not by the effects of twin peaking." TrustPower should be asked to show the evidence of how they conclude that erosion is *primarily triggered* by flood events. There is no doubt that floods exacerbate erosion, however in our experience a flood event is more likely to cause damage where there is already erosion or weakness in the bank protection. In our observation of the river banks on Rangitaiki River the trigger for erosion is actually caused by weak or non-existent bank vegetation. This is exacerbated by various factors, however a significant factor is the regular fluctuation in river levels. The regular fluctuations create a 'tidal' zone where vegetation tends to be denuded and/or the constructed vegetative edge protection works (eg willow tree groynes) struggle to become established and/or the regular ingress of water into, and the seepage of water out of, the river bank soils, all contribute to the bank being weak and unstable in the first place. It therefore becomes relatively easy for any fresh or flood events in the river to erode those vulnerable areas.

   Because of the difficulty in establishing riparian vegetation in the fluctuation zone, we are usually forced to carry out erosion repairs using rock rip-rap. This method is more resistant to the level fluctuations, but is considerably more expensive for the river scheme ratepayers than the alternative bank protection works using trenched willow tree groynes. I acknowledge that TrustPower makes an annual contribution of approximately $9,000 to the river scheme to assist with maintenance works. This is appreciated, however to put it in perspective, typical rock rip-rap edge protection work costs approximately $350 per lineal meter, therefore the annual contribution will pay for approximately 26 lineal meters of rockworks each year.

Bruce Crabbe
Manager Rivers & Drainage

Appendix M, Photograph 1a & 1b

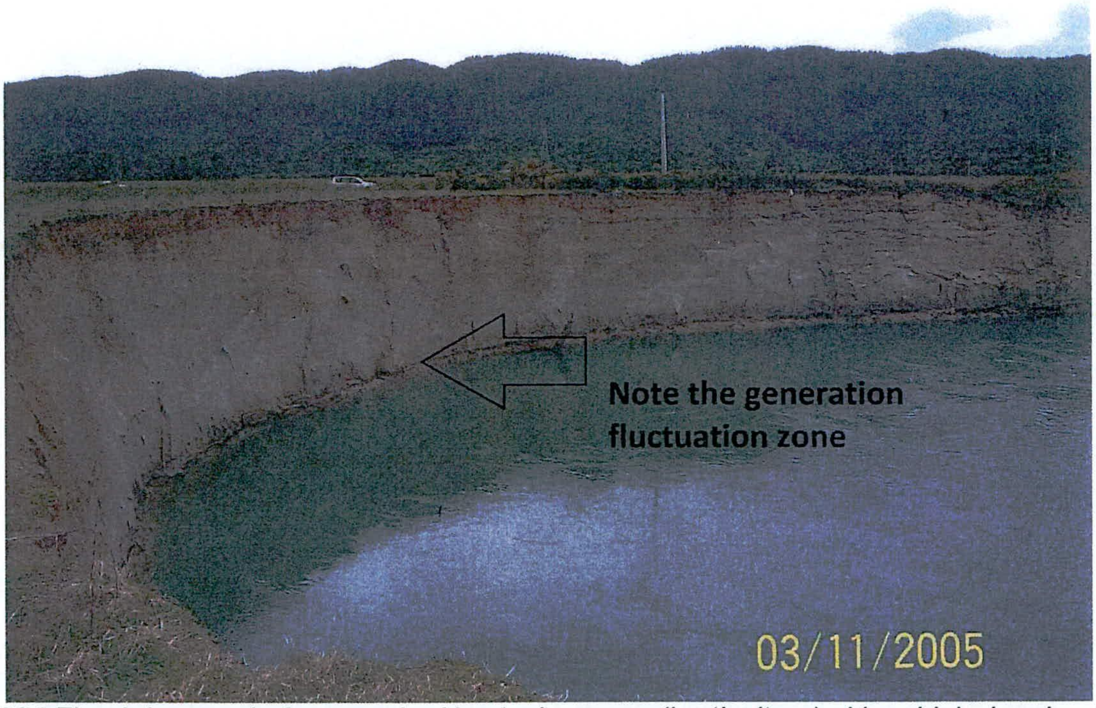
1a **Rangitaiki Right Bank, 27.0km, Carter / McCauley Site**
2004 Flood damages prior to repair



1b **Rangitaiki Right Bank 27.0km Carter / McCauley Site**
Rock edge protection works completed - Repair cost $222,000

Appendix M, Photograph 2a & 2b

2a **Rangitaiki Right Bank, 30.6km, McKeown Site**



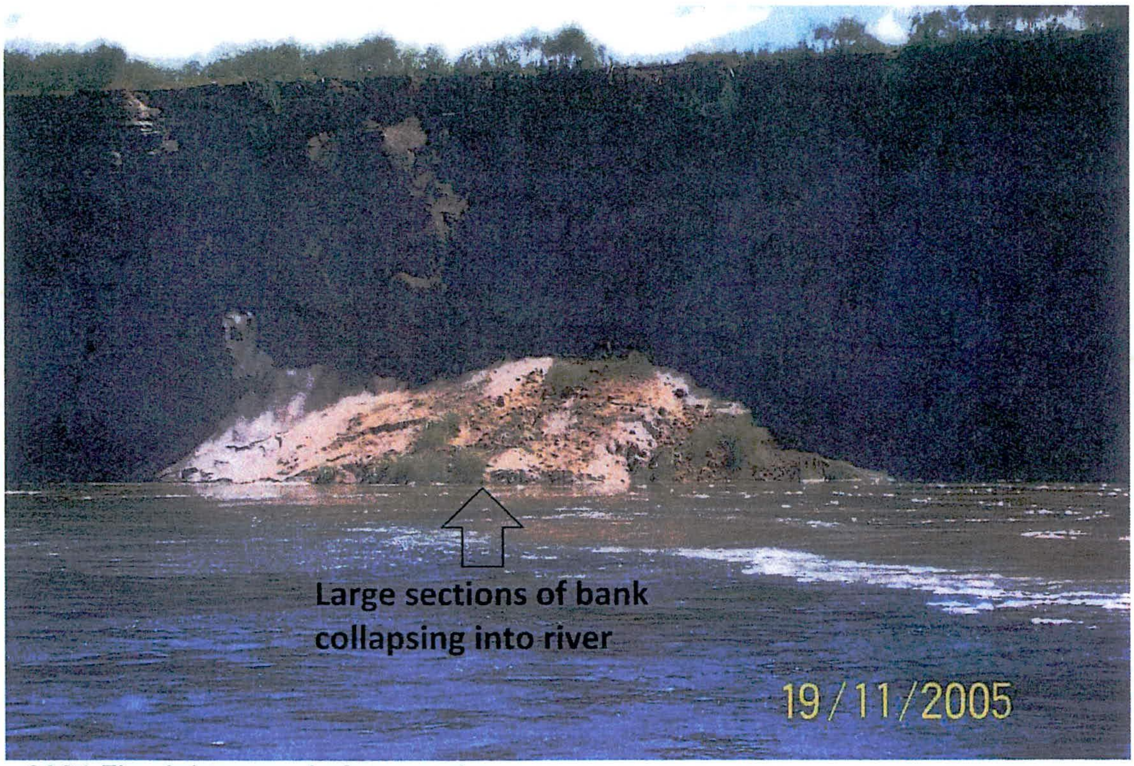
2004 Flood damage before repair. No stock access (horticulture). Very high river bank approx. 10m and deep water approx. 4m.

2b **Rangitaiki Right Bank, 30.6km, McKeown Site**

2004 Flood damages prior to repair

Appendix M, Photograph 2c & 2d

2c **Rangitaiki Right Bank, 30.6km, McKeown Site**



2004 Flood damages before repairs

2d **Rangitaiki Right Bank, 30.6km, McKeown Site**

2004 Flood repairs completed. Cost of works $264,000

Appendix M, Photograph 3:

Rangitāiki River Left Bank, 15.8km, Kōkōhinau Bend, 0.5km downstream of fault line

During 2004 flood event: Erosion migrated back into top of stop bank.
Note close proximity of roadway and dwellings in background

Appendix M, Photograph 4:

Completed berm reinstatement and rock protection works completed at Edgecumbe, Tanekaha Street. Works carried out as part Geotechnical Strengthening Works Project, but effectively is an erosion protection works.

Appendix M, Photograph 4:
Rangitaiki River Left bank, 15.5km, Eruera Site

River edge and stopbank foundation partly eroded away during 2004 flood event, exposing layers of sand and ash. Previously had been willow trees and some native plantings, but repaired using significant berm reinstatement rockworks. Repair cost $499,000

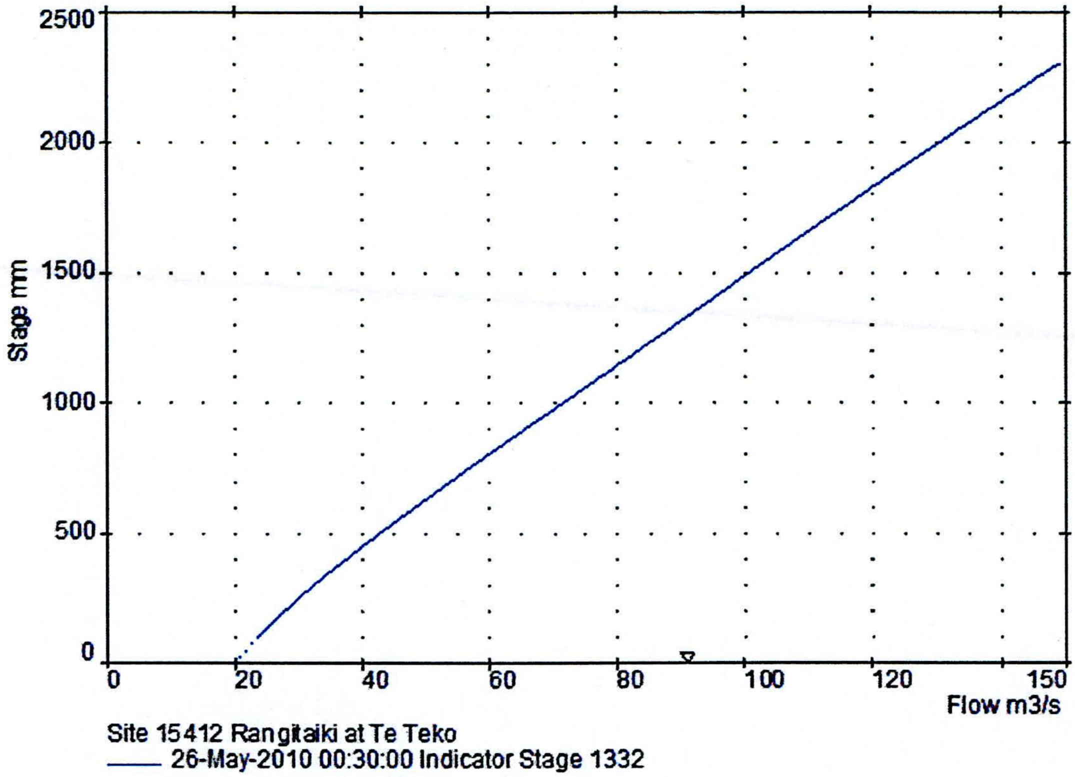
Appendix M, Photograph 5:

Rockworks at Carter Site, 27km: 3 July 2011.

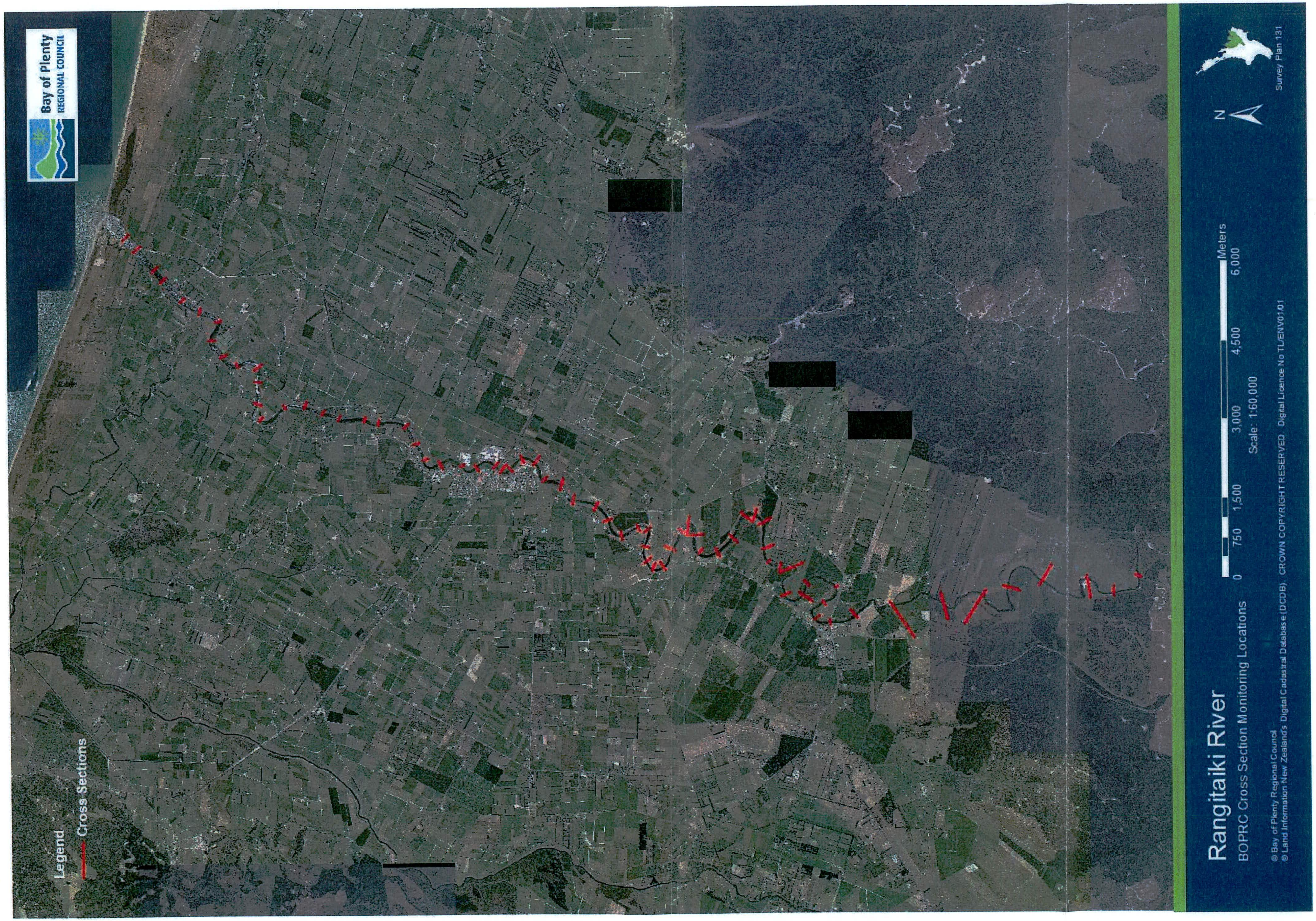
Post 2004 rock protection works completed in January 2006 showing loss of rock material at the fluctuation zone.

Appendix N: River Level Compared With Flow Rate at Te Teko Recorder.

(20 to 150 cumec range only)



Appendix O


Bay of Plenty
REGIONAL COUNCIL
Legend
Cross Sections
Rangitaiki River
BOPRC Cross Section Monitoring Locations
0 750 1,500 3,000 4,500 6,000
Meters
Scale : 1:60,000
N
Survey Plan 131
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Appendix P1

ENVIRONMENT B·O·P
Bay of Plenty Regional Council

Memorandum

To: Greg Pemberton

From: Phil Wallace, Tony Dunlop

CC: Andy Bruere

Date: 09 February 1998 **File Reference:** 5810 02 R01

Subject: **EFFECTS OF POWER STATION OPERATION ON RANGITAIKI RIVER**

Background

The condition of the edge protection and riverbanks has been affected by the operation of the three hydroelectric power stations within the Rangitaiki catchment – the Matahina, Aniwhenua and the Whaeo. All three stations vary their generation during a typical day to meet electricity demands, and as a result the discharges from the turbines, and hence water levels downstream, vary. Water level fluctuations caused by operation of each of the power stations are typically as follows

- Whaeo power station – 250-450mm at Murupara (NIWA records, quoted by Ross Titchmarsh in the Scheme Maintenance Review).
- Aniwhenua power station – probably less than 450-700mm on the Waiohau Plains (as predicted by Ross) – maybe 500-1000mm (site observations)
- Matahina power station – 1300-1600mm at Te Teko, and a significant influence as far downstream as Edgecumbe (NIWA/Ross). 1.5-2m midway Te Teko-Matahina (works staff).

Landowners and Environment B.O.P works staff have expressed concern that the water level variations increase bank erosion.

Previous Investigations

Matahina

Operation of the Matahina Dam was altered in 1980 for approximately ten weeks to a two peak per day load scheme. However the change caused damage to riverbanks, and the station was returned to a mixture of one peak per day and run-of-the-river operation. Damage downstream of km16 (midway Te Teko and Edgecumbe) was prevented by existing riprap. The NZED agreed to help fund repair work, which included placing rock riprap. NZED initially agreed to provide $40000 for 1981/82 with more to follow. Actual expenditure in 1981/82 was $30000. For 1982/83 the BOPCC revised the total cost estimate to repair and stabilise all damaged banks (ie including that already repaired in 81/82) was $120,000 (ie 2500m at $48/m). The BOPCC proposed $47500 of works for 850m in 1982/83. I am not sure what was eventually agreed to by NZED.

Contribution Formula for the Matahina Power Station – Rangitaiki River

The formula used to estimate ECNZ's contribution is:

1/5th of EBOP's annual maintenance costs for edge protection (rockwork, vegetation protection, rubble protection) on the Rangitaiki River from the Matahina Power Station to Te Teko, as defined in the Asset Management Plan for the Rangitaiki-Tarawera Rivers Scheme.*plus*

1/10th of EBOP's annual maintenance costs for edge protection (rockwork, vegetation protection works, rubble protection works) on the Rangitaiki River from Te Teko to Edgecumbe, as defined in the Asset Management Plan for the Rangitaiki-Tarawera Rivers Scheme.

From the EBOP Asset Management Plan for the RangitaikiTarawera Rivers Scheme published in 1998, contribution from ECNZ for the Matahina Power Station is estimated at $8567 pa (at a Cost Construction Index of 3790).

(The proportions were based on a 10 metre protection zone, with a typical 2m variation in water level above Te Teko and 1m below Te Teko).

When the water right to the Matahina Dam was renewed in 1989, the operation returned to peak load operation. For the first 2 years of the right, a more rapid ramping down of power output (and hence downstream flow) was allowed, with monitoring of the riverbank conditions to be performed. In the second year a second intermediate peak was also trialled. Eleven sites were monitored annually for cross-sectional area changes by EBOP (but paid for by ECNZ – i.e. EBOP was contracted to do the survey). Very little actual reporting of the results appears to have been done. What there was suggests that the change in operating conditions did not appear to significantly change erosion patterns. (Memo attached).

As a result, the water right/consent was changed to allow peaking operation to continue. Monitoring of the 11 sites was to continue also, but on a biennial basis. If significant erosion was noted, EBOP could require ECNZ to reduce the rate of ramping down. The results of monitoring of the changes appear to have been inconclusive, and after some of the survey pegs were lost or became inaccessible by 1995, the monitoring appears to have stopped. New methods for monitoring the effects of the power station operation were to be developed, possibly based around a jet boat inspection and photographic record (so as to get a complete picture of the banks rather than at a set of discrete locations), but no progress appears to have been made.

A 1988 report by Works Consultancy Services for ECNZ concluded that bank erosion evident at that time downstream of the Matahina Dam appeared to be primarily the result of river floods (Dahm et al. 1996). However, the report also suggested that in some locations the water level fluctuations could have been a contributing factor, and that under some operating regimes the fluctuations could weaken the banks. Furthermore, since then the operating regime has changed from a single peak to a twin peak per day, which the report's authors indicated could have a greater influence on bank instability.

The Maintenance Review for the Rangitaiki Tarawera River Scheme concluded that the fluctuations 1996 aggravated erosion initiated by floods, and that some contribution from the station operators towards the river scheme maintenance should be negotiated.

<u>Whaeo</u>

The station operators have been required to provide cross-section information for 10 sections on the Whaeo between the dam and the Rangitaiki and then 4 sections on the Rangitaiki to Murupara. Sections before the station commenced operating were required, and after the first year sections at 6 monthly intervals have been required. Results indicate erosion of the Whaeo since the station commenced operations, but are inconclusive for the Rangitaiki. Note that the areas surveyed are not part of the Rangitaiki-Tarawera River Scheme.

Current Situation

Notwithstanding the lack of conclusive evidence from earlier investigations, concern is still expressed by both works staff and landowners. Continual rise and fall of the water levels can be expected to both weaken the bank (constant wetting and drying, drawdown) and to make establishment of vegetation more difficult. Inspection of the river banks reveals that water level variations do appear to have weakened the bank protection as expected. In some locations, a distinct line of bank slumping has occurred at approximately the peak water levels from normal power station operation. Photographs of such sites are attached. Elsewhere, the vegetation can be seen to stop at around the high water level, as it cannot grow below water.

During the time that the Matahina power station has been out of action for dam repairs, Environment B.O.P works staff have noted that riverbank vegetation downstream of the dam has grown near the waterline where before it did not. Some additional protection is thus afforded to the bank. Photographs are attached.

Options

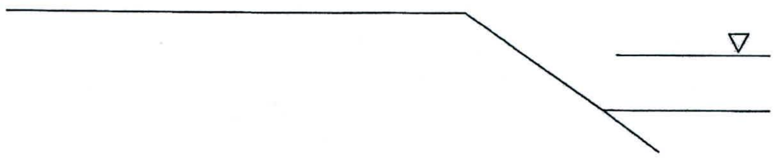
Ideally the remediation of the river bank erosion caused or aggravated by the power station operations should be linked to the consents for those activities. This does not appear possible given the conditions attached to the consents now.

It may however be possible to seek remedy via rating classification changes currently being investigated.

Possible methods for assessing the cost of the effects of water level variations are as follows

1. As a percentage of the annual maintenance of the edge protection works.

In an ideal situation, a 10m wide strip of vegetation protection would be created. Assuming a typical 1m variation in water level, then as sketched below 1/10 of the strip is continually under greater stress.



In many cases, a strip of 10m cannot be obtained, and the proportion under greater stress might be higher. Also the area affected will be greater than that of the actual water level variation.

This 1/10 will then be likely to require greater maintenance. However, as obviously other factors contribute to erosion – eg freshes and minor floods (larger floods being covered by flood damage reserves) maintenance, pest and stock damage, etc, - then maybe taking 1/12 of the average maintenance costs for edge protection is be reasonable.

As for instance water level varies by a greater amount downstream of Matahina than elsewhere, he above formula could be biased towards ECNZ. The formula could be refined by taking a better local estimate of the water level variation. An appropriate formula might be

Reach	Average water level variation[1]	Average proportion under greater stress	Reach Maintenance Costs per annum[2]	Contribution per annum
Edgecumbe to Te Teko	1m	1/10	40194	4019
Te Teko to Matahina	2m	1/5	16165	3233
Waiohau Plains	0.5m	1/20	11018	551
Aniwhenua to Murupara	0.4m	1/25	19414	777

1. Crude estimate based on variations discussed on first page. Could be improved by measurements.
2. Includes plant edge protection, rock work, rubble. Excludes fencing, management, surveys, weedspray

This assumes that the effect of each power station only extends as far as the next power station downstream, and that the upstream effects of the lake levels are not significant.

According to this formula, rates per hectare might be

Owner	Contribution per annum	Area owned in Scheme	Contribution per annum per ha
ECNZ (Matahina)	7252	50ha	145.04
BOP Electricity (Aniwhenua)	551	275ha	2.00
Trustpower (Whaeo)	777	10.7ha	72.61

Total Contribution $8580 per annum.

This level of contribution is considered too small to include in the rates take, considering the risk of delaying the current reclassification process. It has therefore been decided to develop agreements with the power station operators in order to obtain the contribution.

2. A proportion of capital works.

A contribution towards funding capital works might be an option. This might be particularly so where erosion problems require greater protection than at present. An example where this might be the case is at Coates property (between Matahina and Te Teko). Currently the site is protected by a mixture of rockwork and trenched willows. When the Matahina begins operating again, the trenched willows might be insufficient to hold the steep bank, and additional rock could be required.

An alternative to direct contribution to maintenance funds is to provide material. In particular, Environment B.O.P could approach ECNZ to obtain rock for protection work from its quarry operations. The advantages of this are that rock is usually difficult to obtain, and that the quarry site is close to the river, thereby reducing transport costs.

A difficulty with this approach is that much of the capital work has already been completed. Expenditure in the short-medium term is likely to be maintenance.

3. Monitor

A further option, or in addition to either of the above, would be to

- reintroduce some closer, more controlled, monitoring of the effects of the water level variations, and,
- to repair any damages concluded to be the result of the operations, costs to be met by the power station operators.

A good opportunity for a semi-control exists with the Matahina Dam being out of action. When the station commences operations, the effects on river bank stability could be compared to conditions now.

Preliminary discussions with ECNZ indicate that it is willing to resurrect a monitoring programme, and an inspection of the banks below Matahina by jet boat is planned for March. Provided we can justify our damage estimates, ECNZ also appears willing to consider any request for contributions.

Drawdown during Dam repairs

Dam drawdown has occurred during Matahina repairs after the 1987 earthquake and in 1997. A jet boat trip was undertaken 1996 prior to dewatering, and a photographic record taken to document the pre-dewatering condition of the banks. It was intended that the exercise be repeated after dewatering, to assess the effect of the dewatering. However this was not followed up.

Unless the effects of past drawdowns have been documented, which it appears is not the case, it is suggested that in the future an applicant address the effects at the time of the consent application. At that time, possible compensation, or contribution to maintenance and capital works could be then assessed by Environment B.O.P.

Conclusions/Recommendations

- A jet boat trip be undertaken in March, with Environment B.O.P staff and ECNZ representatives, to identify locations for continued monitoring.
- Cross-sections be obtained at these sites at a regular interval – 2 years would be reasonable.
- Photographic records of the riverbanks are obtained on a regular basis, to provide additional evidence of the effects of power station operation. The monitoring sites as above should be included. A record should also be taken immediately before the Matahina Dam is recommissioned, and within say 3 weeks after.
- The breakdown of the proportion of maintenance costs attributable to power station operation be refined further with the assistance of regular inspections and photographic records, and be presented to the power station operators, with a view to obtaining a contribution for damage caused.
- The possibility of rock being obtained from ECNZ in lieu of any financial contribution be raised with ECNZ. (Provided that Environment B.O.P can identify a need for additional rock protection or rockwork maintenance.)
- Future dewatering consents require the applicant to take surveys immediately before and after the dewatering, to monitor the effect on riverbank stability. Survey sites to be agreed with Environment B.O.P. Photographic records to be taken. Any adverse effects to be repaired with a funding contribution from the applicant.

Appendix P2

AGREEMENT

Agreement made this day of 1998

BETWEEN **ELECTRICITY CORPORATION OF NEW ZEALAND LIMITED** ("ECNZ"), a duly incorporated company having its registered office at Wellington, together with its successors and assigns.

AND **BAY OF PLENTY REGIONAL COUNCIL** ("EBOP"), a local authority under the Local Government Act 1974.

(hereinafter together referred to as "the parties.")

WHEREAS

1. ECNZ owns and operates the Matahina Power Station and discharges water from the Matahina Power Station into the Rangitaiki River.

2. EBOP is the statutory manager of the Rangitaiki-Tarawera Rivers Scheme.

3. ECNZ was granted water and discharge permits ('the deemed permits") in 1989 to operate the Matahina Power Station.

4. Conditions 5.5 and 5.6 of the deemed permits provide for the consent holder to monitor river erosion trends at 11 sites on the Rangitaiki River between the Matahina dam and Thornton, on a biennial basis throughout the term of the permits, and to provide the results of monitoring to EBOP by 31 August of the same year that the monitoring is carried out.

5. Condition 5.7 provides that, in the event that biennial monitoring shows a significant change to the pattern or rate of river erosion as a result of the changed operating conditions relating to the maximum load decrease, then the ramping download decrease would be changed back to a maximum rate of 8 megawatts per hour.

6. ECNZ wants to profile accurately, its operations against erosion effects with a view to applying for a variation and/or renewal of all or any of the conditions of the deemed permits on the basis of a change of circumstances since the deemed permits were granted.

7. EBOP has a report by Titchmarsh, 1996, noting that

(i) "erosion of the river below the dam has always been a problem with a certain amount natural and some no doubt resulting from water level fluctuations from the dam", and

(ii) "the two years of trial operating conditions did not appear to alter the pattern and rate of erosion significantly".

8. ECNZ has a report from Dr Cave, 1998, indicating that:

(i) "There are a variety of erosion mechanisms at work including stock trampling, the Edgecombe Earthquake, enhanced groundwater flows from adjoining pasture, significant wash from the jetboats and some erosion due to high water flows after heavy rainfall."

(ii) "The level of erosion on the river is not significantly different from what would be expected in any river with or without a power station; in particular one new site (number 12) was clearly eroding significantly in 1944;"

(iii) "The style, scale and distribution of erosion is consistent with the normal behaviour of a meandering river flowing through a flood plain made up of poorly consolidated, highly permeable pumice materials", and

(iv) "The principal driver of erosion in the river is most likely to be periodic flood events."

(v) "The capacity of the power station to buffer the peaks of these events due to storage capacity probably mitigates erosion to some extent".

(vi) "in the area of monitoring site 12 there has been a significant drop in the rate of erosion since construction of the dam" and "this is consistent with experience elsewhere which indicates that the ability of dams to provide buffer against flood flow tends to slow down the rate of erosion."

(vii) "a number of the 11 sites ECNZ is required to monitor coincide with where rupture zones of the Edgecombe Earthquake crossed the Rangitaiki River".

9. The 11 sites on the Rangitaiki River were found to be in good condition when inspected on 22 June 1998 by EBOP and ECNZ and a report by ECNZ recording the inspection was provided to EBOP. (At this time, the Matahina power station was out of commission due to allow a dam strengthening project).

10. It was agreed that the original 11 sites would be documented on the river inspection for comparison against previous monitoring but that other sites would be identified for consideration as future sites to be monitored. The final selection of sites would require the mutual agreement of both ECNZ and EBOP.

11. EBOP has agreed not to pursue any claims against ECNZ for erosion damage of the downstream riverbanks said to be caused by the drawdown of Lake Matahina in 1996.

12. EBOP has advised ECNZ that as from 1 July 1998, the rating basis for the Rangitaiki-Tarawera Rivers Scheme has changed from a land value classification rating system to an area-based differential rating system. In the new system, land is rated on the basis of benefit/exacerbation.

    The rates for Class A4 are principally based on the perceived benefits of erosion prevention and flood protection that a landowner receives (both directly to the land concerned and indirectly to the area as a whole) from the Rangitaiki-Tarawera Rivers Scheme.

    For 1998/99, the ECNZ land at Matahina Power Station is rated at $10.41 (incl. GST) per hectare (based on classification Group A, A4). This compares to the 1997/98 rate of 0.0716cents per dollar of rateable land value (Class E land).

13. EBOP has prepared an asset management plan for the Rangitaiki-Tarawera Rivers Scheme, and adopted it in July 1998. The plan defines EBOP management objectives, a maintenance programme and funding requirements for the Scheme.

14. EBOP has advised ECNZ that it intends to reach an agreement with the owners of the three power facilities at Matahina, Aniwhenua and Wheao to secure funding assistance to the EBOP river maintenance programme on a set formula basis over and above contributions received through rates, as recommended in the asset management plan. Without this assistance, the rating described in Clause 12 above would be increased.

15. ECNZ agrees in principle to contribute to EBOP river maintenance on a without prejudice basis, and subject to the completion of an agreement formalising the arrangement with EBOP.

Now therefore it is agreed as follows:

1. ECNZ shall pay to EBOP an annual sum commencing 1 July 1998 towards the EBOP river maintenance programme, calculated on the basis of the EBOP "contribution formula" (a copy of which is appended hereto). For the year

from 1 July 1998, the sum has been assessed at $8,500. EBOP may give notice that the sum is to be revised, in accordance with movement in the Cost Construction Index.

While EBOP has endeavoured to ensure the Asset Management Plan is as accurate as possible, regular revisions of the Plan will be required and EBOP agrees to consult with ECNZ during revision of the Plan.

The "contribution formula" may be changed by agreement between EBOP and ECNZ.

The annual amount will be invoiced by 30 September each year.

2. Such payment shall be made by ECNZ and accepted by EBOP on the basis that EBOP acknowledges and accepts that from the monitoring of the 11 sites completed to date in accordance with conditions 5.5 and 5.6 of the deemed permits, there appears to be little or no conclusive evidence that ECNZ activities have caused or exacerbated the rate of erosion in the Rangitaiki River downstream of the Matahina Power Station and that ECNZ does not admit any legal liability whatsoever therefor.

3. EBOP acknowledges that it will not pursue any claims against ECNZ for downstream erosion alleged to be caused by the drawdown of Lake Matahina in 1996.

4. EBOP will:
   (i) involve and consult ECNZ on any planned expenditure on river work which may have a significant impact on the level of contribution;
   and

   (ii) support in principle ECNZ's endeavours to profile accurately, operations against erosion effects.

5. Should ECNZ be able to supply surplus rock or any other suitable material to EBOP, EBOP may accept this in lieu of one or more of the annual payments in Clause 1, subject the rock being of a quality acceptable to EBOP, and at a price to be agreed upon by the parties.

6. ECNZ shall, on the basis of the understanding between the Parties in clauses 1 and 2 of this Agreement, voluntarily monitor sites numbered 12, 13, 14 and 15 identified by EBOP in addition to the 11 sites mentioned in condition 5.5 of the deemed permits, commencing June 1998.

7. ECNZ shall give notice to EBOP of any planned outages of the Matahina Power Station for the purpose of avoiding undue hindrance of EBOP's construction and maintenance work in the Rangitaiki River caused by ECNZ

exercising its rights under the deemed permits and shall notify EBOP of any changes to the programme of planned outages.

8. This Agreement shall terminate on 30 November 2009 or earlier by mutual agreement.

9. Unless otherwise specified, any notice given under this Agreement shall be in writing and delivered or transmitted as follows:

ECNZ
Matahina Power Station
P O Box 61
Te Teko

Telephone: 07 322 8014
Fax: 07 322 8024

EBOP
P O Box 364
Whakatane

Telephone: 07 307 2545
Fax: 07 307 2544

or to such other address as either party shall notify to the other.

A notice given under this Agreement shall be properly given and received:

(a) When delivered by hand;

(b) Three days after being posted by mail with prepaid "FASTPOST" postage;

10. (i) In the event of any dispute arising between the parties in respect of or in connection with this Agreement, the parties shall, without prejudice to any other right or entitlement they may have under this Agreement or otherwise, explore whether the dispute can be resolved by use of the alternative dispute resolution technique of mediation. The rules governing such technique shall be as agreed between the parties or as recommended by the New Zealand Law Society or as selected by the Chairman of the New Zealand Chapter of LEADR (Lawyers Engaged in Alternative Dispute Resolution).

(ii) In the event the dispute is not resolved within 60 days of written notice by one party to the other of the dispute (or such further period agreed in writing between the parties), either party may refer the dispute to

arbitration under the provisions of the Arbitration Act 1996 or any Act passed in substitution therefor. The arbitrator shall be agreed between the parties within 10 days of written notice of the referral by the referring party to the other or failing agreement appointed by the President of the New Zealand Law Society. In either case, the arbitrator shall not be a person who has participated in any informal dispute resolution procedure in respect of the dispute.

11. If ECNZ sells the Matahina Power Station ECNZ may at any time and from time to time, by not less than 10 days notice (a "Transfer Notice") from ECNZ and the Purchaser of the Scheme to EBOP, transfer by way of novation to that Purchaser ECNZ's interest in this Agreement and all of its rights and obligations under this Agreement on the date specified in the Transfer Notice shall automatically and without any further act being required by any person be deemed to be held by the Purchaser and EBOP and the Purchaser shall be bound to each other accordingly. The Purchaser shall agree in the Transfer Notice to be so bound. Upon such transfer by way of novation becoming effective ECNZ shall automatically, and without further act being required by any person, be released from all liabilities and obligations in relation to EBOP in respect of this Agreement.

SIGNED for and on behalf of)
ELECTRICITY CORPORATION)
OF NEW ZEALAND LIMITED)
by:)
)
in the presence of:-)

SIGNED for and on behalf of)
BAY OF PLENTY REGIONAL)
COUNCIL)
by:)
)
in the presence of:-)

(Copy of 2 original copies)

Appendix Q1

Bay of Plenty
REGIONAL COUNCIL
Thornton School Site
at 2.6km on the Right Bank
Laws Corner Site
at 5.6km on the Left Bank
Riverslea Wall Site
at 10.5km on the Left Bank
Legend
River Center Line
Site Visits
Rangitaiki River
Site Vists
© Bay of Plenty Regional Council
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0 425 850 1,700 2,550 3,400 Meters
Scale: 1:32,580
N
Survey Plan 130

Appendix Q2


Bay of Plenty
REGIONAL COUNCIL
Kokohinau Site
at 15.7km on the Left Bank
Omataroa Trust Site
at 20.5km on the Right Bank
Walker Site
at 21.2km on the Right Bank
Neway Site
at 24.6km on the Left Bank
Newdick Site
at 28.5km on the Right Bank
Legend
River Center Line
Site Visits
Rangitaiki River
Site Visits
0 425 850 1,700 2,550 3,400
Meters
Scale 1:32,580
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Survey Plan 130
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IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of an application by **TRUSTPOWER LTD** to the **BAY OF PLENTY REGIONAL COUNCIL** for water permits associated with the operation of the Matahina Hydroelectric Power Scheme

STATEMENT OF EVIDENCE OF MARIANNE O'HALLORAN

1. INTRODUCTION

Qualifications and experience

1.1 My name is Marianne O'Halloran. I am a sole practice geotechnical engineer and work predominantly in the Bay of Plenty and Waikato areas. I am an owner and director of Ice Construction Ltd and Ice Geo and Civil Ltd and undertake contract management and quality control for Ice Construction.

1.2 My qualifications are a Bachelor of Engineering (Civil) (Auckland University / 1979), a PhD in Geotechnical Engineering (Auckland University / 1983) and a post graduate Diploma of Business Administration (Massey University /1997). My PhD thesis was on the earthquake stability of earth structures with detailed assessment of an embankment dam. I am a trained Urban Search and Rescue Engineer with an interest in disaster preparedness, rescue and recovery. I am a Chartered Professional Engineer and a member of the Geotechnical, Structural and Earthquake Engineering Societies.

1.3 I started work in the Special Projects office of the Ministry of Works Head Office in 1983. Some of the work that I carried out there which is relevant to this hearing is the identification of sites for potential irrigation dams around the Waipaoa Plains, the investigations for possible irrigation schemes in Otago and

slope stability assessments of various cuts and fills around Lake Dunstan. I also assessed the stability of some major slips.

1.4 In 1986 I transferred to Hamilton and continued with the Ministry of Works and its successors. While in Hamilton I assessed the stability of slopes associated with roading, designed some stormwater detention dams for coal mines at Rotowaro and supervised the construction of many earthworks projects including detention dams, weirs and large, deep, effluent storage ponds.

1.5 I worked for Beca Carter Hollings and Ferner in Tauranga from 1994 to 2002. While with Becas I helped with the identification of possible landfill sites near Gisborne and carried out the in situ investigations. I investigated ground water flow and slope stability problems following significant failures around Maungatapu in Tauranga and many other sites across the North Island between Auckland and Mangaweka. I also carried out some work along the Rangitaiki River.

1.6 Since commencing as a sole practitioner in 2002, I have carried out a wide variety of geotechnical work, mainly for various local bodies, other consulting engineering companies and the New Zealand Transport Agency. I am what is termed a "Category 1 Geotechnical Engineer" with the Tauranga City and Western Bay of Plenty District Councils. These local councils have a registration system due to the recognition of the particular problems of a young terrain strongly influenced by soils of volcanic origin. I am often engaged as a Peer Reviewer.

1.7 Much of my work has involved the assessment of slope stability for natural slopes, cut slopes and embankments. In 2005, along with most of the geotechnical engineers in Tauranga, I was heavily involved in the assessment and monitoring of many slope failures within Tauranga City due to an intense storm. My work involving water ways includes the investigation and design of a large wetland at Ohaaki for Fish and Game New Zealand in soils similar to those along the Rangitaiki. I have also carried out the geotechnical design of some wetlands and stopbanks associated with the Tauranga Eastern Link Road project.

Involvement in Matahina Hydroelectric Power Scheme consent process

1.8 Following the failure of the Rangitaiki River stopbank in 2004, I was requested by the Environmental Hazards Group ("EHG") of the Regional Council to investigate the causes of the failure. My investigations and the amount of damage caused along the river during the 2004 flood highlighted the fragility of the river banks and the flood protection system. Since 2004, I have carried out in situ investigations and analysed the stability of many sections of the Rangitaiki River bank between Te Teko and the river mouth and have advised the EHG as to the work required to improve the security of the flood protection scheme. I have carried out a smaller amount of work along the Whakatane, Tarawera and Otara Rivers and various canals and drains.

1.9 The EHG has engaged me to prepare and present this evidence in support of its submission in relation to the resource consent application for the Matahina Hydroelectric Power Scheme based upon the investigations along the Rangitaiki River that I have undertaken for the EHG since 2004.

Expert Witness Code of Conduct

1.10 I have been provided with a copy of the Code of Conduct for Expert Witnesses contained in the Environment Court's Consolidated Practice Notes 2006. I have read and agree to comply with that Code. This evidence is within my area of expertise, except where I state that I am relying upon the specified evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Purpose and scope of evidence

1.11 The purpose of my evidence is to provide contextual information on the geology of the area and comment on the nature and extent of the geotechnical issues which arise along the Rangitaiki River and the work that is being carried out in an effort to mitigate these issues.

1.12 Specifically, I will address:

(a) The geology and topography of the Rangitaiki River and adjacent plains which will demonstrate the sensitivity of the Rangitaiki River to geotechnical problems (Section 3).

(b) The possible mechanisms that can bring about stopbank failure (Section 4).

(c) Specific problems which the geology and topography of the Rangitaiki River cause for the flood protection system (Section 5).

(d) The geotechnical investigations which I have carried out along the river since 2004 and the mitigation measures that have been undertaken or are currently being considered (Section 6).

(e) The effect of water level fluctuations on surface erosion and river bank stability(Section 7).

(f) The effect of silt layers lining the river banks on inland water pressures during floods (Section 8).

(g) The analyses undertaken by Beca on behalf of TrustPower, their conclusions and my opinion in respect of those conclusions (Section 9).

1.13 My evidence needs to be considered alongside the evidence of:

(a) Bruce Crabbe; and

(b) Gary Williams.

1.14 A summary of my evidence is contained in Section 2.

2. SUMMARY OF MY EVIDENCE

2.1 In my evidence I have tried to explain the complex nature of the problems of the flood protection scheme along the Rangitaiki River and how sensitive the security of the scheme is to what might be considered minor changes in the river environment.

2.2 I have shown how erosion can be caused in some of the soils in the Rangitaiki Plains due to fluctuating water levels and how on-going erosion can significantly reduce the stability of river banks and stopbanks.

2.3 I have shown how the proposed new low river level can have an impact on the security of the stopbanks.

2.4 I have also made an effort to quantify the effect of an intact silt layer on the riverbank on water pressures developed inland during floods and hence the increase in risk of stopbank failure if the silt layer is lost.

2.5 I conclude that TrustPower's proposed plan for managing river flows will increase the erosion along the river and have a detrimental effect on the security of flood protection scheme.

3. THE GEOLOGY AND TOPOGRAPHY OF THE RANGITAIKI RIVER AND PLAINS

3.1 This section of my evidence will address the geology of the Rangitaiki Plains; the nature of the soils, particularly in terms of their permeability; the topography of the Plains and the changes to the landform caused by the Edgecumbe earthquake. My aim is to highlight the complexity of the geological environment.

Geology

3.2 The Rangitaiki Plains are the most northern extent of the Taupo Volcanic Zone on land and are in a seismically active area with felt earthquakes being relatively frequent. They are close to the Okataina Volcanic Centre which is considered to be the most volcanically active area in New Zealand. Two layers of Tarawera Ash can be traced across much of the Rangitaiki Plains. The dune system and alluvial lowlands within 10km of the coast have formed in only the last 8,000 years. The plains are therefore geologically very young and unconsolidated. This means that the soils can be readily disturbed by changes in water level, load or earthquakes.

3.3 The plains have been built up by over-bank alluvial deposits from meandering rivers in flood, wind blown sand, airfall ash deposits and peat formation in

depressions. The active volcanism of the upper Rangitaiki River catchment and the high erodibility of the volcanic tephra result in a large source of sediment which can be deposited on the plains.

3.4 The outcome of the plain formation processes is a wide and unpredictable variety of soil types and grain sizes within small horizontal and vertical distances. **Figure 1** in **Attachment A** to this evidence illustrates the floodplain environment of a meandering river with bank erosion and cut-off channels which has resulted in the unpredictability of individual soil profiles within the Plains.

3.5 The Rangitaiki Plains geology is further complicated by the airfall ash deposits blanketing the landform and the faults made evident in the 1987 Edgecumbe Earthquake.

3.6 A large proportion of the upper Rangitaiki catchment consists of pumice soils. As pumice soils are typically highly permeable and have large void spaces they can store large volumes of water. This means that water is released from pumice country over a long period, compared to say greywacke or Papa country. This slow release of water results in drawn out flood flow hydrographs in the streams and rivers.

Soils

3.7 A critical soil property for stopbank design is the permeability of the underlying soils as flow beneath a stopbank can lead to its failure.

3.8 Most of the soils within the plains are silts, sands and gravels with moderate to high permeability. There are also some layers of peat, particularly in the lower parts of the Plains. Much of the soil is of pumiceous origin and there are many layers of pumice sands and gravels ranging from lapilli size, which is up to say 10mm, to cobbles about 100mm in diameter. These layers have very high permeability.

3.9 A surface layer of more cohesive low permeability silt is found in many areas and this is often the only reason why there are not excessive flows under stopbanks into the land beyond. Within the surface silt is often a clearly

defined layer of 1886 black Tarawera Ash as shown in **Photo 1** in **Attachment A**. This ash is typically found at 200 to 300mm depth which gives an indication of the rate of alluvial deposition prior to the construction of the stopbanks along the river.

3.10 The pumice soils are much lighter than most other soils and some pumice can float. The specific gravity of pumice can be as low as 1.7, that is pumice weighs 1.7 times the weight of the equivalent volume of water. It is the air voids within pumice that makes it float. Most other soils would have specific gravities in the range of say 2.4 to 2.8. Its light weight and lack of cohesion means that pumice can be moved by lower water velocities than other soils.

3.11 The methods of deposition of the soils within the Rangitaiki Plains have created complex and unpredictable layering which in many areas has resulted in highly permeable layers being sandwiched between much lower permeability layers. This concentration of flow combined with the erodibility of the pumiceous soils can lead to a variety of problems for the flood protection scheme. These are addressed below.

Topography

3.12 As has been briefly described in Mr Crabbe's evidence, the Rangitaiki River lies in an incised channel immediately down stream of the Matahina Dam, however beyond Te Teko the river rises relative to the adjacent ground. By the time it reaches Edgecumbe it is within a river levee with the natural ground sloping away from the river bank. A fall of 2.0m within 100m of the stopbank is not uncommon.

3.13 **Figure 2** in **Attachment A** shows an aerial view of the Rangitaiki Plains in the greater Edgecumbe area. Some of the old flow paths and the Edgecumbe fault can be seen in this photo. The adjacent LIDAR plot highlights the ground contours in Edgecumbe.

3.14 The fall in ground level away from the river tends to increase as the river progresses towards the coast. **Figure 3** shows the contours in the area of

Thornton School. It can be seen that there is a large drop in level from the river bank which is typically at RL 2.6, to the low area which is as low as RL -0.5.

3.15 Therefore, although the stopbanks are quite low in some areas there can still be a reasonably high head difference across the stopbank to the low lying areas. As shown in **Figure 4** at the Thornton School the stopbank is only about 1m high but in the 100 year flood the effective pressure head difference across the river levee is 4.1m. In this area, the direction of ground water flow when the river is at a normal level is away from the river, whereas further upstream the predominant flow is towards the river. This means that as soon as the river level is elevated the water pressure in the adjacent ground increases. The low lying areas of the Plains have sunk since drainage works began in the 1950s at an estimated rate of 4mm per year. The potential head difference across the stopbanks is therefore slowly increasing in these areas. (It should be noted that there could be sub-surface saline water flow from the river to the farm land due to the saline wedge in the river. This has been identified as a problem further down stream near Moore Road.)

1987 Edgecumbe Earthquake

3.16 On 2 March 1987, the Rangitaiki plains experienced a Richter magnitude 6.2 earthquake. This was preceded by a series of foreshocks as big as Magnitude 5.2 starting on 23 February 1987 and was followed by several significant aftershocks. It was estimated that the main earthquake was centred within 10km of the earth's surface.

3.17 The earthquake caused reactivation of the Edgecumbe, Onepu and Rotoitipakau Faults and several new surface ruptures ranging in length from 0.5 to 7.0km. Typically, the north-western side of the rupture dropped relative to the south-eastern side. The largest displacement was near the centre of the Edgecumbe Fault rupture and was up to 2.5m vertically and 1.8m horizontally. The rupture crossed the Rangitaiki River about 5km upstream of Edgecumbe.

3.18 The earthquake swarm caused extensive liquefaction of the young alluvial deposits within the plains. I don't think the process of liquefaction requires any explanation after the Christchurch experience. Following liquefaction, the

ground surface settles as excess water pressures dissipate and a new denser state is achieved by the alluvial soils. After the Edgecumbe Earthquake, 1 to 2m of ground settlement was recorded from where the fault crossed the river to downstream of Edgecumbe. **Figure 5** shows the measured settlement two months after the earthquake. Near McCrackens Road the rate of settlement was measured at up to 7mm a day. Local farmers are still experiencing ground movement 24 years after the earthquake.

3.19 Some of the springs that were activated by the earthquake are still flowing. The fault movement, plus the post liquefaction settlement means that Edgecumbe is now sitting in a shallow basin.

3.20 The damage caused to the stopbanks by lateral spreading, slope failures and rupture during the earthquake was quickly repaired. The main long term effect on the flood protection system was the need to lift the level of the stopbanks relative to the surrounding ground. Therefore a 1.5m high section of stopbank upstream of Edgecumbe became 3.5m high.

3.21 The relevance of this increase in height of the stopbanks due to the earthquake is addressed in Section 5.

4. STOPBANK FAILURE MECHANISMS

4.1 Before I address the particular geotechnical issues that arise along the Rangitaiki River and the effect of fluctuations in river levels, I will briefly outline the main failure mechanisms for stopbanks. These are:

(a) Overtopping;

(b) Slope stability failures of either side of the stopbank;

(c) Piping caused by the removal of soil particles and the formation of a hole through or beneath the stopbank which eventually causes stopbank collapse; and

(d) Heave of inland soil layers followed by a piping failure.

4.2 Some illustrations of these failure mechanisms and a photo of a pipe formed in the river bank upstream of Edgecumbe are shown in **Attachment B**.

Overtopping

4.3 Overtopping occurs when the water level exceeds the height of the stopbank. This should not be a problem if the stopbanks are well maintained and the design flood is not exceeded.

Slope stability failures

4.4 The failure of the slope on either side of a stopbank can lead to overtopping and rapid erosion of the stopbank, or accelerate a piping type of failure.

4.5 The most critical time for slope failure is when the river level drops rapidly, leaving high water pressures within the stopbank face. Stopbank cross sections showing slope stability failures are included in **Attachment G**.

4.6 Slope failures can be avoided by having suitable stopbank batters and river berms. If there is active erosion of a river berm it may be necessary to protect it by some means, such as rock rip rap, so that the stability of the stopbank above is not threatened.

Piping failures

4.7 Heave and piping failures can be much harder to design against than slope failures because assessing their risk requires a good understanding of the subsurface soils and their variability.

4.8 Piping occurs when the hydraulic gradient of the water flowing through the soil is sufficient to move soil particles and the soil particles escape to the ground surface or into a coarser layer. Thus, a "pipe" forms in the soil which allows unimpeded water flow and, in turn, the further movement of soil particles along the "pipe". This is illustrated in **Figure** 1 in **Attachment B**.

4.9 Hydraulic gradient is an indication of the difference in water pressure across a soil particle. It is a ratio of the difference in water pressure along a soil layer to the length of the seepage path and is measured in terms of metres of water

head per metre of seepage path. The "critical hydraulic gradient" for a particular soil is that when soil particles can begin to move, that is, piping can begin. Therefore lengthening a seepage path can be a means of preventing piping as it reduces the hydraulic gradient.

Heave

4.10 Heave occurs when the water pressure within a soil layer is greater than the weight of a less permeable soil above it. This causes the surface layer to lift up or heave. If the surface layer bursts open and the layer below is prone to piping, a large volume of water and soil can be emitted which may result in rapid erosion back to the stopbank and complete stopbank collapse. Plant roots can provide some tensile strength to the surface layer which means that quite large bulges in the ground surface can develop without rupture.

5. GEOTECHNICAL PROBLEMS WHICH ARISE ALONG THE RANGITAIKI RIVER

5.1 This section of my evidence addresses how the geology and the topography of the lower river system have created many problems for the flood protection scheme and the river system in general. The following section will address how fluctuations in river levels further exacerbate these problems.

Erosion of river bank soils

5.2 The most consistent problem along the river is the ready erosion of the river bank soils. The rate of erosion has increased upstream of the Edgecumbe Fault since the 1987 earthquake due to the relative uplift of the upstream side of the fault causing a water fall and now rapids around a forest which was buried in the river bed.

5.3 **Photo 1** in **Attachment C** shows the extensive erosion in the river bank just upstream of the fault exacerbated by the buried trees. **Photo 2** shows the erosion in layered pumice silts around a tree.

5.4 The buried trees can also create some short circuits under stopbanks. **Photo 3** shows a hole in a paddock behind a stopbank where an old tree has rotted out. Water can flow from the river bank through sand layers and up through the hole

to the ground surface. In the worst conditions this could lead to a piping failure. It can be seen in **Photo 2** that the top of the tree stump has rotted faster than the part that used to be permanently below water level. Locals consider that there is an increased frequency of holes forming in paddocks upstream of the fault since the earthquake. This could be due to the upper parts of the trees being more exposed to air.

5.5 The stopbanks themselves have been built from readily erodible locally won soils, however there is good grass cover on most of them and no surface erosion due to floods has been observed. Rabbit burrows in the stopbanks can be a problem.

Heave and piping

5.6 The highly permeable soil layers which extend under the stopbanks from the river bank give rise to problems with heave. A highly permeable sand layer can be seen in **Photo 4** layered between silts and peat. Due to the erosion along the river bank the ends of these sand layers are often unprotected by a build up of silt or vegetation which could slow the flow of water and reduce the potential for heave. I will cover this in more detail in Section 8.

5.7 The surface silts and peats above the permeable layers are light and readily lifted. A typical bulk density of the silts is 1.55 t/m^3 and peat could be as light as 1.05 t/m^3. Ploughing of paddocks can produce a low permeability smeared zone at the base of the plough as shown in **Photo 5**. This can prevent water seeping from the ground surface and result in thin layers being subject to heave. It is not uncommon when the river is high to find areas in the paddocks behind the stopbanks that feel like a trampoline to walk on.

5.8 Due to the fall in ground level away from the river most of the springs observed when the river is high are found well away from the river. Similarly the observed stopbank failures have been the result of heave and piping well away from the stopbank. The potential for heave was identified by the Catchment Commission when the stopbanks were initially designed and some fill was placed across low areas in old river meanders at the time of the initial stopbank construction.

5.9 The rapid variation in soil types and layering makes it very difficult to design a stopbank system which can take into account all possible foundation conditions. Most seepage analyses are two dimensional and are carried out at right angles to the river bank. They do not account for three dimensional flows along old flow paths behind the stopbank as can be seen in the LIDAR plots in Attachment A.

5.10 Other things that can influence seepage paths through and under stopbanks are:

(a) poles, posts and tanks intercepting coarse layers;
(b) soak holes;
(c) trees;
(d) rubbish pits;
(e) effluent ponds;
(f) cable and pipe trenches;
(g) buried coal, flyash and earthquake debris.

5.11 The long duration of the floods in the river means that high water pressures have time to develop well away from the river. The present 100 year design flood flow hydrograph is 14 days long. In many river systems this hydrograph would be less than one week.

5.12 The original stopbanks were up to about 1.5m high and there is no record of any problems along them prior to the 1987 earthquake. The potential pressure difference across the stopbanks has been more than doubled in some areas due to the stopbank top ups required after the earthquake. This means that there are now more areas susceptible to seepage problems than before the earthquake. Since the earthquake seepage problems have been observed in 1998, 2004 and 2011. It has also been found that seepage can track along fault ruptures inland from where they cross water courses.

6. STOPBANK INVESTIGATIONS AND REMEDIATION MEASURES

6.1 This section of my evidence will address the geotechnical investigations which I have carried out in relation to the stopbanks and the remedial measures being undertaken in order to reduce the risk of stopbank failure. I will address the

contribution of fluctuating water levels to the failure risk in Sections 7 and 8 and comment on the conclusions formed by Beca in Section 9.

Rationale for and overview of investigations

6.2 My investigation of the 2004 stopbank breach concluded that it was due to the heave of upper soil layers and piping of the underlying sands. The breach highlighted the fragility of the stopbank systems and it was decided that a systematic investigation into the security of the flood protection scheme was required. I will now discuss how areas were chosen for closer assessment, how the assessments are carried out and the remedial measures considered.

6.3 It came to light in my discussions with locals during the breach investigations that they knew there were areas of heave, described as spongy areas, and seepage whenever the river rose above the natural ground surface. This information had never been passed on to the Regional Council. The first step of our more extensive study was therefore to send out a questionnaire to 200 landowners and rural contractors along the river asking if they had noticed a variety of things that could have an influence on the security of the flood protection scheme. A copy of this questionnaire is included in **Attachment D**. We received 27 responses from landowners, who were subsequently visited to discuss their observations.

6.4 Immediately following the 1987 earthquake a comprehensive study of the stopbanks was carried out identifying eight different types of stopbank damage. It was noted that there was a correlation between some types of stopbank damage and the presence of old stream channels. These areas were therefore noted for further investigations. The locations of old watercourses were also identified from old maps, aerial photographs and local knowledge. LIDAR information was unavailable at this stage.

6.5 All of the available stopbank drawings, reports and subsurface information were collated and a master spreadsheet was developed which covered all the stopbanks along the river. The spreadsheet includes the stopbank geometry, width of river berm, use of the river berm for fill, the presence of rock protection

and the fall of the land within 100m of the river. Each section of stopbank was then graded in terms of possible risk.

Stopbank Analyses

6.6 So far I have investigated 17 sections of stopbank ranging from a few hundred metres length to a few kilometres in length. This work has been reviewed by Opus International Consultants Ltd, who have carried out their own assessments of several sections of stopbank, including those at the Transpower Substation and the Fonterra Dairy Factory. I will now describe how I assess each section of stopbank. I will discuss some specific examples in Section 8.

6.7 The in situ investigations consist of a series of hand augers carried out in cross sections along the river bank which extend to the low point a hundred metres or more away from the stopbank if necessary. The spacing of the cross sections and augers is dependent on the complexity of the stopbank and land geometry and whether there are any points of interest, such as patches of reeds. The cross sections are typically 50 to 80m apart. Soil samples are gathered for particle grading analysis and some in situ falling or constant head tests have been carried out to gain an idea of permeability.

6.8 Once a subsurface soil model has been developed for each cross section computer analyses are carried out to assess:

(a) the potential for piping through or under the stopbank;
(b) the potential for heave of upper soils layers; and
(c) the stability of both stopbank faces under high river, low river and rapid drawdown conditions.

6.9 The design 100 year flood level is used in the analyses. As the stopbank models almost invariably develop heave problems if steady state conditions are assumed, transient analyses are carried out for the 100 year flood flow hydrograph. These analyses model the rise and fall of the river during the flood. Due to the erosion along the river banks the ends of sand layers that are exposed in the river banks below normal water levels are assumed to be open to the river flow. Those layers above normal water levels typically have a silt

covering. The computer software and method of transient analysis used is the same as that used by Beca. Some sensitivity analyses are carried out varying the permeability of various layers, the ratio of horizontal to vertical permeability, and the thickness and type of soil below the depth of the hand investigations.

6.10 If the sensitivity analyses show that deeper soil layers have an influence on the response of the stopbank system to the flood, deeper machine boreholes are carried out to confirm the nature and thickness of these layers. A bore log from a deep borehole drilled through the stopbank just down stream of the Transpower substation is given in **Attachment E**. Also included is the subsurface profile derived from five deep boreholes along this section of stopbank. The variability in soils along the riverbank can be seen in this profile.

Remedial Measures

6.11 If a potential problem is identified by the computer analyses various remedial measures are modelled. The remedial measures which have been used, or are being considered, to reduce the risk of heave and piping are:

(a) overlays on the landward side to add weight to the ground surface (these are not practical over large or built up areas);
(b) overlays on the river side to block flow along high permeability layers;
(c) pressure relief trenches to allow water to escape in a controlled manner;
(d) pressure relief wells where trenches are impractical or the problem layers are too deep;
(e) controlled flooding to reduce pressure differentials where there are large areas at risk; and
(f) low permeability cut offs through permeable layers.

6.12 The aim is to try to achieve a factor of safety against heave of at least 1.1. This means that the weight of the layers above a layer with high permeability is at least 1.1 times the highest expected water pressure in the high permeability layer. This factor of safety is considerably lower than would be used in most other situations but is often all that be achieved without excessive expense.

6.13 The remedial measures are also designed to keep the maximum expected hydraulic gradients where flow paths reach the ground surface below 0.4. Testing has shown the critical gradient for the typical stopbank and inland surface soils to be between 0.6 and 0.75.

6.14 It has to be remembered that the analyses are based on tests carried out at discrete points and the Rangitaiki soils can vary rapidly over short distances. Therefore the soil models used may not in fact be the worst combination of soils in the area being assessed. The analyses also do not take into account any flow from directions other than perpendicular to the river bank.

6.15 Rock berms are the primary means of improving the stability of the river banks and protecting them from further erosion. Silt can become trapped within the rock which helps to prevent rapid flow along high permeability layers in the river bank when the river rises.

By-laws

6.16 In addition to the ongoing stopbank assessment and protection work, some By-laws have been put in place to help prevent problems associated with the stopbanks. These include the following:

(a) No excavation within 150m of the landward side of a stopbank.
(b) No excavation in the river berm.
(c) No installation of pipes through stopbanks.
(d) No structures within 12m of a stopbank.
(e) No planting of trees on a stopbank.
(f) No overgrazing on a stopbank.

6.17 An effort is also being made to persuade farmers in low lying areas to turn off their drainage pumps when the river is high. This is to reduce the head differential across the stopbanks and it used to be common practice.

7. THE EFFECT OF WATER LEVEL FLUCTUATIONS ON SURFACE EROSION AND STABILITY OF STOPBANKS

7.1 This section will address the effect of fluctuating water levels on the erosion potential of layers of pumiceous soils in the river bank and the effects of this

erosion on the security of the flood protection scheme. This is a different erosion mechanism than erosion due to high velocity water flow.

7.2 Erosion of the river banks can affect the security of the stopbanks in two major ways:

(a) By removing the river berm and potentially the stopbank foundations, which can result in slope stability failure.

(b) By removing layers of silt, deposited over the river banks and within rock protection layers during periods of steady water flow, which inhibit the flow of water along high permeability soil layers.

7.3 The cohesionless pumiceous soils along the river are the most susceptible to erosion and of these, fine grained soils such as silt and silty fine sands are most susceptible to loss of particles due to fluctuating water level. This can be readily observed along the river bank in the form of differential erosion in the soil layers as can be seen in **Photo 1 Attachment F**. The erosion of fine grained cohesionless layers can lead to overhangs of over lying soils which eventually leads to collapse and regression of the river bank as shown in **Photo 2 and 3.**

7.4 Silts and silty fine sands are most susceptible to erosion due to fluctuating river level because their permeability is low compared to the rate of drawdown in the river. If a hydraulic gradient towards the river develops in the soil greater than its critical hydraulic gradient there can be a loss of soil particles as the river drops. This results in gradual eroding back of the face with each cycle of river level fluctuation.

7.5 If the slope is steep, small drawdown type failures can develop due to elevated water pressures within the slope during the water level fluctuations. These shallow failures have been identified by Beca at their monitoring sites and are discussed in their May 2009 Beca Reconsenting Report. It is considered that these small scale failures would be classified as erosion rather than a drawdown failure, which is normally associated with the drop in water level after a flood. As the river removes the failed soil a cycle of small failures and removal can lead to the river bank regressing inland.

Erosion Modelling

7.6 I will now discuss the results of an assessment of the effects of a fluctuating water level on a layer of silt using a simple seepage model.

7.7 The 100 year flood flow hydrograph for the river upstream of Edgecumbe typically has a drawdown rate of about 0.1m of river level per hour. The drawdown rate for other floods is probably similar. I have carried out a simple seepage analysis of 1m of drawdown at a rate of 0.1m per hour on a vertical face of silt with a permeability of 5×10^{-7} m/s. Figure 7 of the May 2009 Beca Reconsenting Report shows that 1m is a typical daily fluctuation in river level between the dam and Edgecumbe due to the flow control at Matahina. My analysis resulted in hydraulic gradients in the silt face of over 1.0, as shown in **Figure 1** of **Attachment F**. Beca have stated in their report that erosion can occur with gradients above 0.3 to 0.4, therefore loss of particles from silt layers should be expected during the drawdown stage of floods.

7.8 Measured fluctuations in water level along the river on a normal week day have shown a drawdown rate of about 0.2 m per hour. The Beca May 2009 Hydrogeology and Riverbank Stability Report Figure 2 shows that the drawdown rate could be as high as 0.4 m per hour in some flow regimes. I have re-run the soil model with both drawdown rates and found similar hydraulic gradients to the analysis for the 0.1 m per hour drawdown rate as shown in **Figure 2**. This means that loss of soil particles could occur on a daily basis.

7.9 I used the drawdown curves in Figures 1 and 2 to estimate the drop in water level required to reach a hydraulic gradient of 0.4, which is when loss of soil particles will be occurring. At a rate of 0.1m per hour approximately 0.65m drop is required and at 0.4m per hour, 0.5m. This means that if a drawdown rate of 0.4m per hour occurs during fluctuating river flows any river level drop over 0.5m could result in the loss of soil particles.

7.10 I repeated the analysis for the 0.4 m per hour draw down rate with a horizontal permeability of 5×10^{-6} m/s and the vertical permeability 5×10^{-7}m/s to represent the finely layered silty fine sands and silts observed in many places,

such as around the stump in **Photo 1** in **Appendix B**. After 1m fall in water level the hydraulic gradient reached 0.5 (compared to about 1.15 for a homogeneous silt), which is still enough to cause the loss of soil particles (**Figure 3**).

7.11 I carried out further analyses of the silt layer modelling a 1m change in river level as a daily cycle. Analyses for one day, two days and five days showed a build up of water within the river bank, which without any other influence, would result in the water level within the ground slowly building up to the peak level in the cycle. The shape of the river level cycle assumed and the build up in water level in the ground are shown in **Figures 4, 5** and **6** in **Attachment F**.

7.12 Over five days of cycles the peak hydraulic gradient in the silt face increases to 0.6 if the starting water level is taken as the base of the cycle. If the starting water level is taken as the top of the cycle the hydraulic gradient settles down to about 0.95. These results are included in **Figures 7** and **8** in **Attachment F**. It can be seen from the parts of the curves above a gradient of 0.3 that soil particles can be lost from the silt face over a reasonable proportion of the day.

7.13 Also included in **Attachment F** is a plot of the hydraulic gradient in the silt face 0.5m below the lowest part of the fluctuation cycle, that is a point permanently below water level (**Figure 9**). Even here it can be seen that the hydraulic gradient is up to 0.35, which may cause some erosion.

7.14 A sensitivity analysis was carried out to see if the thickness of the silt layer has a significant influence on the hydraulic gradient developed during a drop in river level. Five days of the daily water level cycle were applied to a 500mm thick layer of silt with sand above and below. The results of the analysis are shown in **Figure 10**. This figure should be compared to **Figure 7**. It can be seen that the proportion of the daily cycle in which soil particles can be lost is considerably smaller than when there is no sand present, but loss of particles is still possible. This means that erosion of a face with thin layers of silt and sand may be slower than a face with thick silt layers but regression of the face will occur.

7.15 The simple model that I have analysed shows that fine grained soil particles can be lost from the river bank on a daily basis if there is a fluctuating river level. Particles can also be lost if the river level is lowered due to natural fluctuations. It is however, considered that as the daily fluctuations are more frequent, and possibly faster, than those due to natural flows, they are therefore causing more rapid erosion of the river banks than natural flows.

The effect of erosion on seepage problems

7.16 As stated earlier the loss of silt layers over the ends of higher permeability layers in the river banks can increase the extent of the problems due to seepage under the stopbanks. This will be discussed further in Section 8.

Erosion protection

7.17 The main means to protect the river banks from erosion is to place rock rip rap over the depth of river bank where there is no good vegetative cover. A lot of this protection work has been carried out along the river. The coarse rock is usually placed over a finer rock to prevent the loss of fines through the coarse rock and where required a berm is placed to improve the overall stability of the river bank.

8. THE EFFECTS OF THE PROPOSED OPERATING REGIME ON THE FLOOD PROTECTION SCHEME

8.1 This section will examine three effects of the proposed operating regime on the flood protection scheme. These effects are:

(a) The reduction in stability due to lower operating river levels.

(b) The reduction in stability due to the loss of river berm as a result of progressive erosion.

(c) The increase in water pressures in inland sand layers due to the loss of a silt lining over a large proportion of the river banks.

Lower Water Levels

8.2 I will now discuss the effects of the proposed new low flow regime.

8.3 To enable more efficient use of their turbines at the Matahina Dam Trustpower are proposing to reduce their permitted low flow rate from 40 cumecs to 20 cumecs. This will have the effect of lowering the water level in the river for possibly days at a time by up to 0.9m below the existing low levels near the Edgecumbe fault and more typically 0.7m.

8.4 In terms of the stability of the riverbank and the river side face of a stopbank, a low water level in the river is more critical than a high river level. The Environment Hazards Group has provided the existing typical low flow water levels at various locations down the river. I have carried out slope stability analyses with low river levels of three of the river bank cross sections I have developed as part of my on-going stopbank assessments. The soil models are shown in **Attachment G**. The cross sections are at Black's Bend and Campbell's Bend, upstream of Edgecumbe and at Waiari, just upstream from the fault.

8.5 Slope stability analyses were carried out for the three cross sections with the existing typical low river level and again with the estimated new flow level. The water level at Black's Bend and Campbell's Bend was lowered by 0.7m and there was a 6% and a 2% reduction in factor of safety respectively. As can be seen from the figures in **Attachment G,** the factors of safety of these cross sections are very low (1.04 and 1.07). The reduction in stability due to the lower water level could therefore be significant in some places along the river.

8.6 At Waiari the analysis was carried out with a 0.9m reduction in water level. The factor of safety reduced by 4%. As the factor of safety at this location is reasonable the reduction is not as critical as at the previous two sites.

Erosion

8.7 I will now discuss the effect of on-going small scale erosion on the stability of the stopbanks.

8.8 As discussed in Section 7 the fluctuations in river level can result in on-going regressive erosion. I re-analysed the Waiari cross section assuming the new low river level and a 500mm strip of the river berm had been eroded away. The factor of safety was found to be 5% below the existing low flow regime with no

erosion. Therefore the erosion has resulted in a 1% reduction in factor of safety. Due to the nature of the slope failure mechanism as the erosion moves closer to the toe of the stopbank, stability will reduce more rapidly with each 500mm strip of river berm lost. Hence although the loss of soil from the river berm due to relatively small fluctuations in river level may not appear significant, over time it could lead to slumping of the stopbank face.

8.9 The Waiari cross section was analysed again to assess the reduction in stability due to drawdown after the 100 year return period flood with a loss of 500mm of soil from the river berm. This showed a similar 1% reduction in stability as before. The lowest factors of safety for river side stopbank faces are usually found in drawdown conditions, therefore a 1% reduction in what already may be a marginal factor of safety could make a significant difference. An accumulation of 1% reductions could be the difference between a slope failure just taking out the stopbank shoulder and taking out the crest causing overtopping.

River Bank Silt Layers

8.10 I will now discuss the effect of silt layers lining the river banks and bed on the development of water pressure in sand layers beneath the stopbanks.

8.11 As discussed in Section 5 the development of high water pressures in sand layers can cause heave of the surface soil layers inland from a stopbank, which can lead to piping and the eventual collapse of the stopbank. Mr Williams has discussed in his evidence how silt layers develop on river banks and beds in natural river systems and how vegetation can bind this layer, helping to prevent erosion in floods. In Section 7 I have shown how even quite small fluctuations in river level can cause the loss of a silt layer in and below the zone of fluctuation.

8.12 I have assessed the effect of silt layers on the pressure in sand layers in two stopbank cross sections that I have developed as part of my work. One cross section is on the right bank just downstream of the Transpower substation in an area referred to as Section 6. The second is in Section 3 which is on the left

bank within the industrial area of Edgecumbe. These cross sections are included in **Appendix G**.

8.13 The cross section analysed in Section 6 has about a 2.5m thick layer of sand 2m below the ground surface at the stopbank, as shown in **Figure 5**. Transient seepage analyses for the 100 year return period flood were carried out with and without a 0.5m thick layer of silt on the river bank. The assumption is made that the silt layer remains in place at least until the flood peak has passed.

8.14 **Figures 6 and 7** show the water pressure at RL2.0 at the river bank and in the sand layer 50m from the inland toe of the stopbank when there is silt on the river bank. It can be seen that the peak water pressure has dropped from about 48kPa at the river bank to 22kPa in the sand layer. **Figure 8** shows the inland pressure when there is no silt on the river bank. It can be seen that the peak pressure is about 6kPa higher than for the analysis with the silt layer.

8.15 This 6kPa difference is equal to about 400mm thickness of the local soils, that is, with the silt in place 1.4m of soil is required to resist the water pressure in the sand layer. Without the silt layer on the riverbank 1.8m of soil is required to resist the water pressure. Therefore the silt layer on the river bank could make the difference between heave occurring and not occurring.

8.16 The two analyses were repeated for the Section 3 cross section. At this cross section a 6m thick layer of sand has been assumed 3m below the ground surface at the stopbank. An approximately 1m thick layer of silt was assumed on the riverbank. **Figures 10, 11** and **12** show the water pressure at the river bank and in the sand below the stopbank toe, with and without the river bank silt layer. It can be seen that the silt causes about a 6kPa drop in water pressure. **Figures 13** and **14** show the pressure 50m from the inland toe of the stopbank. At this distance the silt layer has about a 3kPa effect on the water pressure.

8.17 It can be seen from the analyses carried out that the presence of an intact river bank silt layer can have a significant influence on the water pressure in sand layers beneath stopbanks. The reduction in pressure due to the silt layer could in some areas make the difference between heave occurring or not occurring.

9. **BECA ANALYSES**

9.1 In this section I will address the differences between my assessment of the effects of TrustPower's management of river flows on the river banks and flood protection scheme, and that presented by Beca Consultants.

Beca May 2009 Report

9.2 Section 7.2 of the Beca Report discusses the river bank erosion studies carried out. It notes that the river peaking regime could cause a 10% reduction in the stability of erosion monitoring Sites 10 and 14, and this could cause "shallow surficial erosion" but that a flood will have a much greater impact. Beca do not seem to have considered that on-going surficial erosion could have a significant effect on stability in some areas.

9.3 In Section 7.3.3 Beca conclude that the effects of small failures due to drawdown are minor. I consider that the effect of these small failures is very much dependent on their location with respect to stopbanks. If they are in areas of minimal river berm, or expose soil layers with high permeability the effects may not be minor in the longer term.

9.4 In Section 7.3.4 it is stated that fluvial erosion resulting from water level fluctuation only has an effect on stopbank stability where there is no set back from the river bank. The analyses that I carried out and discussed earlier show that water level fluctuation can cause on-going erosion which leaves river banks much more susceptible to fluvial erosion than a bank protected by stabilised silt and vegetation. Therefore there is increased potential to reduce stopbank stability in a flood.

9.5 It is noted in Section 2 of Appendix B of the Beca Report that the 2003 study of trial twin peaking of the river concluded there was an increased potential for piping of fine grained soil and erosion with twin peaking compared to single peaking. TrustPower are now proposing an unlimited number of daily peaks in river flow but have not commented on the increased rate of erosion with multiple peaks.

9.6 The seepage analyses of erosion Sites 10 and 14 described in Appendix B produce much lower hydraulic exit gradients than those found with similar drawdown conditions in my simple soil model. This could be because the two sites analysed consisted predominantly of sand within the depth of water level fluctuation and / or because the analysis mesh was much coarser than that I used. My model had elements at the slope face only 100mm by 100mm. This is much finer than would normally be used in analysing a whole stopbank system but enables the effects of small inflows and outflows in thin layers of relatively low permeability soils to be more accurately assessed. Beca did find higher gradients at Site 14 compared to Site 10 because some of the soils at Site 14 are finer than those at Site 10.

9.7 The Discussion section of Appendix B says that Sites 10 and 14 are considered the worst sites over the study length. They may be the steepest cross sections, but they are unlikely to be the worst in terms of erosion potential due to river level fluctuations as other sites may have greater proportions of fine grained soils in their soil profile.

Mr Levy's Evidence

9.8 In Section 80 of Mr Levy's evidence he presents a table of erosion sites per kilometre. From my experience along the river problem sites could vary from 100m to a kilometre or more. I consider that a percentage of the length of eroding faces compared to the total river bank length would be more relevant and the percentage of existing rock protection should also be given as an indication of previous erosion.

Dr Toan's Evidence

9.9 In Section 2.3 of Dr Toan's evidence he states that the stopbanks are up to about 2.5m in height. Due to the subsidence following the Edgecumbe Earthquake there are now sections up to 3.5m high. This extra head can make a critical difference to the security of sections of stopbank.

9.10 In Section 5.11 Dr Toan states that drawdown assessment was carried out at Sites 10 and 14 as they are "more critical river banks" due to being high steep banks with "only minor safety margins". The steepness may make them critical

in terms of overall slope failure but they are not critical in terms of erosion potential under repeated drawdown due to their soil profile, or due to their location, critical in terms of the effect of failure on flood protection security.

9.11 In Section 5.12 Dr Toan states that large scale slumping due to piping has not been observed. I do not consider large scale piping towards the river to be a significant problem. I consider the issue to be small scale loss of particles from the river bank on a daily basis due to high hydraulic gradients. This leads to the development of small overhangs, collapse of the soils above and a gradual regression of the river bank.

9.12 In Section 6.2 Dr Toan states that there is a relatively low risk of deep seated river bank failure due to drawdown on the basis of the ground water monitoring carried out by Beca. Beca's monitoring was carried out at a few sites in the upper portion of the river which happened to have a large proportion of sand in their soil profiles. There are large variations in soil profile along the river and as discussed in previous sections fine grained soils such as silt lead to the development of higher water pressures in the river bank after the river has receded than sands. Large scale slumping of the river banks occurred during and after the 2004 flood. Some of these slumps may have been due to drawdown affects rather than toe erosion during the flood.

9.13 It is stated in Section 6.5 that river bank stability is not reduced when there is $20m^3/s$ of flow compared to $40m^3/s$ because this will occur in long dry spells. I understand that this low flow could occur at any time of the year, not just in summer conditions. My analyses have shown that the reduced river level does cause a small, but possibly significant reduction in stability.

9.14 In Section 6.11 Dr Toan suggests that shallow losses from river banks would not have serious consequences in terms of flooding risk. My analyses have shown if a silt layer bound by roots or within rock protection can become established on the river bank, as occurs in natural flow conditions, this will significantly reduce the risk of heave and piping developing in flood conditions. Mr Williams states in his evidence that this layer could remain throughout a flood. The daily fluctuations in river level prevent the development of this silt layer.

9.15 In Section 8.3 of Dr Toan's evidence he acknowledges that repeated losses of soil from a river bank can lead to instability of the stopbank. He fails to recognise that the daily fluctuations in water level caused by Trustpower's operations are the major cause of these soil losses.

Mr Tate's Evidence

9.16 In Mr Tate's Section 4.3 he comments on the original standard of investigation and design of the stopbanks. I have reviewed many of the available drawings and documents prepared by the Catchment Commission for the construction of the stopbanks and discovered sub-surface investigations were carried out along the river and the potential problems of heave and piping were recognised. I refer to this information when carrying out my own assessments of stopbank stability. The Catchment Commission installed several series of piezometers to measure the ground water levels at right angles to the river and used the information gained to design specific surcharges or overlays in particular problem areas behind the stopbanks. I have found the original stopbanks to be well constructed in my observations of the Sullivan's Breach and in subsurface investigations through the stopbanks. Unfortunately the Edgecumbe Earthquake caused a significant increase in stopbank heights in some areas and made some of the Catchment Commission's surcharging work inadequate.

9.17 I agree with Mr Tate's comment in Sections 6.5 and 6.8 that the presence of silt on the river bank is not usually relied upon when carrying out seepage analyses and I do not include it in my analyses. However as shown in the analyses previously discussed, the presence or absence of this layer can have a significant effect on the risk of heave. Any seepage analysis along the Rangitaiki is really at best just an approximation of a very complex and sensitive system of soil layers and ground water flows. Beca's analyses and my own show the marginal factors of safety against failure of the flood protection system, therefore anything that improves the factors of safety against stopbank failure should be protected.

9.18 In Section 7.2 Mr Tate comments on lateral erosion as a cause of stopbank failure and that he was unaware of any failures caused by erosion along the

Rangitaiki River. In the 2004 flood there was significant erosion which in at least one location came very close to causing a stopbank breach. This was at Campbell's Bend on the left bank upstream from Edgecumbe. At this site removal of the river berm caused the stopbank face to slump into the river leaving only about 1m width of intact stopbank at the crest level.

10. CONCLUSIONS

10.1 The following are my conclusions about the Rangitaiki River, the flood protection scheme and the influence of Trustpower's manipulation of the river flows.

10.2 I consider the geology and topography along the river make it one of the most, if not the most difficult large river in the country to provide flood protection along.

10.3 The soils along the Rangitaiki River are particularly susceptible to erosion due to being predominantly cohesionless and lighter than soils derived from non volcanic sources.

10.4 Observations along the river and my analyses show that regular fluctuations in water level cause on-going erosion of river banks which if left unprotected could lead to the collapse of stopbanks.

10.5 The over-steepening of river banks due to erosion has left many areas in a state of marginal stability and a reduction in water level in the river could further reduce this stability.

10.6 The flood protection system along the river could be described as being marginally secure in that the effects of high water levels in the river can be found 100m or more from the river and it is very difficult to achieve what would normally be considered acceptable factors of safety against failure.

10.7 I consider the fragility of the flood protection scheme to be such that anything that reduces the security of the flood protection scheme, even if by a relatively small or unquantifiable amount, should be prevented. This includes the steady erosion of river berms and the loss of silt coverings from river banks.

10.8 Therefore I consider that the range of operating levels in the river and the number of peak flows per day should not be increased. My preference would be for the dam to be operated in a run of river manner so that the river banks can stabilise.

Marianne O'Halloran
July 2011

Attachment A

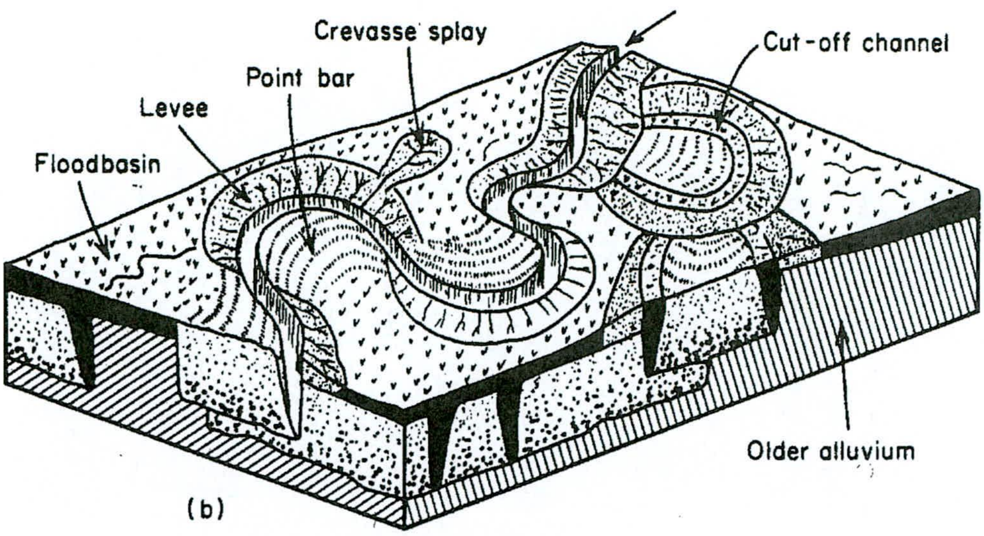


Figure 1: The floodplain environment of meandering rivers
(Figure 4.2 Freeze & Cherry (1979))

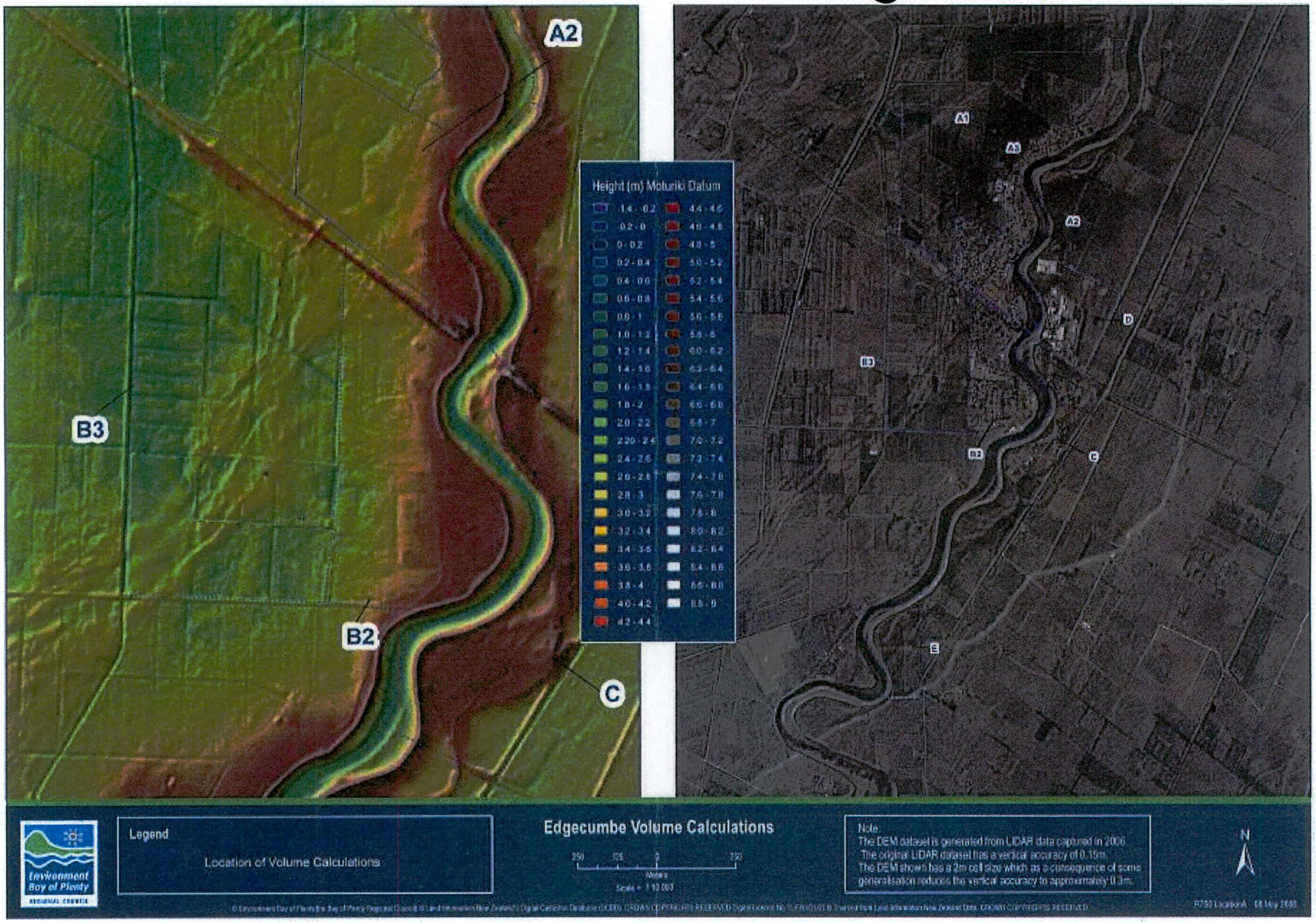


Figure 2: LIDAR plot of Edgecumbe area

Aerial view of the greater Edgecumbe area and fault

Figure 3: Ground contours around Thornton

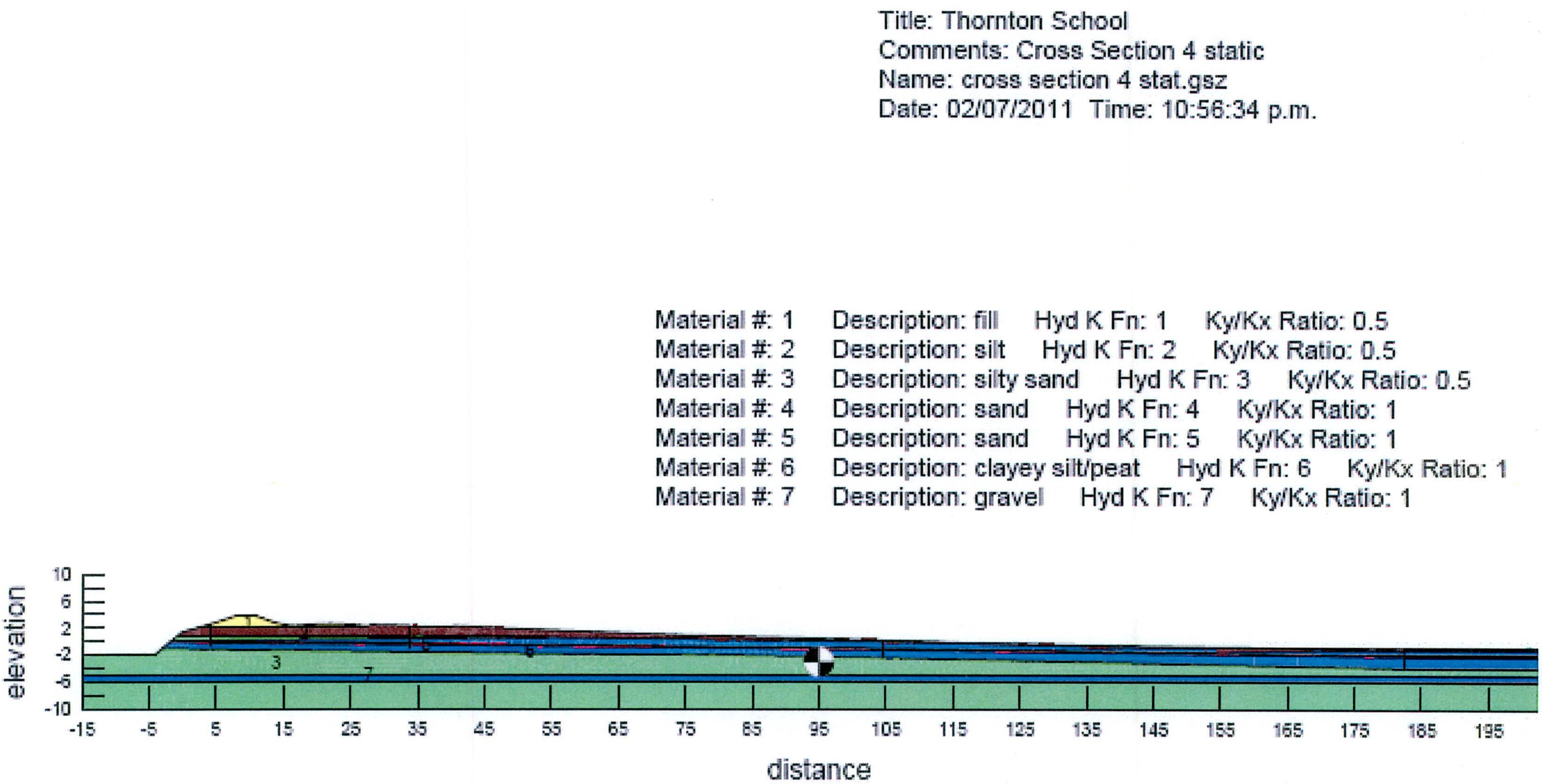


Figure 4: Right Bank Cross Section at Thornton School

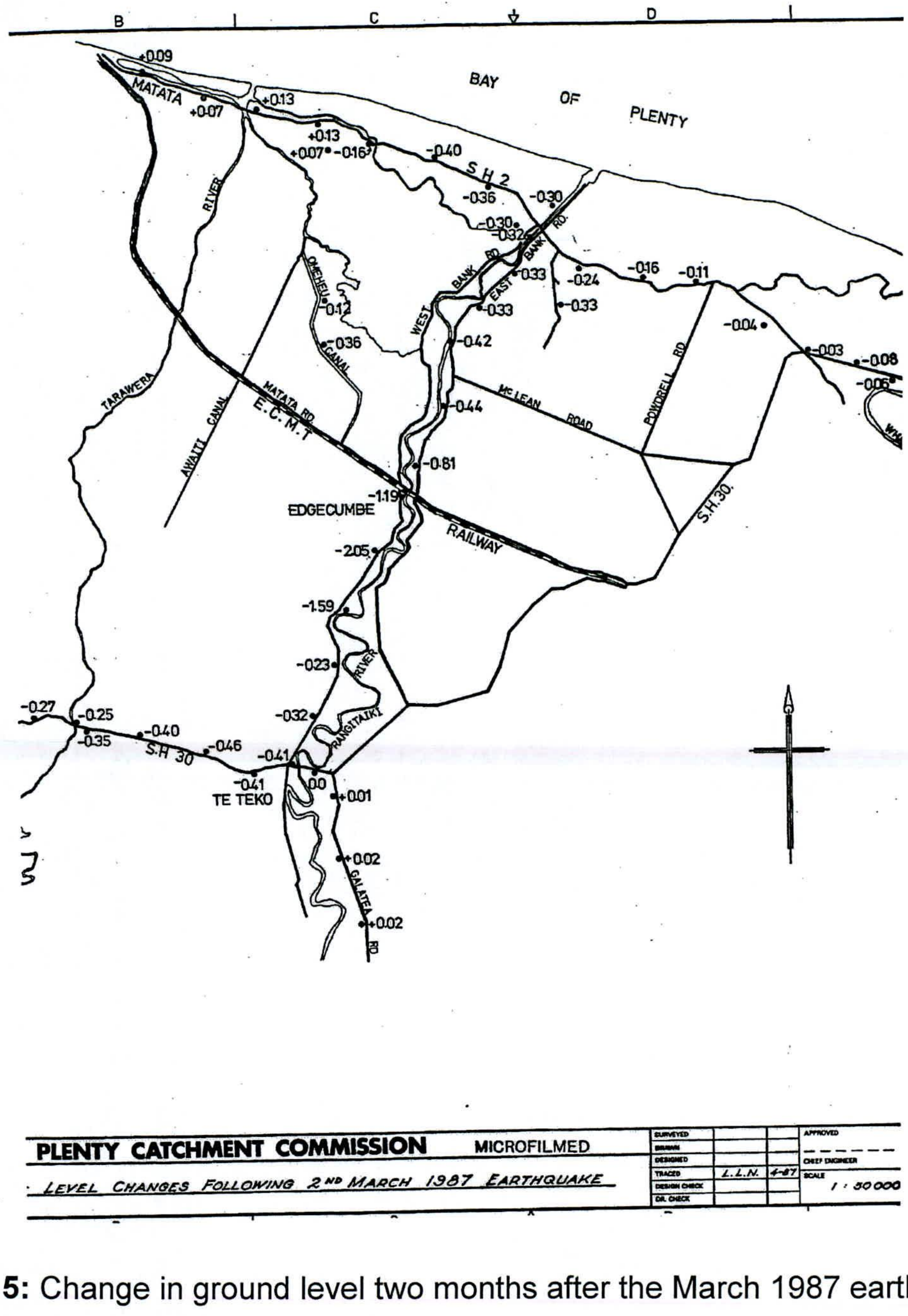
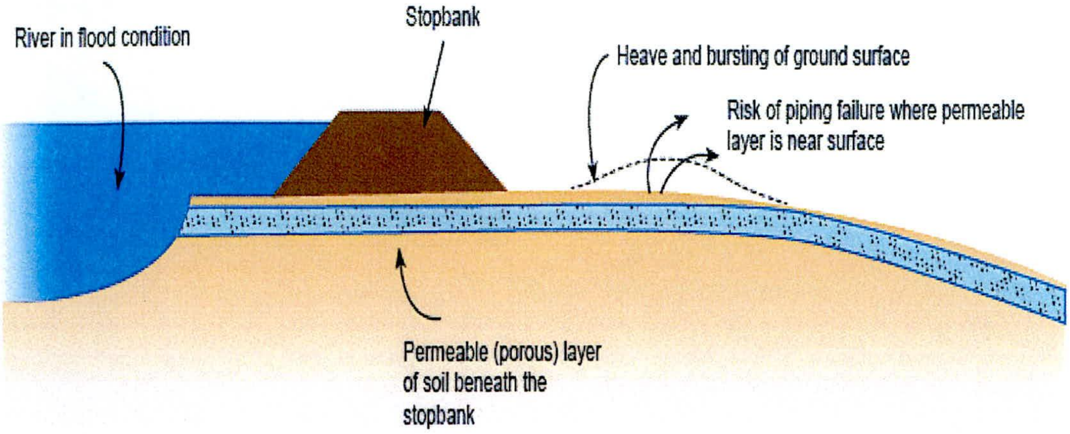


Figure 5: Change in ground level two months after the March 1987 earthquake

Photograph 1:
The downstream end of the stopbank breach showing the black Tarawera Ash layer

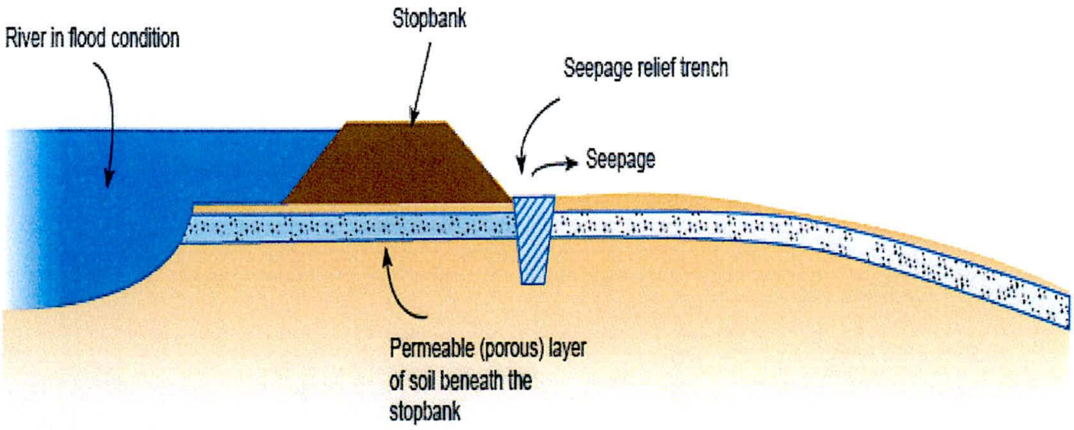
Attachment B

1 Existing situation



Potential Piping Failure: If the permeable layer has seepage water flowing through it under pressure from the high river water level, the pressure may cause the surface soil layers to burst open allowing a greater velocity of water flow that leads to erosion of the soil and formation of a pipe. Eventually the pipe grows so large the stop bank collapses and the floodwaters breach through the stop bank.

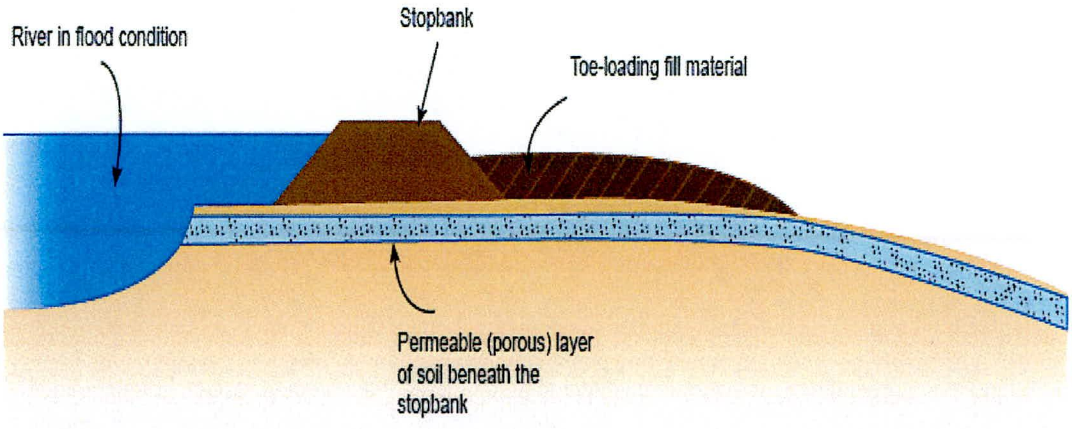
2 Seepage pressure relief trench option



Seepage Relief Trench: A seepage relief trench is installed to intercept the permeable layer. The trench collects the seepage water over a wide area and allows the water to seep out of the trench so that less pressure is developed in the permeable layer, thus reducing the risk of creating a piping failure.

This option is suitable where there is limited space, i.e. house or buildings close by.

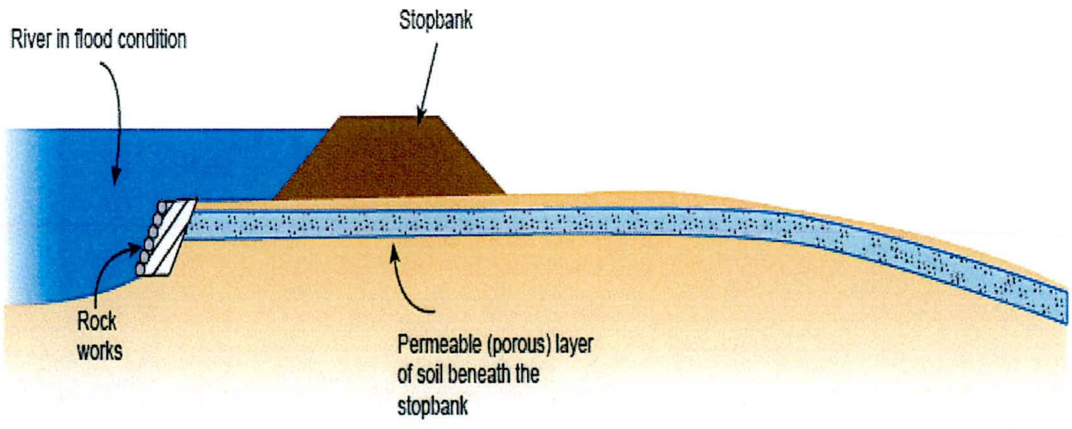
3 Toe-loading option



Toe-Loading: Toe-loading involves placing fill over the top of the permeable layer to prevent it heaving up. The toe-loading puts additional weight of fill over the permeable layer to counter balance the water pressure. The toe-loading layer will still allow seepage water to flow through it to the surface, but it spreads the seepage over a wide area and reduces seepage pressure and velocity.

This option is only suitable where there is space available near the stop bank as the toe-loading may need to extend up to 60 to 100 metre from the stop bank.

4 Rock edge protection



Rock works and cut-off layer: This is used to strengthen the river bank against erosion. The rock may trap sufficient sediment to reduce the seepage flows in the permeable layer. Sometimes used in conjunction with other treatments above.

Photo 1: A hole in the river bank caused by piping

Attachment C

Photo 1: River bank erosion above the Edgecumbe Fault

Photo 2: Erosion of silt layers around a buried tree

Photo 3: Hole caused by rotting tree

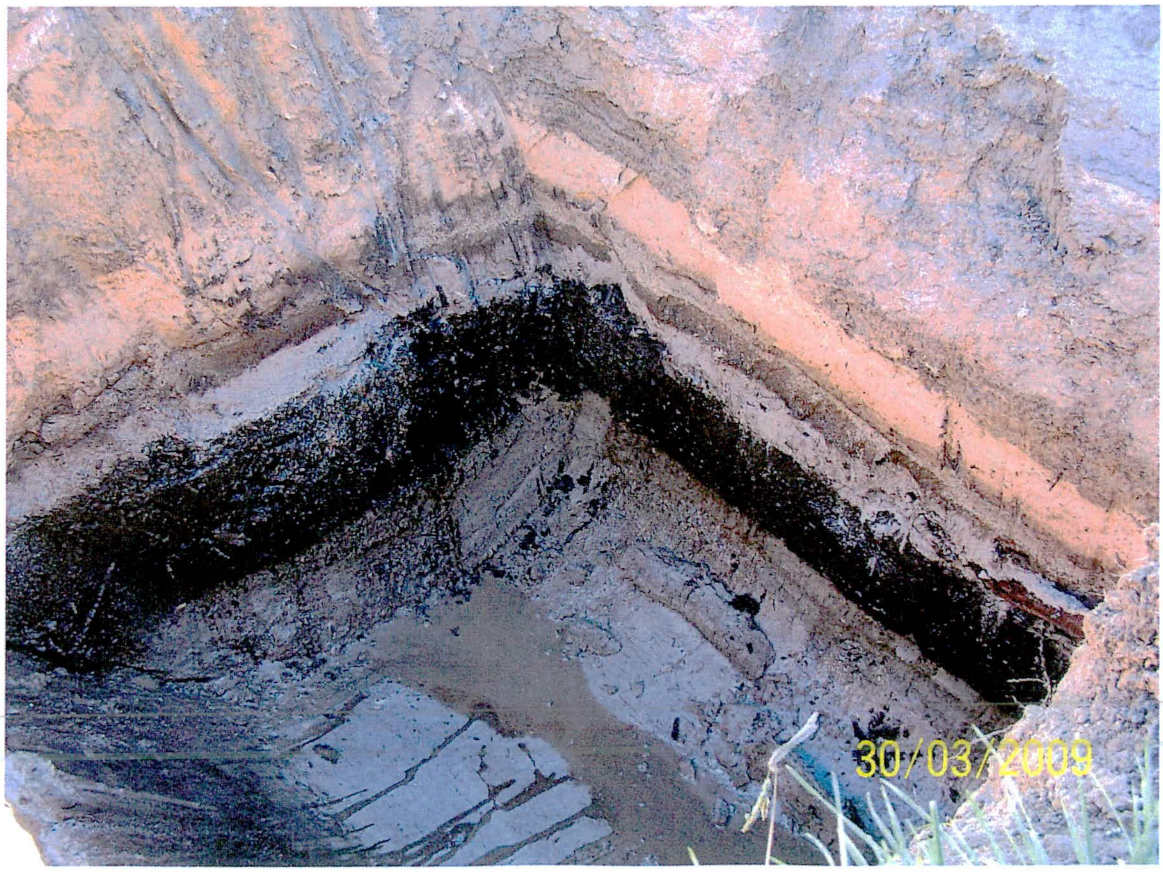


Photo 4: Highly permeable sand layer above peat

Photo 5: Ploughing zone and 1886 Tarawera Ash Layer

Attachment D

Stopbank Observations

Please place this form into the return addressed envelope provided and into the mail.

If you have any queries or would like someone to come and discuss issues with you please phone Peter West at Environment Bay of Plenty (0800 368 288 Ext. 9587).

Name:	
Address:	
Phone No.	

Please tick where appropriate.

Have you noticed sponginess or seepage in paddocks behind stopbanks during floods?	
Have you noticed water coming up alongside any posts or poles or movement in posts, poles or gates?	
Have you noticed sand layers within 1 metre of the ground surface?	
Are there any old rubbish pits or other excavations within 100m of the stopbank?	
Are there rabbit holes in or near the stopbank?	
Are there any pipes through your section of stopbank?	
Have you observed any cracks in the stopbank?	
Is there anyone else who is familiar with the history of the land? Please give contact details if known.	
Any other comments/observations	

Attachment D

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Are there any pipes through your section of stopbank?	
Have you observed any cracks in the stopbank?	
Is there anyone else who is familiar with the history of the land? Please give contact details if known.	
Any other comments/observations	

Attachment E

Bore Hole Log

Borehole: BH2

ICE GEO & CIVIL

Project: **Rangitaiki Stopbanks**
Client: **Environment Bay of Plenty**

Location: **Section 6**
Co-ordinates: East 90 North 0
Elevation: 7.20 Datum: Moturiki

depth (m)	elevation (m)	recovery (m)	graphic log	Classification	description	samp depth (m)	sample type	SPT result	Vane result (kPa)	other
0.00					brown **medium to coarse SAND**, rare grey gravel					
0.50	6.95				brown / grey **fine to medium silty fine SAND**, firm to stiff, 1.2m some pumice lapilli to 3mm					
1.00										
1.50		100				1.4	dis			
2.00										
2.50										
	4.40				lost					
3.00	4.20				brown **SILT**, some organics and clay, firm					
	4.10				black **medium to coarse SAND**, Tarawera Ash					
3.50	4.08	100			grey with Fe staining **SILT**, some fine SAND, firm	3.7	dis			
4.00	3.40				grey with Fe staining **silty fine SAND/ fine sandy SILT**, firm					
4.50	3.00				lost					
5.00	2.20				grey **fine SAND**, some Fe staining, some silt					
5.50	1.70	100			brown **SILT**, some organics, soft					
	1.60				grey fine **SAND**					
	1.50				grey **pumice lapilli** to 3mm					
6.00	1.46				grey fine **SAND**					
6.50	1.20				grey with Fe staining coarse SAND and fine GRAVEL, gravel black and brown rounded to 3mm	6.3	dis			
7.00	0.60	80			grey **fine lapilli** to 1mm, some fine sand, some hard rounded gravel to 4mm, some pumice to 4mm	7.3	dis			
7.50	-0.40				**pumice lapilli** to 3mm and dark grey **medium to coarse SAND**	7.8	dis			
8.00		45								
8.50										

Observations:

Vane no.
Core Dia. 68mm

Rig: Edson
Contractor: Perry

Date started: 05/08/2008
Date finished: 05/08/2008
Logged by: MO'H

Bore Hole Log

ICE GEO & CIVIL

Borehole: BH2

Project: **Rangitaiki Stopbanks**
Client: **Environment Bay of Plenty**

Location: **Section 6**
Co-ordinates: East 90 North 0
Elevation: 7.20
Datum: Moturiki

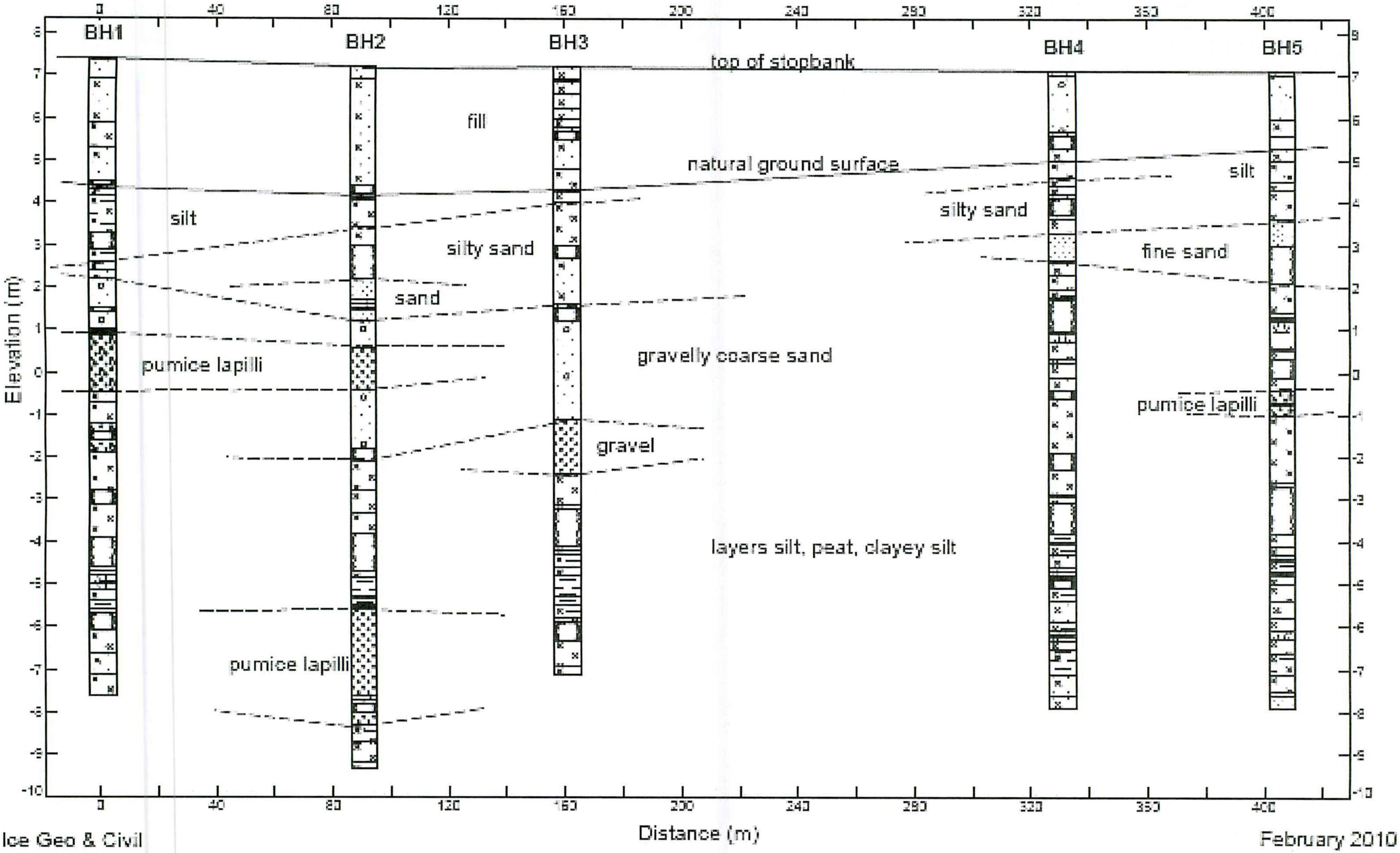
depth (m)	elevation (m)	recovery (m)	Classification	description	samp depth (m)	sample type	SPT result	Vane result (kPa)	other
8.50									
9.00	-1.80			lost					
	-2.10			grey **pumice SILT**, rare angular pumice to 5mm, firm to stiff, 9.5m 50mm pumice rich band, rare organic fragments					
9.50		100							
10.00	-2.80			grey **pumice SILT**, some fine brown varving and leaves, sensitive					
10.50	-3.30	100		grey **pumice SILT**, brittle, dilatant, rare angular pumice to 4mm and organic fibres					
11.00	-3.80			lost, grey fine **pumice lapilli** to 1mm ?					
11.50									
	-4.70			light grey and grey varved **pumice SILT**, some organic material					
12.00	-4.85			dark brown / grey **organic CLAY** with fibrous material, spongy, medium strength					
12.50	-5.30			**timber**					
	-5.35			grey **fine SAND**					
	-5.36	100		dark brown / grey **organic CLAY** with fibrous material, spongy, medium strength					
	-5.50			grey fine **pumice lapilli** to 2mm					
13.00	-5.53			light **grey SILT**, some fibrous material					
	-6.60			5mm black organic layer over grey **fine pumice lapilli** to 2mm, rare to 5mm	14	dis			
13.50									
14.00									
14.50		90							
	-7.60			dark grey **medium SAND**					
	-7.70			grey fine **pumice lapilli** to 2mm, rare to 5mm					
15.00	-7.80			lost					
	-8.00			grey fine **pumice lapilli** to 2mm, rare to 5mm					
15.50	-8.30	100		green grey **clayey SILT**, stiff, brittle					
	-8.70			green grey **SILT**, stiff, brittle					
16.00									
	-9.20			brown / grey **SILT with fine layers of organic material**, stiff					
16.50	-9.30			EOB					
17.00									

Observations:

Vane no. Core Dia. 68mm	Rig: Edson Contractor: Perry	Date started: 05/08/2008 Date finished: 05/08/2008 Logged by: MO'H

Project: Rangitaiki Stopbanks
Client: Environment Bay of Plenty
Location: Section 6
Number:

Figure 1 **Subsurface Long Section Through Stopbank**



Ice Geo & Civil

February 2010

Attachment F

Photograph 1: Differential erosion of soil layers

Photograph 2: Silt loss and development of an overhang

Photograph 3: Silt loss leading to the development of an overhang and vegetation loss

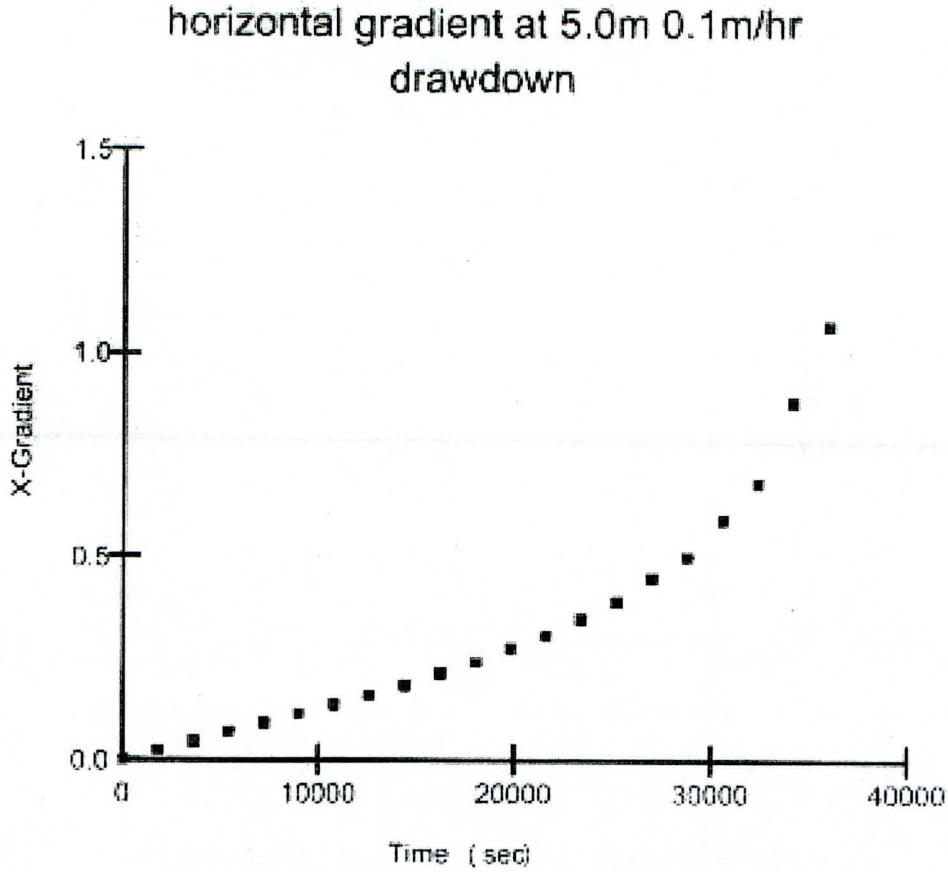


Figure 1: Drawdown in silt layer at 0.1m/hr

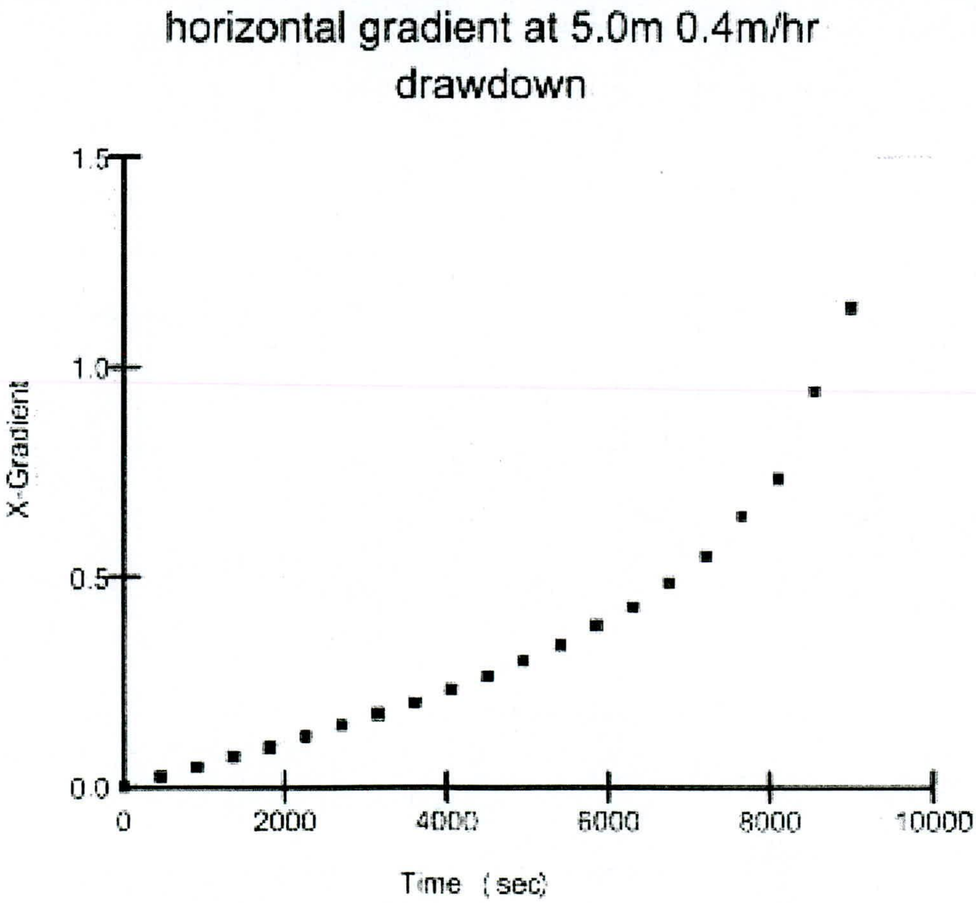


Figure 2: Draw down in silt layer at 0.4m/hr

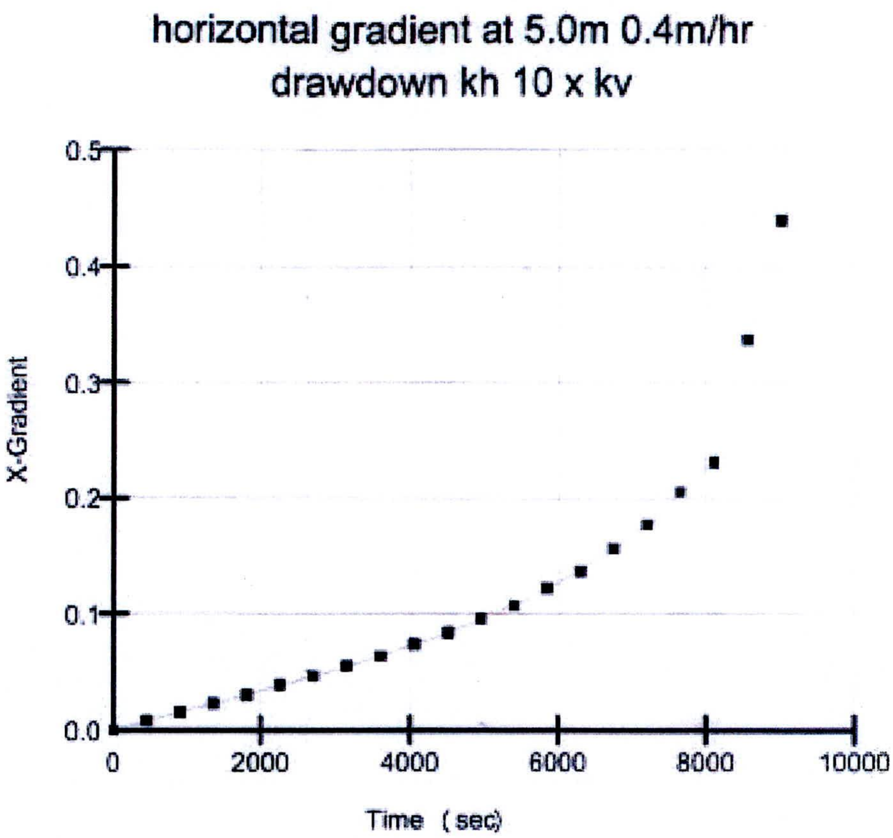


Figure 3: Draw down in finely layered sand and silt at 0.4m/hr

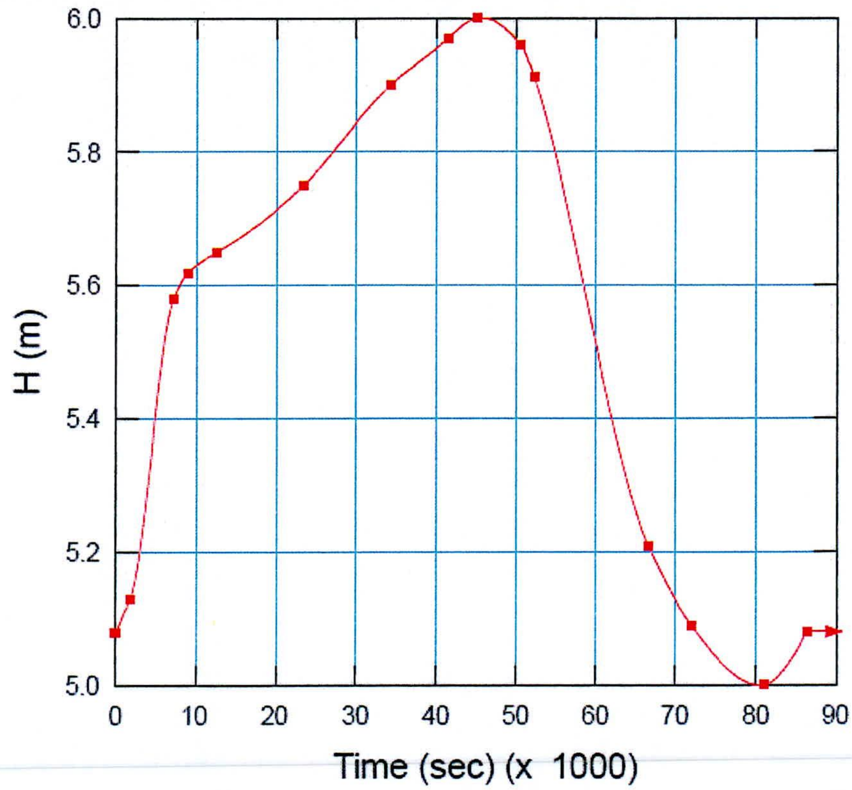


Figure 4: Assumed daily water level cycle

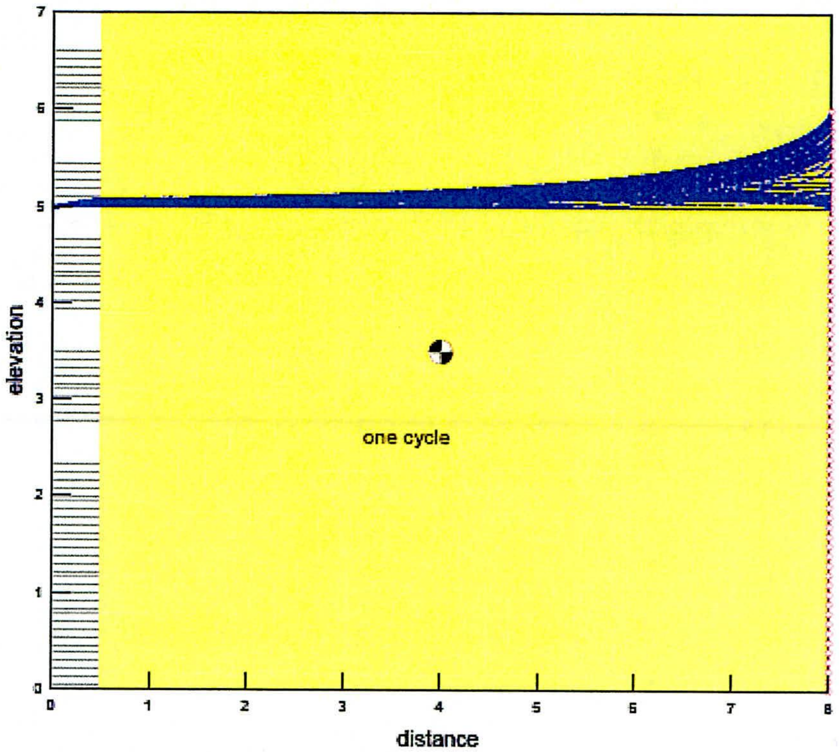


Figure 5: Water level in silt face over one day cycle, peak rate 0.18m/hr

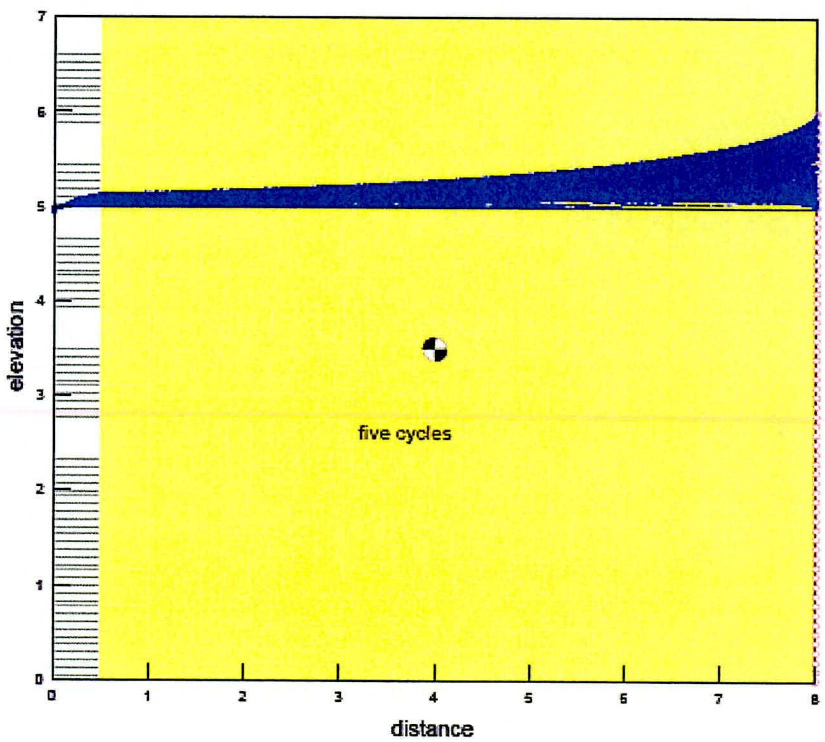


Figure 6: Water level in silt face over five daily cycles, peak rate 0.18m/hr

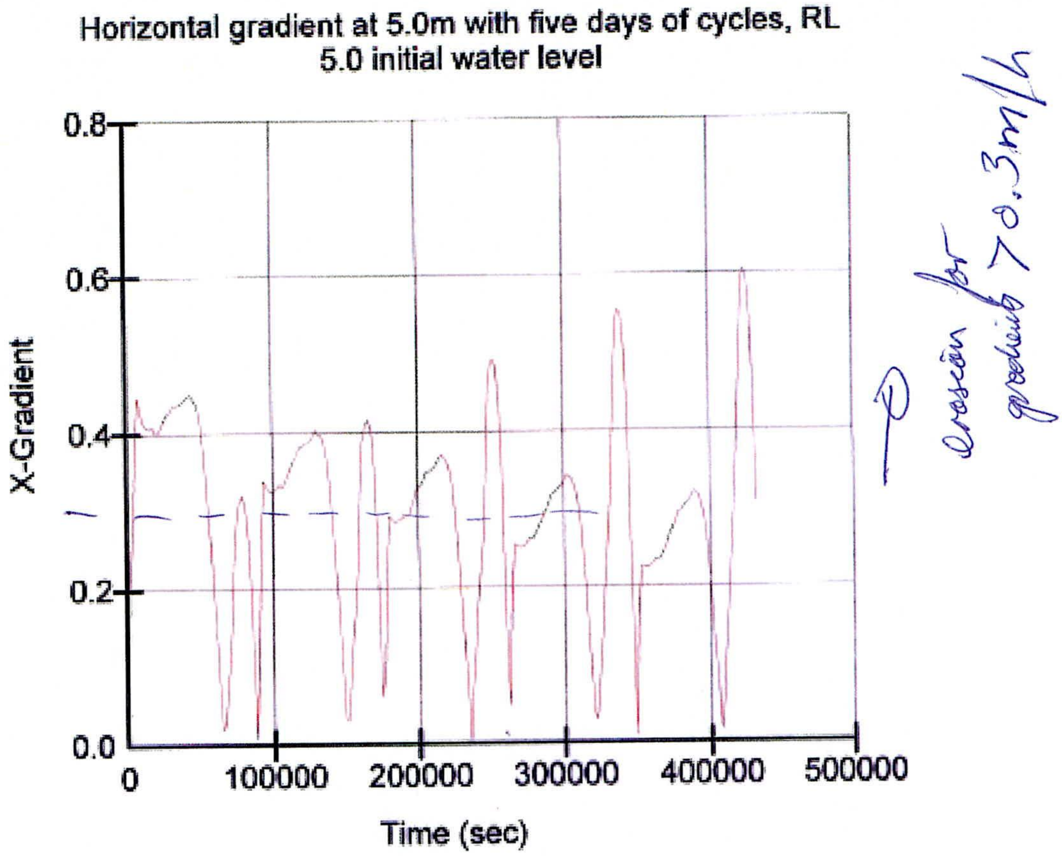


Figure 7: Build up in hydraulic gradient with daily cycles (starting from low level)

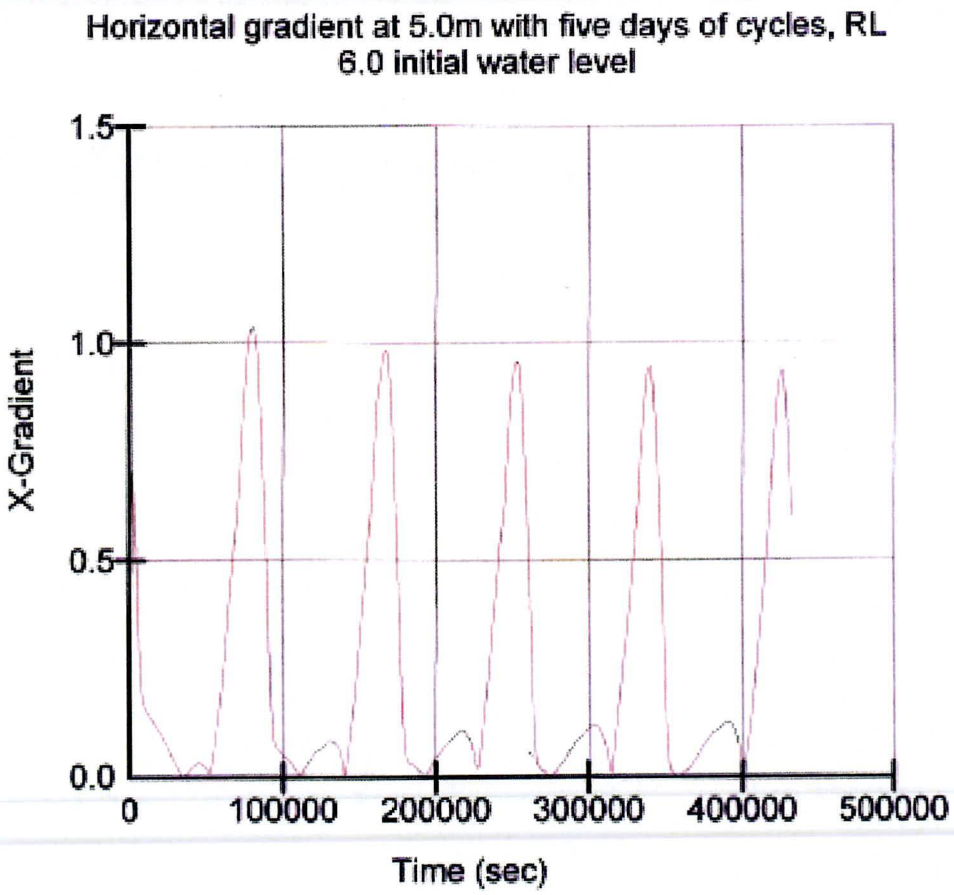


Figure 8: Stabilising of hydraulic gradient with daily cycles (starting from high level)

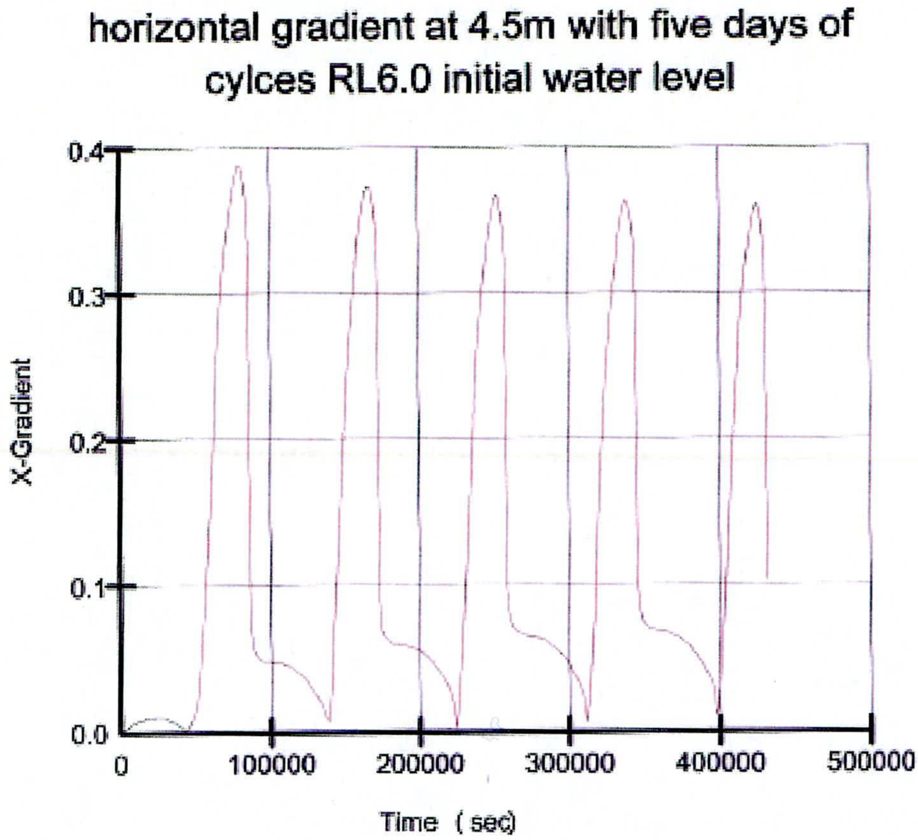


Figure 9: Hydraulic gradient 0.5m below permanent water level

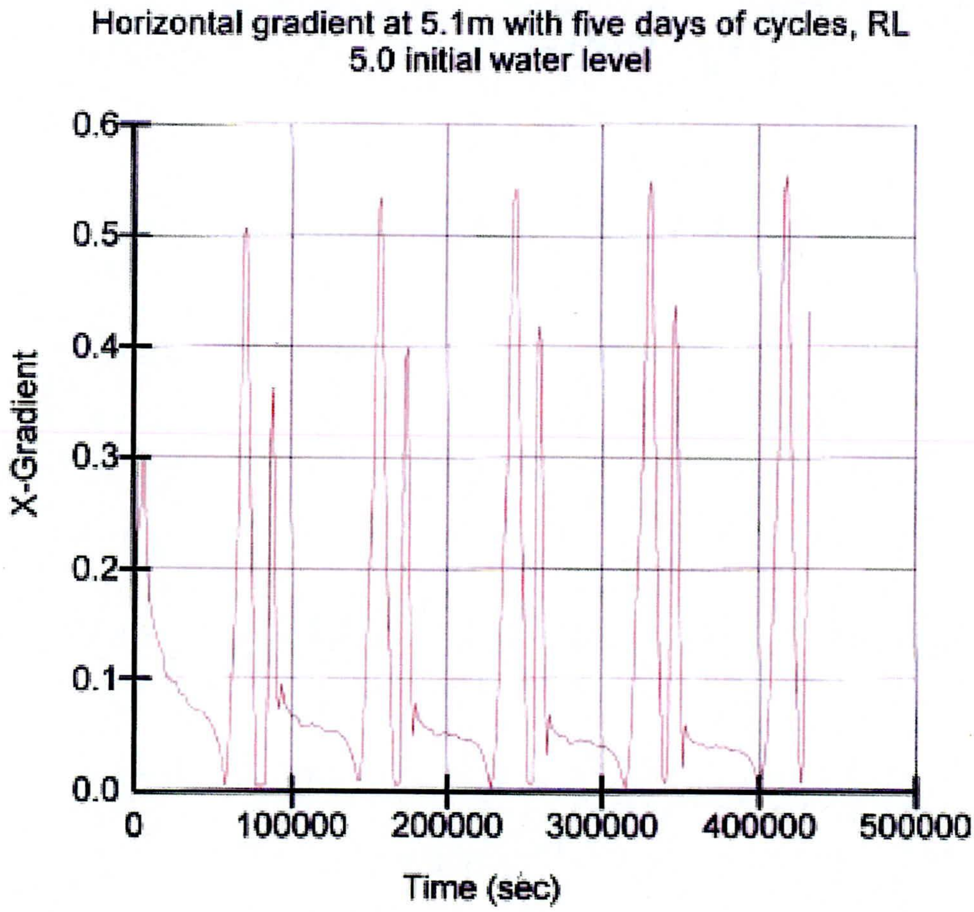
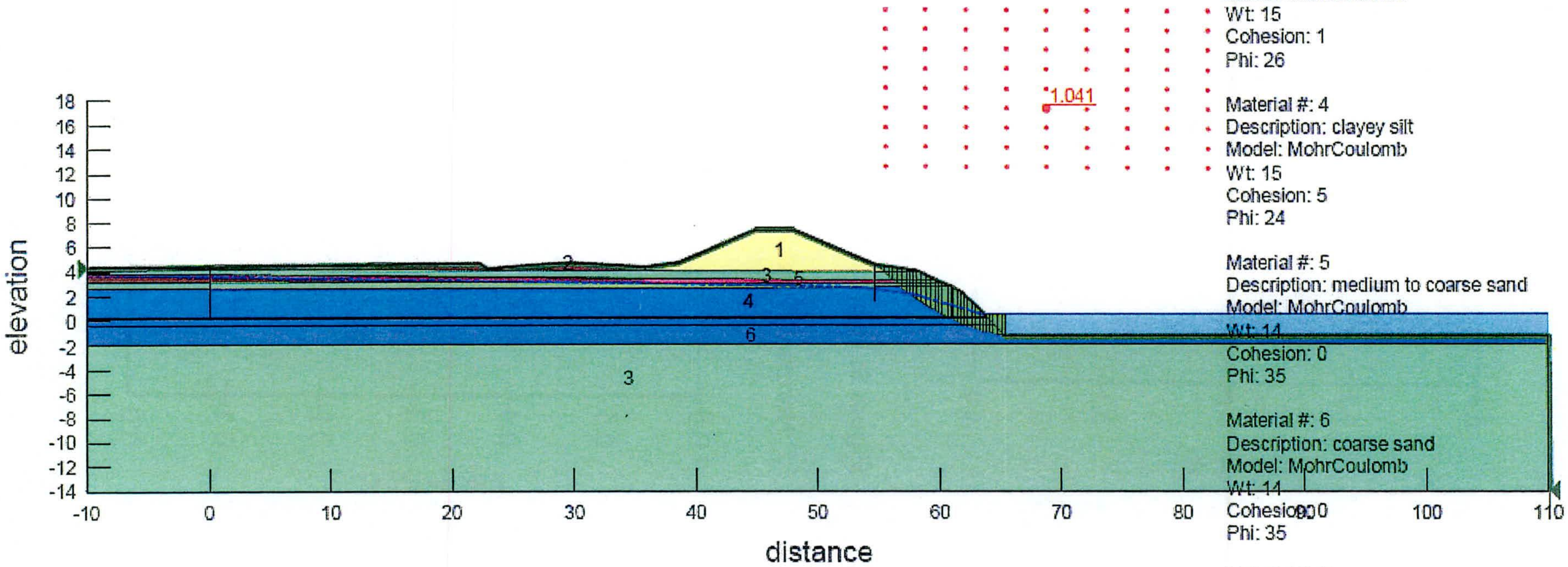


Figure 10: Hydraulic gradient in thin silt layer between sand layers

Black's Bend Cross Section 3
River Level RL0.5

Name: cross section 3 stab low river.gsz
Comments: Cross Section 3
Date: 01/07/2011 Time: 5:59:43 p.m.



Material #: 1
Description: stopbank fill
Model: MohrCoulomb
Wt: 16
Cohesion: 2
Phi: 26

Material #: 2
Description: silts
Model: MohrCoulomb
Wt: 15.5
Cohesion: 2
Phi: 24

Material #: 3
Description: silty fine sand
Model: MohrCoulomb
Wt: 15
Cohesion: 1
Phi: 26

Material #: 4
Description: clayey silt
Model: MohrCoulomb
Wt: 15
Cohesion: 5
Phi: 24

Material #: 5
Description: medium to coarse sand
Model: MohrCoulomb
Wt: 14
Cohesion: 0
Phi: 35

Material #: 6
Description: coarse sand
Model: MohrCoulomb
Wt: 14
Cohesion: 0
Phi: 35

Material #: 7
Description: Water
Model: NoStrength
Wt: 9.807

Figure 1

Campbell's Bend Cross Section 3
River Level RL0.8

Name: cross section 3 stab low river.gsz
Comments: Cross Section 3
Date: 01/07/2011 Time: 6:53:29 p.m.

Material #: 1
Description: stopbank fill
Model: MohrCoulomb
Wt: 16
Cohesion: 2
Phi: 26

Material #: 2
Description: silt
Model: MohrCoulomb
Wt: 15.5
Cohesion: 2
Phi: 24

Material #: 3
Description: silty fine sand
Model: MohrCoulomb
Wt: 15
Cohesion: 1
Phi: 26

Material #: 4
Description: clayey silt
Model: MohrCoulomb
Wt: 15
Cohesion: 5
Phi: 24

Material #: 5
Description: coarse sand
Model: MohrCoulomb
Wt: 14
Cohesion: 0
Phi: 35

Material #: 6
Description: fine sand
Model: MohrCoulomb
Wt: 14
Cohesion: 0

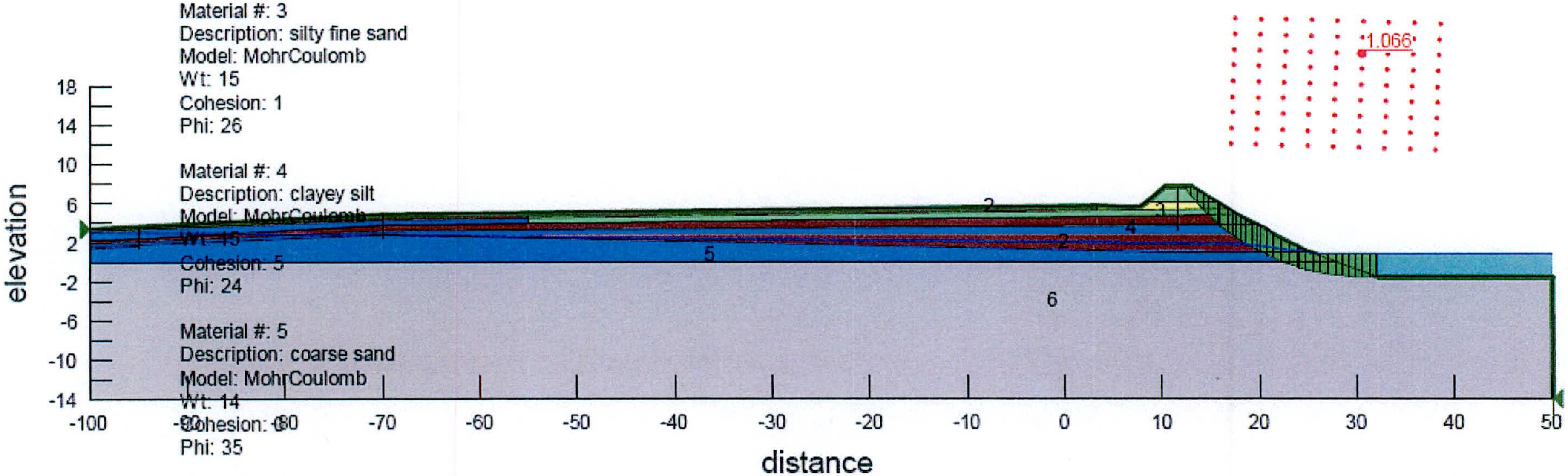


Figure 2

Description: stopbank fill
Wt: 16
Cohesion: 2
Phi: 26
Description: silt
Wt: 14
Cohesion: 2
Phi: 24
Description: silty sand
Wt: 14
Cohesion: 0
Phi: 26
Description: layer silts and clays
Wt: 15
Cohesion: 5
Phi: 24
Description: coarse sand and gravel
Wt: 14
Cohesion: 0
Phi: 35
Description: layered sands and silts
Wt: 15
Cohesion: 2
Phi: 28

Waiari Cross Section 6
New low river level with 0.5m erosion

Name: cross section 6 stability stat.gsz
Title: Rangitaiki River, Waiari
Comments: Cross Section 6 100 year flood flow hydrograph
Date: 01/07/2011 Time: 3:02:51 p.m.

River level RL 2.4

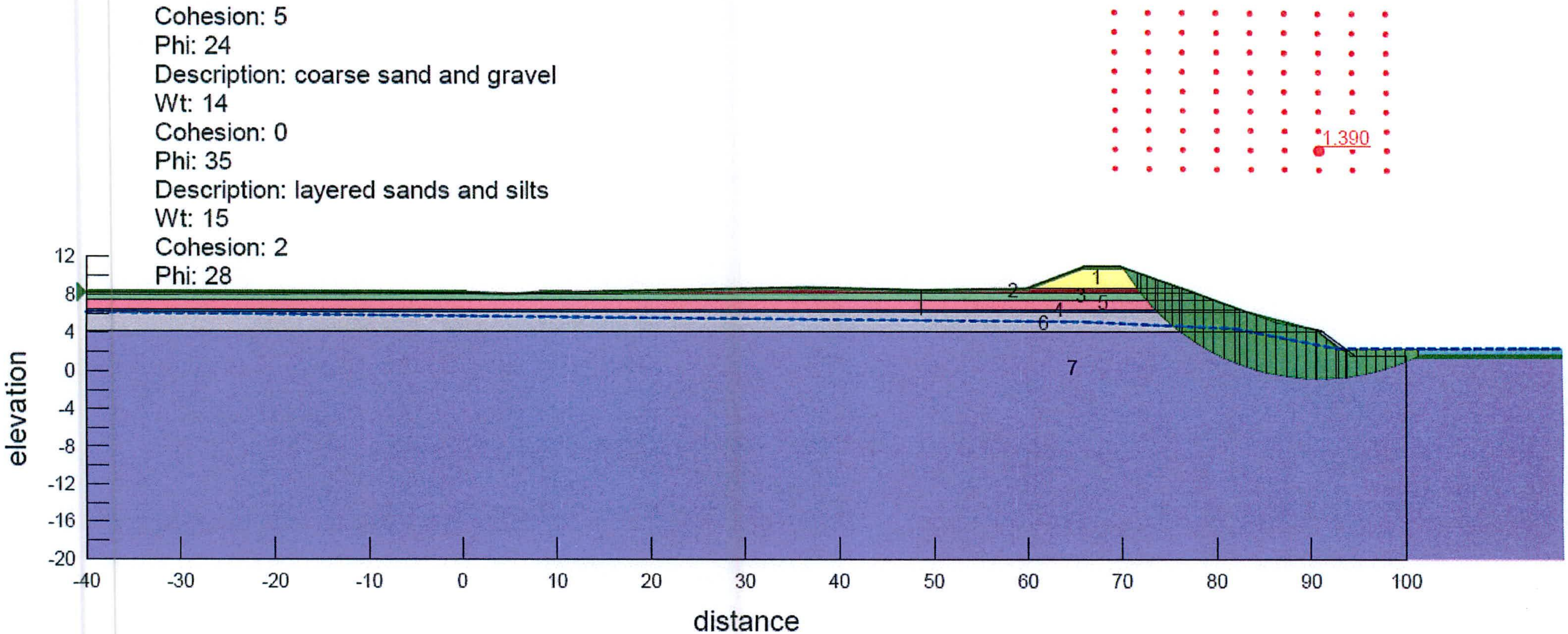


Figure 3

Description: stopbank fill
Wt: 16
Cohesion: 2
Phi: 26
Description: silt
Wt: 14
Cohesion: 2
Phi: 24
Description: silty sand
Wt: 14
Cohesion: 0
Phi: 26
Description: layer silts and clays
Wt: 15
Cohesion: 5
Phi: 24
Description: coarse sand and gravel
Wt: 14
Cohesion: 0
Phi: 35
Description: layered sands and silts
Wt: 15
Cohesion: 2
Phi: 28

Wairi Cross Section 6
Rapid drawdown

Name: cross section 6 stability 0.5m erosion stat.gsz
Title: Rangitaiki River, Waiari
Comments: Cross Section 6 100 year flood flow hydrograph
Date: 01/07/2011 Time: 3:36:05 p.m.

End river level RL 4.4

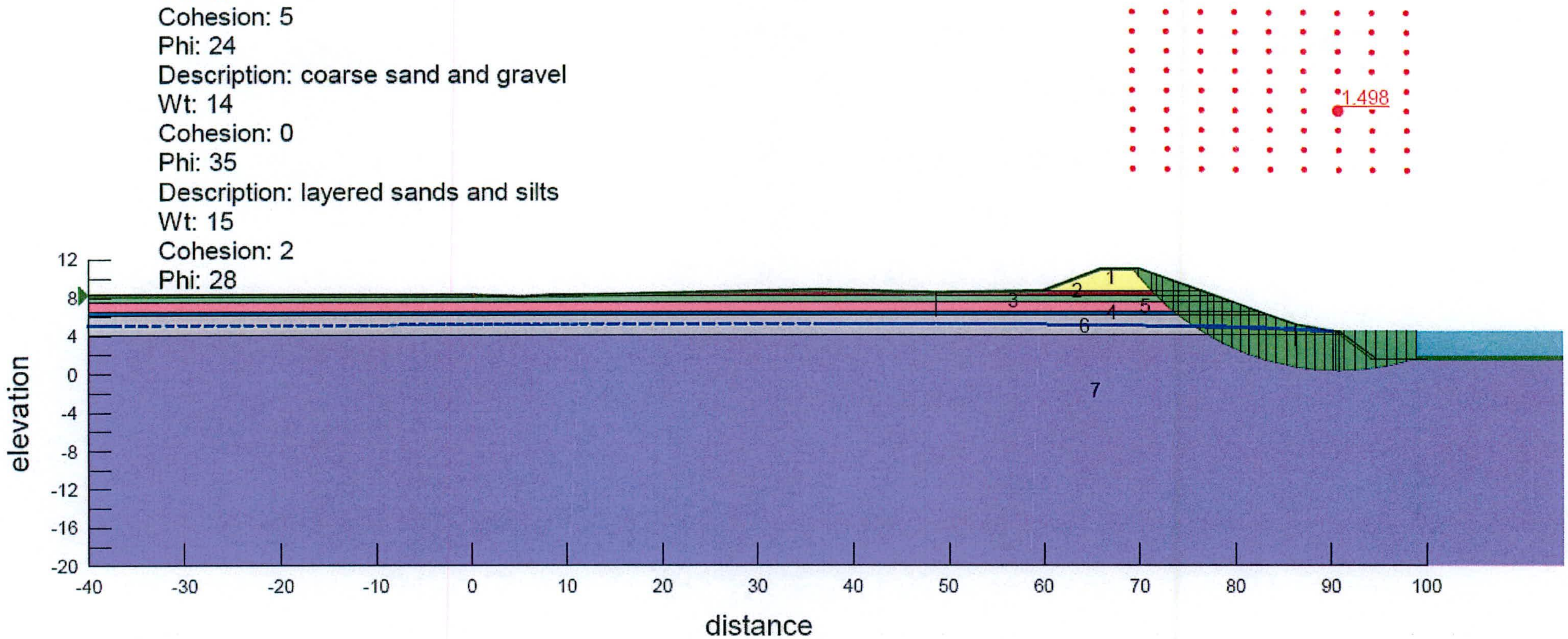


Figure 4

Name: section 6 cs3 100 year no silt cover.gsz
Title: Rangitaiki Stopbanks Section 6
Comments: 100 yr flood
Date: 27/06/2011 Time: 4:14:43 p.m.

time step 42 84 hours

stopbank kh = 2 x 10-6 m/s kv = 1x10-6 m/s

silts k = 5 x 10-7 m/s

silty sands k = 4 x 10-6 m/s

fine sand k = 1 x 10-5 m/s

medium to coarse sand k = 1 x 10-4 m/s

coarse sand to gravel k = 5 x 10-4 m/s

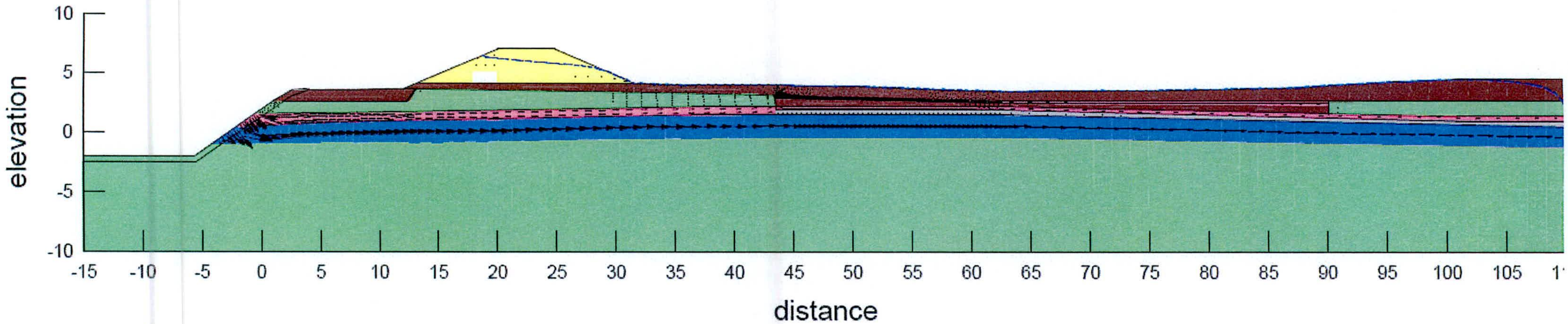


Figure 5

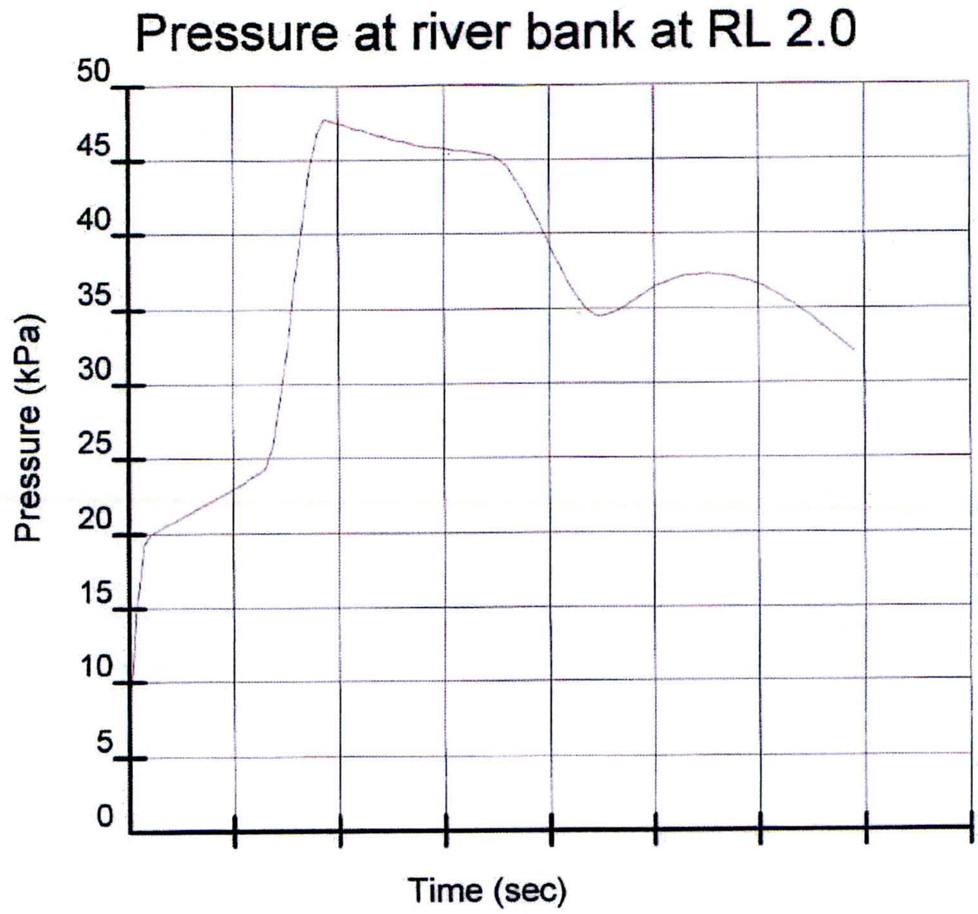


Figure 6: Section 6 Cross Section 3. 100 year AEP flood

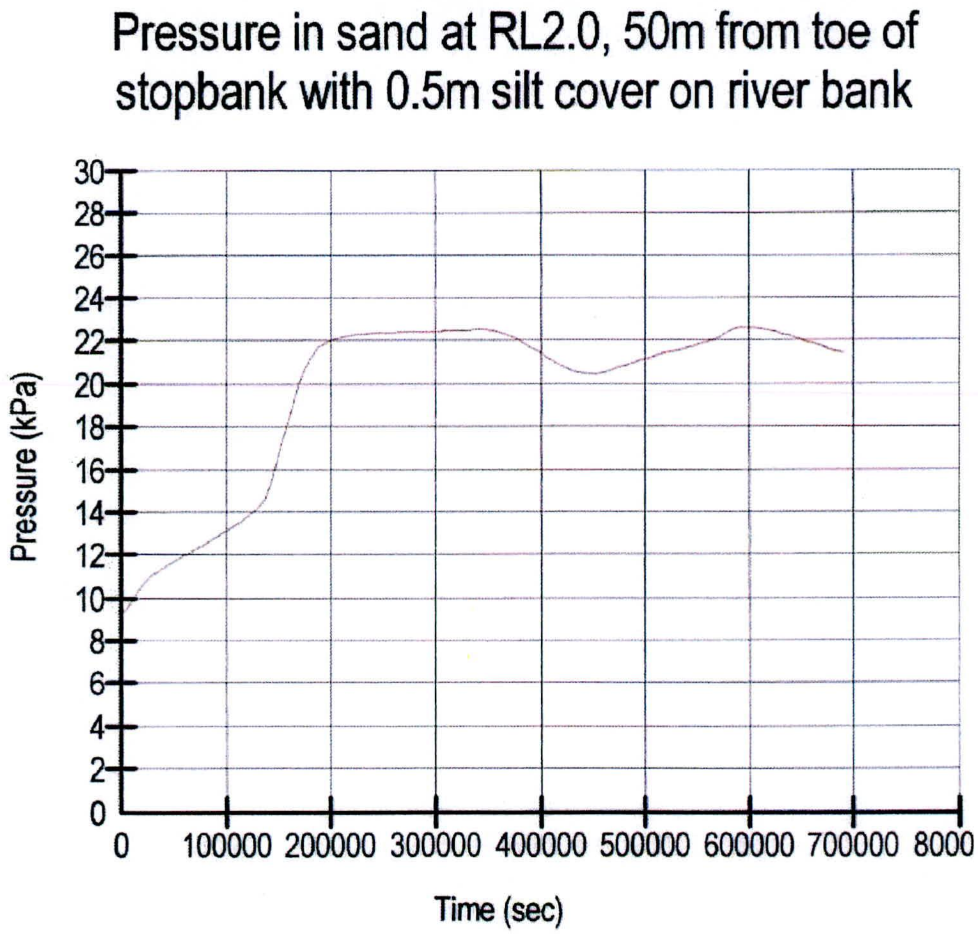


Figure 7: Section 6 Cross Section 3, 100 AEP flood

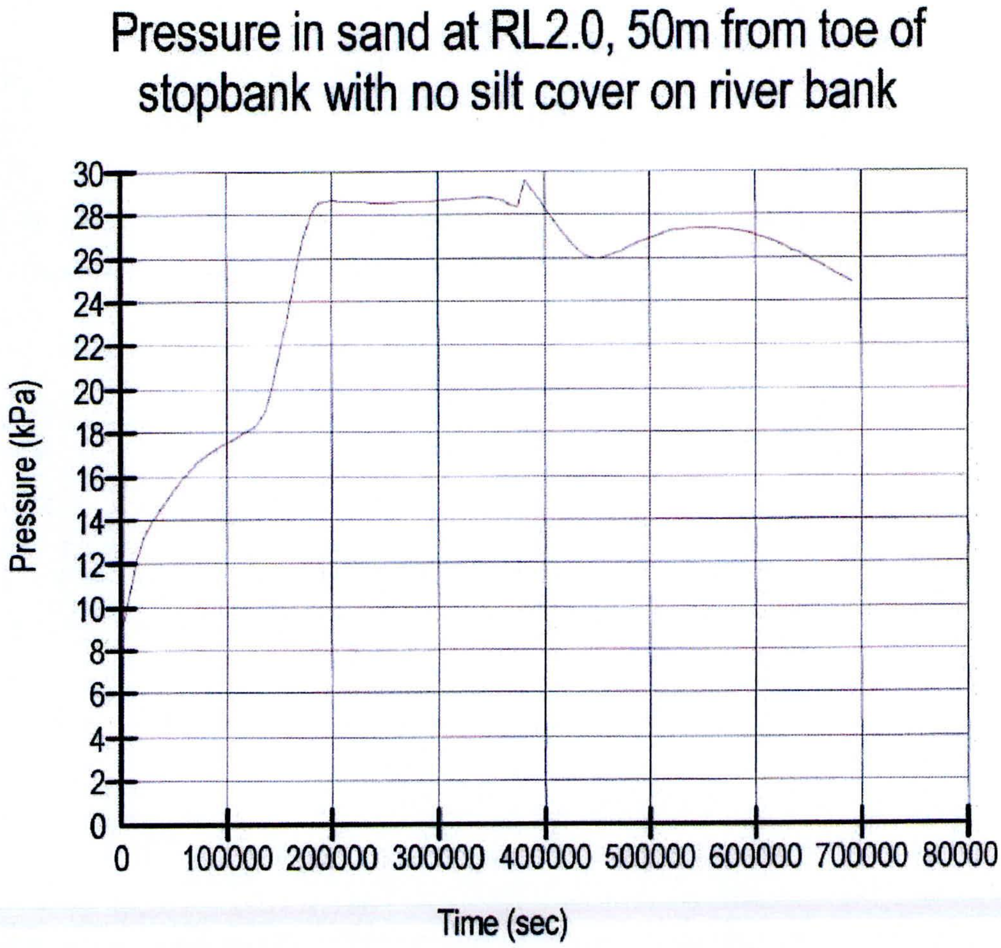


Figure 8: Section 6 Cross Section 3, 100 AEP flood

Name: cross section 9 100 yr flood.gsz
Comments: Cross section 9 100 yr flood
Date: 02/07/2011 Time: 12:01:06 a.m.

Title: Rangitaiki Stopbanks Section 3

stopbank kh = 2 x 10-6 m/s kv = 1 x 10-6 m/s

silt k = 5 x 10-7 m/s

silty sand k = 4 x 10-6 m/s

medium to coarse sand k = 1 x 10-4 m/s

coarse sand and gravel k = 5 x 10-4 m/s

time step 42 84 hours

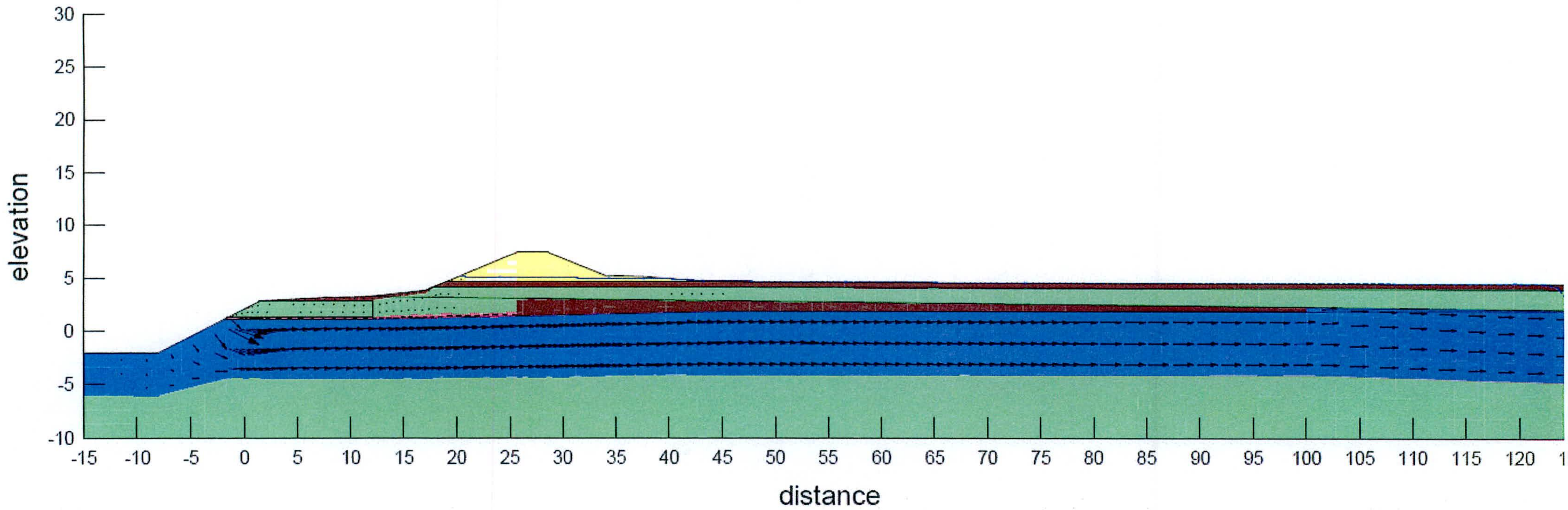


Figure 9

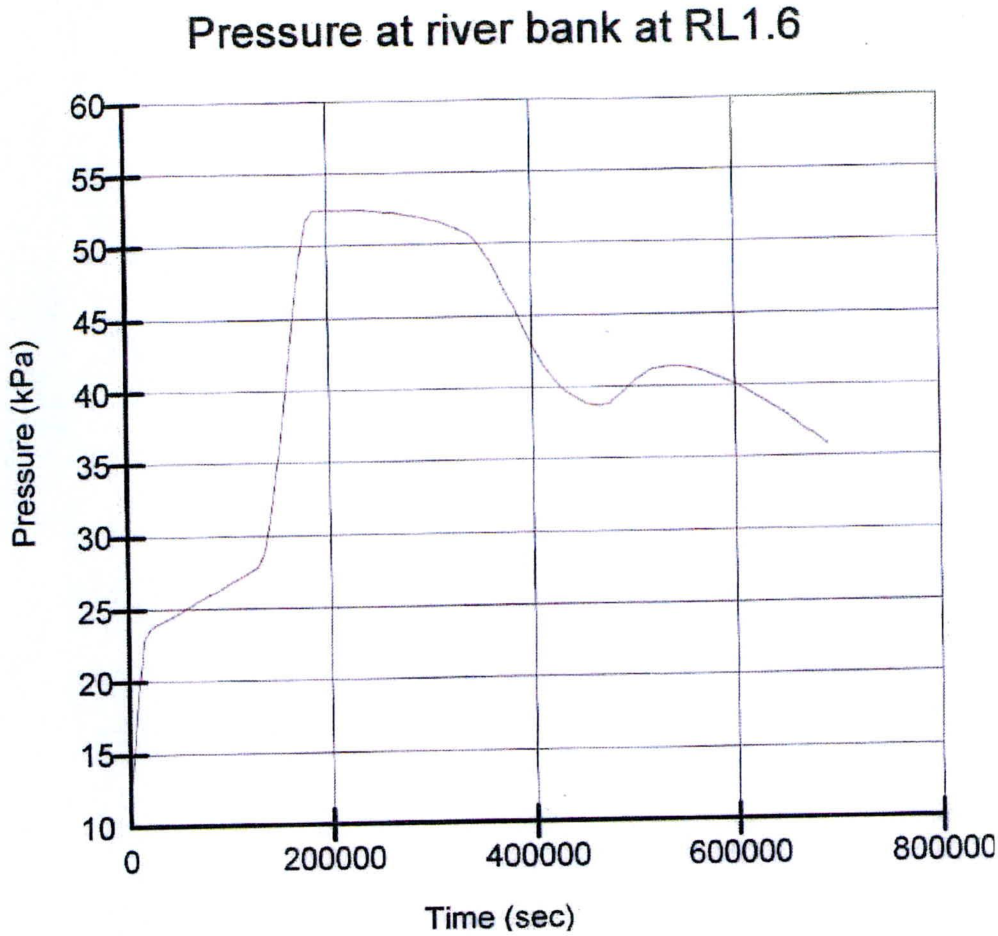


Figure 10: Section 3 Cross Section 9, 100 AEP flood

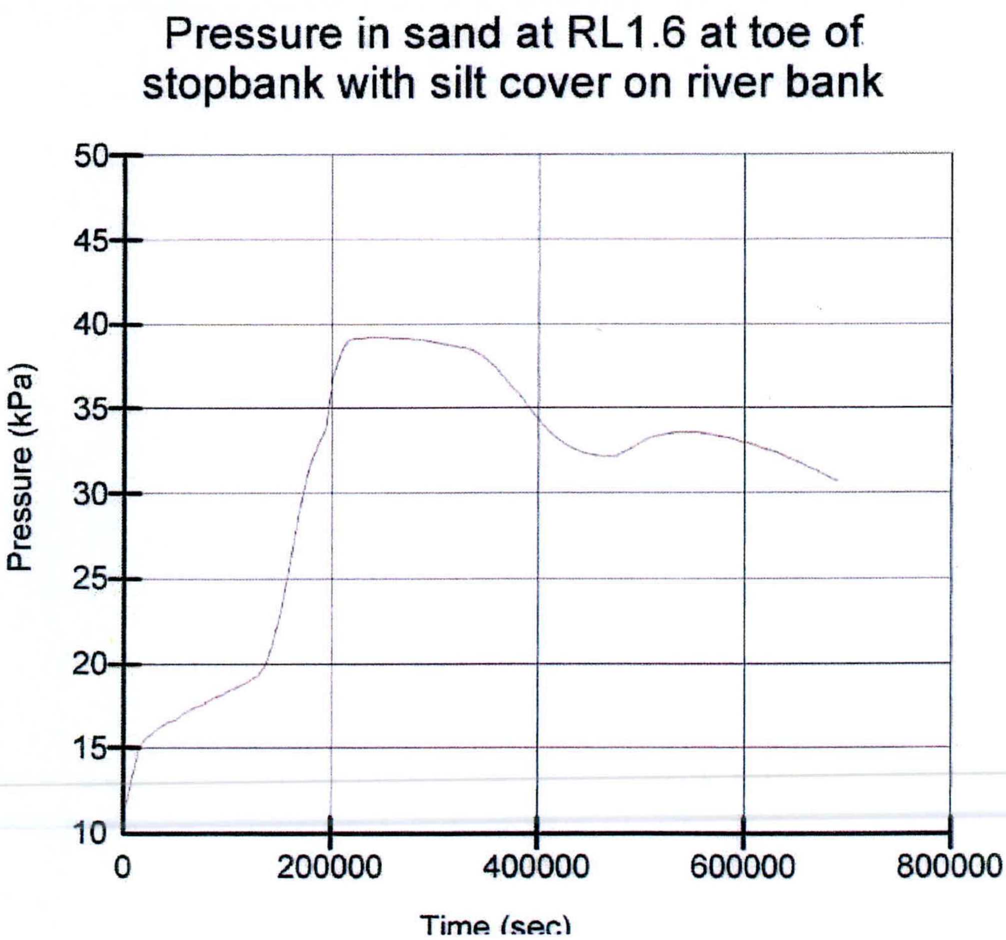


Figure 11: Section 3 Cross Section 9, 100 AEP flood

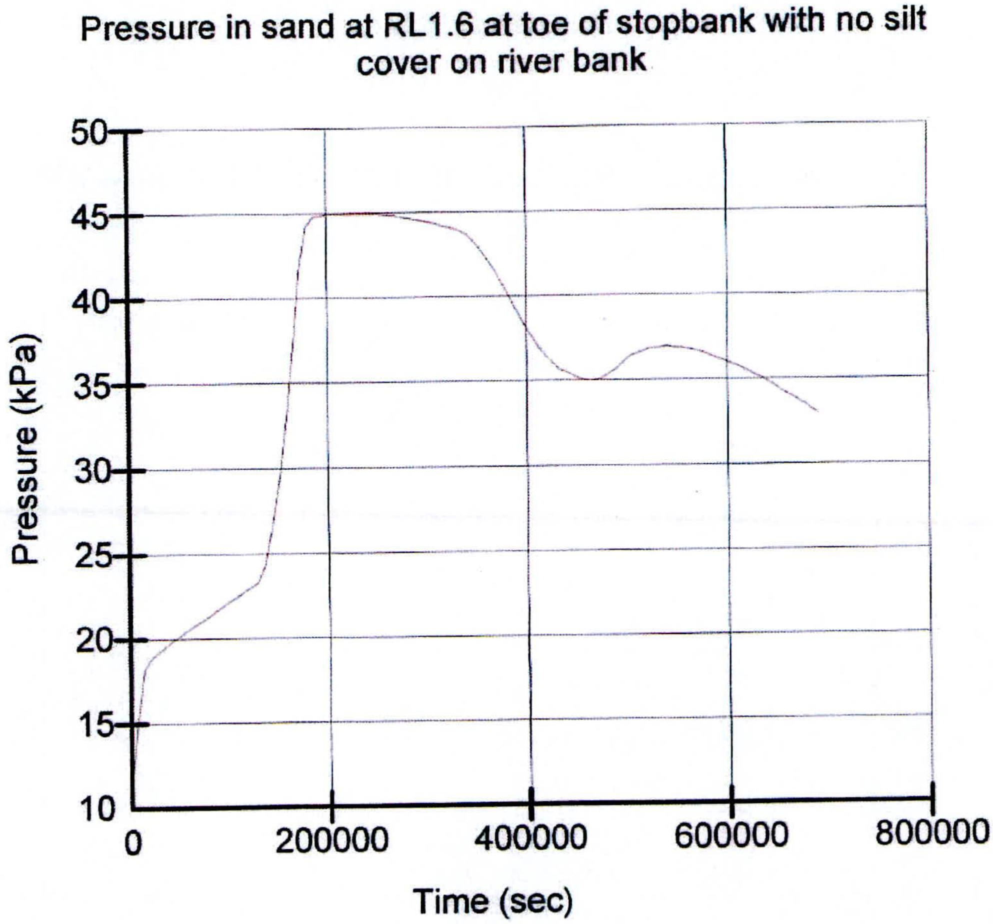


Figure 12: Section 3 Cross Section 9, 100 AEP flood

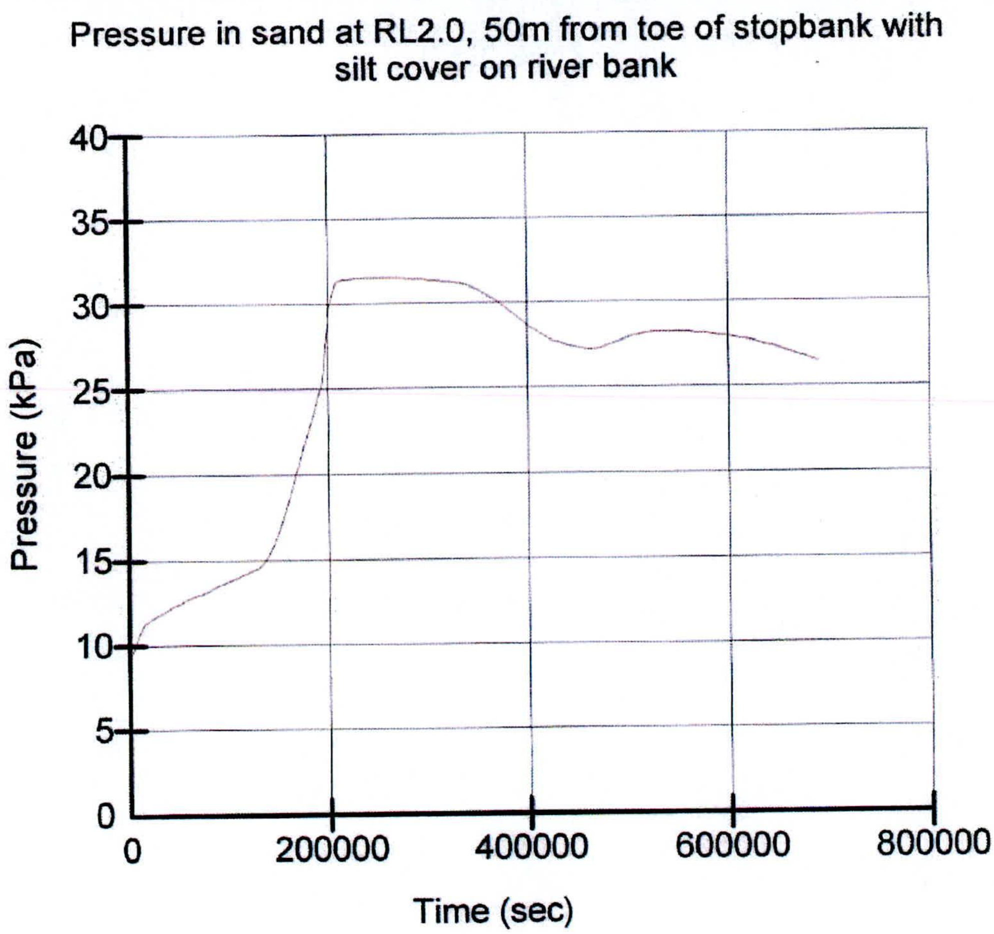


Figure 13: Section 3 Cross Section 9, 100 AEP flood

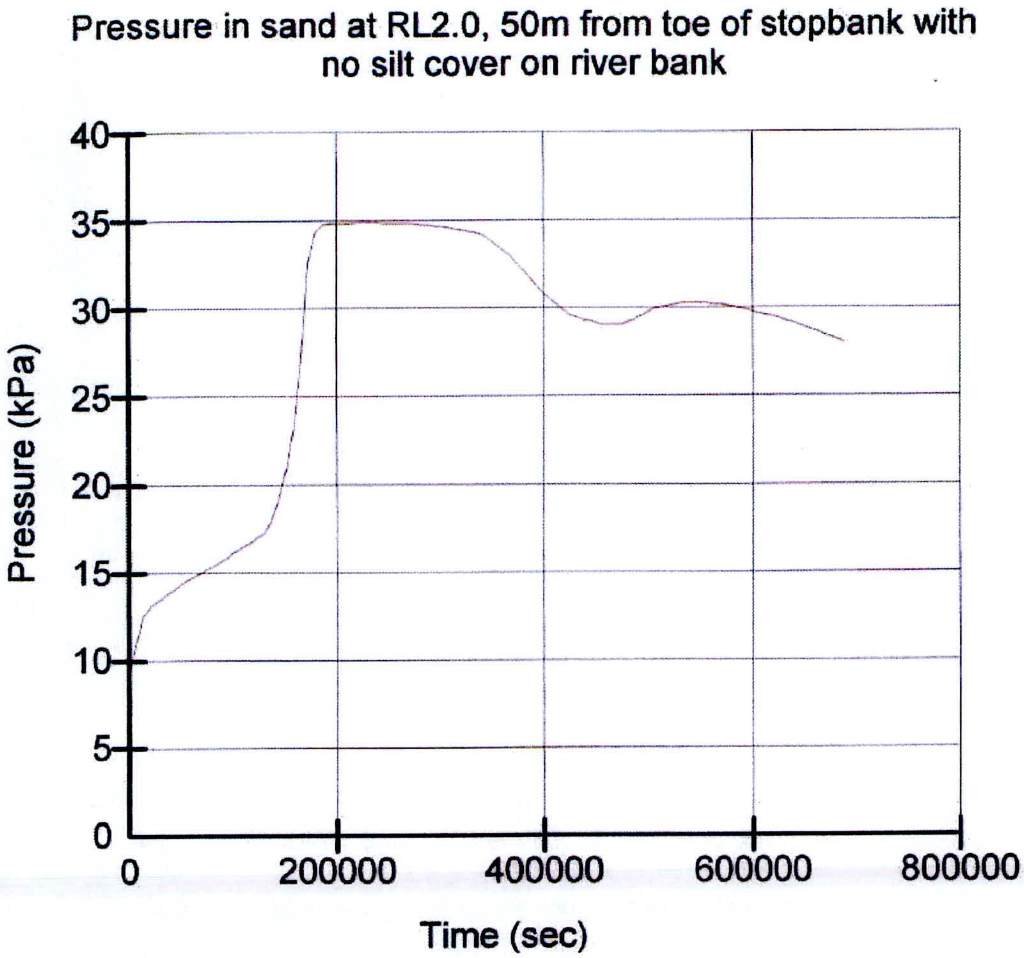


Figure 14: Section 3 Cross Section 9, 100 AEP flood

65750 - 65753
AT62463

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of an application by **TRUSTPOWER LTD** to the **BAY OF PLENTY REGIONAL COUNCIL** for water permits associated with the operation of the Matahina Hydroelectric Power Scheme

STATEMENT OF EVIDENCE OF GARY JOHN WILLIAMS ON BEHALF OF BAY OF PLENTY REGIONAL COUNCIL ENVIRONMENTAL HAZARDS GROUP

1. INTRODUCTION

Qualifications and Experience

1.1 My name is Gary John Williams. I practice as a consulting engineer specialising in the field of water and soil engineering. I hold the qualifications of Bachelor of Engineering, Bachelor of Science and Master of Commerce. I am a member of the Institution of Professional Engineers New Zealand. I have worked for the Water and Soil Division of the Ministry of Works and catchment authorities in New Zealand, as well as overseas.

1.2 Since 1987 I have practiced as a self-employed private consultant. I provide advice, investigation, design and construction supervision services to regional and district councils, government departments, commercial firms and private individuals, as well as providing expert evidence.

1.3 Over the last 35 years I have had extensive experience on many rivers throughout New Zealand, covering all aspects of river management and flood mitigation, including comprehensive investigations, design work, construction supervision, and reviews, as well as investigations on hydro-power operations and their effects on river systems.

1.4 In recent years, as a consultant, I have carried out comprehensive investigations of river behaviour and river management practices, and undertaken final design and

construction supervision for major works on many rivers, including the Waitara, Whanganui, Manawatu, Ngaruroro, Ruamahanga, Waikanae, Otaki and Hutt rivers. I have carried out many investigations of flood hazards, from large rivers to small streams and urban waterways, as well as reviews of flood hazard assessments and flood mitigation schemes.

1.5 I have carried out a number of investigations of hydro-scheme operations, as well as reviews and mediation facilitation on river, river mouth and coastal effects of hydro operations. This includes the Roxburgh Dam on the Clutha River and the Waitaki Dam on the Waitaki River.

1.6 I have undertaken investigations and reviews of river schemes and various aspects of river management for the Bay of Plenty Regional Council ("BOPRC") and the Whakatane District Council. This work has been mainly in relation to the Whakatane and Rangitaiki rivers. In 2008 I undertook a technical review of the Rangitaiki-Tarawera Scheme ("the Scheme") and the impacts of the major 2004 flood event and stopbank failure for the Department of Internal Affairs (Emergency Management).

1.7 In 2009, as part of an investigation into the flooding and drainage implications of climate change, for the Ministry of Agriculture and Forestry ("MAF"), I studied the drainage and flooding hazards on the Rangitaiki Plains and the economic impacts of changes in flood frequency and sea level rise. This year, following the January flood events I inspected flood damage along the major rivers of the Bay of Plenty, including the Rangitaiki River upstream and downstream of the Matahina Dam, and reviewed the proposed repair and remedial measures.

Expert Witness Code of Conduct

1.8 I have been provided with a copy of the Code of Conduct for Expert Witnesses contained in the Environment Court's Consolidated Practice Notes 2006. I have read and agree to comply with that Code. This evidence is within my area of expertise, except where I state that I am relying upon the specified evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Role in Matahina HEPS Consent Process

1.9 In 2009, I was engaged by the now Environmental Hazards Group ("EHG") of the BOPRC to provide advice in relation to the effects of the Matahina Hydroelectric Power Scheme ("Matahina HEPS") on the Scheme in the context of the application by TrustPower Limited ("TPL") for water permits associated with the operation of the Matahina HEPS. This has included a review of the Beca Infrastructure Ltd ("Beca") report on river hydrology, hydraulics and bank erosion ("Beca Report") for the Assessment of Environmental Effects of the TrustPower application ("AEE"). My advice to EHG and responses to the Beca Report were summarised in two memoranda which were attached to the EHG submission, and are attached to this evidence, as Attachment A & B. Please note that the attachments had some minor corrections and additions for clarification, after the date of issue. I will refer to these memoranda in my evidence.

1.10 I have also advised the EHG in relation to the likely costs to the Scheme arising as a result of the adverse effects of the operation of the Matahina HEPS on the Scheme, both in terms of the existing operation and the proposed modified operating regime, and the adequacy of the current contribution that TPL makes to the Scheme. The proposed change in the operational regime is a matter of very serious concern and I will provide my expert opinion on this in my evidence.

Scope of Evidence

1.11 My evidence will cover:

(a) River dynamics and river management as it relates to hydro-power operations, and the effects of the Matahina HEPS on the Rangitaiki River and Scheme management.

(b) The operating regime of the Matahina HEPS in relation to the specific nature of the Rangitaiki River, and the potential stopbank failure modes on this river.

(c) A qualitative assessment of the adverse effects of the HEPS in terms of River Scheme expenditure, for the current and proposed hydro operating regime.

(d) Appropriate monitoring of the effects of the hydro scheme on the river downstream.

(e) Responses to the evidence presented on behalf of TPL concerning effects of the river and river management, including assessments of a TLP contribution to the River Scheme.

1.12 My recommendation concerning the operational regime is that the proposed relaxation of peaking and low flows of the application be rejected, and further, given the small contribution to the Scheme of the suggested consent conditions of TrustPower, that the present peaking and low flow allowances be further restricted because of the adverse effects on the Rangitaiki River below the Matahina Dam, for which TrustPower is undertaking no effective mitigation.

1.13 My evidence is most directly related to the evidence of Bruce Crabbe and Marianne O'Halloran.

2. FINDINGS

2.1 The main findings of my evidence are as follows:

(a) Hydro-power dams have effects on river systems through the disruption of natural sediment transport and erosion/deposition processes, and the modification of flows that also affect these processes.

(b) The Matahina Dam is the lowest hydro-power dam on a major New Zealand river, and has significant impacts on the river and its channel activity and hence river management requirements, like other dams, for instance on the Waikato, Waitaki and Clutha rivers.

(c) The lower reaches of the Rangitaiki River are especially sensitive to flow level fluctuations and acceleration/deceleration, because of the highly permeable and erodible soils on the alluvial floodplain of the river.

(d) There are a number of different failure processes that can give rise to breaching of the stopbanks, and the effects of the hydro peaking on the river banks and channel conditions adversely impacts on the likelihood of all of these failure processes.

(e) The assessment of river effects by Beca is minimal. The stability and hydraulic modelling they undertook is useful, but there is very little engineering interpretation about river management from this information.

There is no assessment of the additional effects of the proposed operating regime.

(f) A contribution to the Scheme from TrustPower could be determined, based on an assessment of relative effects and impacts on river management. An indicative cost share can be determined based on past Scheme expenditure, but any contributions should be derived from actual costs when they occur.

(g) The proposed operating regime is an extreme regime for the benefit of power generation, for high demand flexibility and hence revenue maximisation. It, thus, raises very serious concern for the integrity of the Scheme and the management of the river to mitigate erosion and flooding hazards.

(h) Given the inadequacy of the contribution to the river Scheme of TPL, my recommendation is that the operational regime of the Matahina HEPS return to its earlier operation of run-of-the-river, with a (single) daily peak that utilises available reservoir storage

3. RIVER MANAGEMENT AND EFFECTS OF HYDRO-POWER OPERATIONS ON RIVERS

3.1 I will begin my evidence with a brief overview of the key issues, which arise in the management of rivers for the purposes of flood mitigation, and the effects that hydro-power operations can have on rivers and river management schemes.

Management of Rivers

3.2 River systems are highly dynamic and changeable systems. They are also very responsive systems, which continually change and alter as the many influencing forces on these systems themselves vary. There are complex interactive linkages between the physical processes of an hydrologic regime, sediment transport, and channel migration, and with the biological processes of vegetational and habitat changes along rivers.

3.3 The major activity of the physical processes in rivers — of sediment transport, erosion and deposition, channel migration, siltation and the removal and spread of vegetation — takes place during flood events. However, the pre-conditions — of channel form, vegetation and cover materials — have a significant influence on the nature and extent of the flood activity.

3.4 Because the river is a dynamic and ever-changing natural system of physical and biological processes, river management must continually respond as the river changes, to maintain sufficiently favourable pre-conditions before a flood event to ensure that the flood is contained within the flood defences.

3.5 For that reason, river management is a continuous job which involves undertaking measures and carrying out maintenance in an ongoing manner in order to obtain the best channel and bank conditions possible, within the limitations of budgets and the natural conditions of the river. This continual management over time and throughout the full reach of the management area is aimed at ensuring a state or condition of the river channel and its berms that is adequate to contain the design flood, whenever it may occur, without overtopping or breach failures. The cost effectiveness of this continual management is affected by many factors and variables of the river dynamics and human interventions and alterations of the natural regime.

3.6 There is very little that can be done to manage flood events through the events themselves. Flood response measures are generally limited to such measures as sandbagging to raise crest levels and emergency rock dumping or earthmoving at incipient failure sites. The mitigation of erosion and flooding is achieved as a result of the preventative measures and maintenance undertaken between events in order to reduce erosive forces and strengthen river banks or berm areas.

3.7 The condition of river banks and berms before flood events is thus critical in minimising erosion, groundwater inflows and bank or land instability during the flood event itself.

3.8 It is difficult to determine (and especially quantify) direct cause and effect linkages between pre-conditions and the extent of flood impact, but just because the linkages are not direct and event specific does not mean they do not exist or are unimportant.

3.9 The effect of the hydro-power operation on erosion and flooding hazards arises from its impacts on the pre-conditions of river banks and their soil and vegetation cover. The impact of a hydro operation is not just about the stability of the stopbanks themselves or of the adjacent river bank. There are a number of failure mechanisms that can be affected by changes in the flow regime below flood flows, which also affect the management techniques used and their effectiveness.

Failure Modes

3.10 Considering, first, failure modes that can give rise to the breaching of stopbanks or other flood defences. There are three broad categories of failure that should be taken into account:

(a) Bank collapses from localised slipping and slumping of the river bank;

(b) Bank erosion associated with channel migration; and

(c) Underground piping development and heave failure.

3.11 River bank collapses occur due to on-site instability that arises from rising and falling water levels in the soil materials of the banks. They mostly occur on the recession of river flows, after the bank has been saturated and then falling water levels remove support while the soil moisture reduces soil strength and the bank fails along lines of weakness or failure planes.

3.12 Of more significance in a river is bank erosion associated with channel migration. This arises from the natural erosion and deposition activity of rivers in flood. Such erosion is affected by channel shape (especially by distortions of cross section and plan form), bank cover or strength, and braiding/channel splitting or migration trends.

3.13 Bank erosion gives rise to stopbank breaches through a progressive removal of the berm land between the river bank and the stopbank, and an undermining or direct erosion of the stopbank. Along the lower Rangitaiki River, the stopbanks are very close to the river banks.

3.14 Piping and ground heave occur where there are both permeable layers and layers of fine materials together in the ground adjacent to the river. There is a high risk of this type of failure along the lower Rangitaiki River, and Marianne O'Halloran covers this is more detail in her evidence. In brief:

(a) Piping occurs where material is progressively removed, from either the river banks or the stopbanks and their foundation materials, by hydraulic pressures in the ground. The removal of material creates pathways through which water can travel more easily, which, in turn, results in further removal of

material and the creation of "pipes" in the ground. There can then be a cumulative expansion of these pipe cavities over time.

(b) Ground heave occurs where hydraulic pressures that develop in the ground are sufficient to lift or break through the surface as a water boil. This generally arises where there are surface layers that are relatively tight and confine underlying more permeable layers, and there is a concentrated outflow of water from the ground at some weakness in the surface layers.

(c) Ground heave and piping give rise to stopbank breaches where the removal of ground material is sufficient to cause a scouring back to and through the stopbank, until the stopbank collapses into an enlarging cavity within or under the stopbank.

Managing Pre-conditions to minimise Flood Impacts

3.15 Fundamental to managing rivers and minimising the impacts of flood events on the critical flood defence measures, is an on going management of river conditions, with continual repairs as and when required in response to the activity of the river. The pre-conditions at the time of a flood determine the type and extent of channel activity, and hence erosion and deposition, the exchange of water to and from the river and its floodplain, and the amount of bank re-working.

3.16 Essential to this management along many rivers in New Zealand is the maintenance of a vegetative cover on the river banks. Much of the annual maintenance and repair effort is directed at closing up gaps that arise in the vegetation, and re-establishing vegetation on raw banks. The aim is a continuous band of dense and healthy vegetation, and on many rivers willows are used as the primary tree vegetation. This vegetation provides a very good diffuse boundary to the flood flows of the river, as well as providing root strengthening to the bank. The slower flowing water within the vegetation buffers away strong flows and currents, and this gives rise to quieter water against the bank. This buffering out affects the full height of the bank, not just the flow above normal low flow levels. Willow vegetation along a river bank has to be managed, by periodic layering down and trimming of large overhanging branches.

3.17 Along the Rangitaiki River the willows have another very useful function in trapping finer silt material, from the suspended load of the river. Again this layer of fine material can extend over the full height of the bank. This fine layer is very important in reducing inflows to groundwater and hence reducing the potential for piping and heave failures.

3.18 Rock works are also very common along rivers in New Zealand to provide a relatively strong bank resistant to the erosive forces of flood flows. Rock linings on river banks do, though, tend to increase the depth of bed scour alongside the bank and off the downstream end of the lining. Repair works, then, generally involve further extensions and topping up of rock works.

3.19 There has been a change from vegetative management to rock works along substantial lengths of the lower Rangitaiki River, as vegetative techniques have been found to be inadequate. These works are much more expensive, but once in place are more robust and are less vulnerable to the constant fluctuations of hydro operations. The rocks in the linings along the lower Rangitaiki are, though, being displaced by the hydro oscillations, with fine materials behind the rock being sucked out by the water level fluctuations.

3.20 I will comment further on river management in the context of the Rangitaiki River later on in my evidence.

Effects of Hydro Generation on River Processes and River Management

3.21 Hydro-power schemes affect rivers systems through sediment trapping and flood modification. There have been many investigations and debates, within New Zealand and overseas, about the effects of hydro-power operations on river systems and river management schemes and I will refer to some examples later in my evidence. I accept the Matahina Dam and its sediment trapping as given, and my evidence, therefore, concentrates on the operating regime.

3.22 In summary the key aspects of hydro-power operation that effects river processes and hence impacts on river management are:

(a) The number of flow oscillations or peaks in a given period;

(b) The range of those oscillations between minimum and maximum operating flows under normal (non flood) conditions;

(c) The rate of rise and fall of the oscillations or ramping rates; and

(d) The influence on flood flows of reservoir storage.

3.23 The evidence of Colin Meadowcroft covers reservoir storage and flood effects. My evidence deals with effects downstream of the dam, and in particular the impacts of flow varying operating regimes on the river banks, and hence on potential failures, in terms of loss of land and breaching of stopbanks.

4. OVERVIEW OF THE MATAHINA HEPS AND THE RANGITAIKI RIVER

4.1 I will now outline my assessment of the effects of the Matahina HEPS on the Rangitaiki River and the river management Scheme.

Matahina Dam

4.2 The Matahina Dam is sited at the downstream end of a gorge formed in volcanic rock, and below the dam the Rangitaiki River flows down to and across an alluvial plain to the sea. There is a reservoir above the dam, but the Matahina HEPS is operated essentially as a run-of-the-river generator, with only short term (daily) storage for power demand matching.

4.3 The dam has a sediment trapping effect, with all of the gravel bed material of the Rangitaiki River being stored in reservoirs (Aniwhenua as well as Matahina), while some of the suspended load of the river is also stored in the reservoir. The hydro-power operation modifies the flow regime of the river, generally imposing daily peaks – within its present (normal) operating range of 40 to about 135 m^3/s. When there are lower or higher flows than this range, the natural hydrograph inflows to the reservoir continue downstream, with some attenuation of flood hydrographs.

4.4 There are similarly sited and operated hydro dams on the Waikato, Waitaki and Clutha rivers, which also have valuable floodplain land below them, protected by river management schemes. The Rangitaiki River is smaller than these rivers, but the hydro ramping range of the Matahina Dam is of similar relative magnitude and significance as that of the lowest dam on these rivers, particularly the Waitaki and Clutha. In making my assessment of a contribution to the Scheme I have taken note of what has happened on these rivers.

Rangitaiki River

4.5 Below the Matahina Dam, the Rangitaiki River flows down the centre of the Rangitaiki Plains, past the townships of Te Teko and Edgecumbe, to an artificial mouth, which was cut through the coastal sand dunes in 1913.

4.6 As discussed in Marianne O'Halloran's evidence, the plains have been built up by alluvial deposition of mixed source material from both greywacke and volcanic catchments. There are extensive peat layers, and a coastal dune frontage that is actively worked and affects the river mouths.

4.7 The river has a narrow but pronounced natural levee along its present course, and has naturally migrated across the plains, with old river channels flowing to both the Tarawera and Whakatane River mouths. The volcanic deposits on the plains include highly permeable layers, and there is a high level of interchange between river and ground waters. There are, thus, severe stability problems of ground heave and piping development during flood events, as well as bank erosion and channel migration, which occur naturally but are exacerbated by the operation of the Matahina HEPS.

4.8 As outlined in Bruce Crabbe's evidence, flood and erosion mitigation works along the Rangitaiki River were undertaken as part of the Tarawera-Rangitaiki Rivers Scheme, with the original works mostly constructed between 1971 and 1980. The Scheme has been extensively re-built and added to, following the 1987 earthquake and the major floods of 1998 and 2004. This Scheme is the context in which I have considered river management issues and the impacts of the Matahina HEPS.

5. EFFECTS OF MATAHINA HEPS ON THE SCHEME

5.1 Addressing now the effects of the current operating regime on the Rangitaiki River Scheme and the likely effects of the proposed modified operating regime on the Scheme. I will first consider the current operating regime, which I will take as the average operating regime over the longer term, as we have historical knowledge of this hydro-power operation and the river behaviour and Scheme management responses to it. I will explain this further when I consider a TPL contribution to the Scheme.

5.2 Attached to my evidence is a dossier of photographs taken from the river, during a boat inspection [Attachment E]. I will refer to these photographs through my evidence.

Fluctuations in River Levels

5.3 The operation of the hydro-power plant gives rise to high frequency low amplitude (or level) variations in water levels along the river downstream of the dam, until these variations are swamped out by tidal variations along the lowest reaches of the river.

5.4 The movement of material in a river arises from acceleration and deceleration, from the pulsing and burst of water flow. Changes in channel shape, section asymmetry and protrusions or obstructions generate the eddies, vortices and turbulence that give rise to flow pulsing and hence sediment movement. Variations over time of flows and variations over space of channel geometry then generate the flow forces that cause erosion and deposition.

5.5 The constant water level fluctuation of the hydro-power operation prevents the establishment of vegetation on the bank within this range of levels. Willow vegetation that is established on the banks is, therefore, higher up the bank, above low flow water levels, with less root mass down the bank and relatively more weight up the bank above the low flow levels. The willow material and branches within the fluctuation zone are affected by the constant variations and are less healthy and vigorous as a result.

5.6 The deposition of the suspended load as siltation on the banks and berms of the river channel is important in terms of a fine material cover, which supports vegetation colonisation and growth. The vegetation then increases the deposition on flow recessions. The hydro fluctuations, with the continual flow acceleration and deceleration they generate, affect this deposition and vegetative growth, reducing both vegetation and the sealing up of fine deposits. This in turn has an influence on the in-ground water pressures during floods, and hence bank stability and piping development and ground heave failure away from the river channel.

5.7 It is the loss of fine covering material (with and without vegetation) that is important from a permeability (and hence piping or heave failure) perspective. There can also be complex cumulative effects, as bank slumping occurs, banks become over-steep, there is then less vegetation, which is more likely to be removed by, giving rise to further bank slumping and less bank cover, which is again more likely to be removed. The channel conditions along the lower Rangitaiki River are especially adverse in this

regard, where a well-defined meandering channel has been contained, and this has given rise to steep banks and accentuated channel asymmetry. The hydro scheme, clearly, did not cause this, but this condition makes its operation a more sensitive matter, and more likely to be detrimental from a river management point of view.

5.8 Hydrograph plots at the Te Teko recorder site on the Rangitaiki River are attached (Attachment C). These are highly compressed plots of flow over the record from the late 1940s. The first plot up to 1966 is the natural river flow prior to the commissioning of the Matahina HEPS. Minimum low flows are around 40 m^3/s.

5.9 These plots, then, show the effect of the Matahina Dam and the changing operating regime over the years. The change in flow regime from 1967 is clearly apparent but low flows remain around 40 m^3/s over the next couple of decades. However, there is an increase in the degree of flow ramping between 40 and 135 m^3/s from the 1980s onward. What is also clear is the change in the summer flow regime in recent years, with flows below 40 m^3/s over long periods and with ramping occurring below the 40 m^3/s flow. Minimum flows have been lowered to around 25 to 30 m^3/s over recent summers, since 2007.

Effects on Failure Modes

5.10 All three failure modes described above are affected by the hydro-power operation. The lack of vegetation and hence silt deposits along the banks increases inflows to the ground under and beyond the stopbanks. This increases the potential for piping and heave failure, which is a high vulnerability mode in this river, as demonstrated by the 2004 failure and the large expenditure on remedial measures since then for this type of failure.

5.11 The higher level of raw bank, without any vegetation cover, increases shallow bank slipping over fluctuating flows, including the hydro-power fluctuations, and this increases the overall instability of what are already relatively unstable banks.

5.12 More importantly, the larger area of raw bank and greater difficulty in establishing and maintaining a consistent and continuous band of willow vegetation gives rise to greater channel migration erosion and deposition activity.

5.13 There is also a compounding effect from bank slips aggravating channel asymmetry and plan distortion, as well as bank steepness, which increases channel migration

erosion and which in turn increases the area of raw bank for inflow of flood waters into the adjacent ground.

5.14 The relatively long periods between significant floods is very important in establishing protective vegetation and allowing re-shaped banks to settle down and then vegetate. The constant flow fluctuation of the hydro operation has a very adverse impact on these management operations and the natural recovery processes they depend on. It is a constantly disturbing influence, which is quite unnatural.

5.15 The hydro-power fluctuations give rise to poorer pre-conditions directly, through raw banks and greater discontinuities along the river, and prevent vegetative healing and management improvements that would give rise to better pre-conditions.

5.16 All aspects of the Scheme are though adversely impacted by the higher overall vulnerability of the flood defences, and compounding effects over time of greater erosion activity

Impact on Management Techniques

5.17 The maintenance and re-establishment of willow vegetation along the river banks is, thus, more difficult because of the hydro fluctuations. The water level variations continually move the willow material, restricting root establishment and reducing plant vigour. The continual bank fritter and slumping opens up gaps and weakens the whole vegetation buffer along the banks. Repairs are required more often, and there is greater exposure and hence potential for erosion attack.

5.18 Because of the difficulties with vegetation management, there has been a major change in river bank protection measures since the earlier years of the River Scheme and over the operating period of the Matahina HEPS, from vegetation to rock works. These works are also affected by the hydro operations, requiring more frequent topping up or extension.

Proposed Operating Regime

5.19 I am not clear exactly what TPL is proposing and how different it is from recent HEPS operation. I have made a distinction between a 'current' longer term operation and a 'proposed' when considering proportional effects for a TPL contribution. Again I will

explain this further later on. The most useful information in terms of river effects is, though, the hydraulic modelling output plots of Appendix D of the Beca Report.

5.20 The reasoning behind this change in operation is not clear from the Beca Report, or the evidence of TPL I have read, but presumably is proposed to increase the ability of the hydro operator to match power demand and supply peak loads.

5.21 Referring back to the aspects of hydro operations that affect river processes, the proposed operation is worse in all aspects concerning flow modification. That is:

(a) An increase in the number of flow oscillations or peaks in a given period;

(b) An increase in the range of those oscillations between minimum and maximum operating flows under normal (non flood) conditions;

(c) An increase in the rate of rise and fall of the oscillations or ramping rates.

5.22 The proposed changes for the Matahina Dam continue a trend of increasing variation and more adverse effects on the river downstream.

Recommended Operating Regime

5.23 Given the impacts of the current and proposed operating regimes, with their constant flow fluctuations over substantial heights and the destabilisation and aggravation of the river channel and banks this causes, my recommendation is for a return to the earlier operation of the Matahina HEPS. My preference would be for a completely run-of-the-river operation, as was the case over much of the first decade and a half (from 1967 to the early 1980s).

5.24 The dam does have some storage capacity to allow daily peaking to follow demand, and I accept it is reasonable to use this capacity. I note, though, that a daily peaking operation will have adverse effects on the river downstream, and there has been no adequate recompense from the Dam operators for these adverse effects.

5.25 Given a daily peaking, the closest it can be to run-of-the-river with natural flow recessions, the better. Retaining a longer and hence slower recession, with no significant flow variation reduces the drawdown losses from the river banks, of both shallow bank collapses and removal of fine materials off the bank.

5.26 A suggested operation is, then, for the up and down ramping rates to be no more than the present consent, and no imposed flow fluctuations below 40 m3/s, that is the outflow equals the inflow when the inflows are at or below 40 m3/s. When inflows are above 40 m3/s then outflows still remain above 40 m3/s. Then to keep the single peak outflow as close as possible to the inflow, the range (or amplitude) of the daily peak would be no greater than twice the average inflow over the previous 24 hours. Then, the higher the inflow, the greater the flow variation of the peaking, which is in relationship to the magnitude of inflows or the size of the inflow hydrograph. Once normal outflow capacity is exceeded the Matahina HEPS would be operated in terms of flood management.

6. BECA ASSESSMENT

General

6.1 The Beca Report outlines investigations undertaken on the flood hydrology of the Rangitaiki River and the hydrology-related effects of the Matahina HEPS. It reviews the July 2004 flood event and includes an assessment of the causes of bank erosion in the Rangitaiki River downstream of the Matahina HEPS. There is an attached report on riverbank stability, which includes some groundwater and slope stability modelling. The proposed changes in the power station operating regime are outlined, and comparisons made with the current operating regime.

6.2 An addition to the first report (dated November 2008) was some hydraulic modelling. The Appendix D of the later report (dated May 2009 and part of the application AEE) about this modelling includes some analysis of saline intrusion. Water level plots are provided of an 'historical' flow regime and for the proposed regime, at a number of sites along the river, and for dam outflow hydrographs up to a number of peak magnitudes. There is also a brief description of these plots. However, there is no engineering assessment or interpretation of this modelling, and what the differences in flow regime down the river means.

6.3 The report concludes: "the river morphology effects of the current operation of the Matahina HEPS are minor and can be mitigated." There is considered to be some impact from the daily fluctuations in flow of the hydro-power operation, which is "contributing to some extent to the erosion that occurs downstream, principally due to the effects on riparian vegetation." A mitigation of this effect is proposed through a continuing contribution by TLP to river protection costs.

6.4 The Beca Report provides data and background information on lake levels, operational peaking, floods and bank erosion studies. The 'Discussion on bank erosion' of section 7.3 of their report is very brief and cursory, and is not a substantive engineering assessment and interpretation of bank erosion causes and potential failures with and without the Matahina Dam operation.

6.5 Apart from sediment deficit effects downstream of the dam, from reservoir trapping of sediments, they only consider at site changes in flow velocity and bank groundwater drawdown effects (two bank sites being analysed). There is no consideration of the dynamics of river systems and their processes, including channel migration and sediment transport, of cumulative effects or of the importance of pre-conditions for channel and erosion activity during flood events. They do accept some effect on riparian vegetation from water level fluctuations of the hydro-power peaking – as noted in their conclusions.

6.6 There is no consideration of inflows to groundwater and effects on piping and heave failure at or beyond the stopbanks.

6.7 The proposed operating regime is described thereafter (section 8 of the report). The only comment about effects on the river system and flooding or erosion hazards is a brief comment on (at site) bank stability (8.6.6 of the report), which again refers to the seepage and stability analysis of two bank sites. It is notable that at both sites the indicative stability analyses give safety factors of only 1.0 to 1.1 under low flow conditions. A safety factor of 1.0 means about to collapse, that is, no safety margin.

6.8 I do not accept the conclusions of the Beca Report about bank stability, and it is largely silent about all other aspects of river management and hazard mitigation. I do not consider it adequately covers the downstream effects of the hydro-power operation on the river system and river management to mitigate flooding and erosion hazards.

Geotechnical Investigations

6.9 The geotechnical investigations they undertook have been more fully explained in the TPL evidence of Do Van Toan. I refer to Marianne O'Halloran's evidence in respect to these investigations and her own investigations along the lower Rangitaiki River. I would just note that they are informative of the sensitivity of the river to bank failures and piping development and heave failure at or beyond the stopbanks. The

very low safety factors of the slope stability calculations over the full range of flows, including the hydro operation flows, indicates a high vulnerability to bank collapses. The main influence on bank stability was, in fact, the materials present and their layering and hence permeability differences.

6.10 There is an acceptance by Beca that the hydro fluctuation affects the growth of vegetation on the bank, above normal low flow levels, over the height of the fluctuations. They do not, though, seem to accept that the deposition of silts and fine material on the banks (and in bank vegetation) is also affected, within the fluctuation zone or below it. This fine material cover is important in sealing river channels – bed, banks and berms – and directly influences the interchange of water between the river and its floodplain.

Bank Erosion

6.11 The bank stability analyses of the Beca report consider localised bank collapse potentials, and the likelihood of bank slipping and slumping under drawn down conditions during flow recessions. They do not consider pre-condition impacts, or the on going aggravation that can be caused by lower level high frequency variations in flow, such as that of the hydro-power scheme.

6.12 The Beca Report does not deal with the highest risk failure modes arising from natural channel migration, and its associated erosion of river banks. It does not discuss the dynamic nature of rivers and river processes. The analyses undertaken are not set within a wider context of the complex variations in river conditions that occur over time, and which affect channel migration and erosion and deposition processes.

7. CONTRIBUTION ASSESSMENT

1998 Agreement

7.1 The financial contribution of TPL to the Scheme is very minor. There is a memorandum of BOPRC dated February 1998 that outlines the basis for a contribution, with values being provided for a maintenance contribution, but with contributions to capital works left open. This memorandum is attached to the evidence of Ken Tarboton.

7.2 The 1998 memorandum considered a contribution as a proportion of the annual maintenance costs for works along the reach from the Matahina Dam to Edgecumbe. The proportion was based on the amount of buffer vegetation along the river put under greater stress by the hydro level fluctuations. Capital works expenditure was also considered, but was not included in the agreement on contributions.

7.3 The maintenance contribution was based on percentages, with 10 and 20% being used for the two reaches from Edgecumbe to TeTeko and Te Teko to the Dam. This assessment is no longer relevant, given the changes in the river and river management, and the damage caused by more recent large floods, which have necessitated a change in management approach.

7.4 This study was prior to the flood event of 1998, and maintenance expenditure at that time was relatively low, given a quiescent period for floods. Since then there has been a period of greater flood intensity, including the large flood event of 2004, and the more recent floods of 2010 and 2011. Both maintenance costs and capital expenditure is now much higher.

7.5 The impact of the Matahina HEPS will be different in periods of flood intensity, compared to quiescent periods, while river management programmes and costs will also be different.

Hydro-power Scheme Contributions

7.6 The matter of contributions to river management by hydro-power operators arise on other rivers in New Zealand, and there are other dams on the lower reaches of rivers with similar hydro generation effects. The Roxburgh Dam on the Clutha River, the lower Waitaki Dam on the Waitaki River and the Karapiro Dam on the Waikato River, have similar sediment trapping and flow modification effects as the Matahina Dam on the Rangitaiki River. They are all the lowest dam on the river, with high flow fluctuations for power generation purposes.

7.7 There have been many investigations and long debates about sediment transport and flow modification effects on these rivers. I have undertook reviews and studies on the river effects of the Roxburgh Dam on the lower Clutha River and the Waitaki Dam on the lower Waitaki River. As part of my investigations for EHG on the Matahina re-consenting application, I undertook inquiries and studied reports for re-consenting of dams on the Waikato, Waitaki and Clutha rivers

7.8 There have been different types of agreement on contributions to river management on these rivers. On the Clutha River the hydro operator has paid for works at the river mouth and along the river, and an investigation of sediment and erosion processes downstream of Roxburgh, jointly funded by the hydro and river management authorities, is part of the re-consenting conditions.

7.9 For the Waitaki River, the hydro-power authority has made substantial contributions to river management along the lower reaches over a long period of time. This contribution is being revised as part of the consenting of the North Bank Tunnel project, with the hydro-power authority taking responsibility for the management of the river.

7.10 For the Waikato River, the hydro-power authority does make funding contributions to river management through rates, which covers a number of hydro-generation dams and control structures. However, there are no direct contributions relating to the effects of the operation of the lowest dam at Karapiro. There has been no general agreement on the effects of the Karapiro Dam operation on the river channel and river processes downstream.

7.11 The magnitude of the impacts of the Matahina HEPS on river processes is at about the same level as for theses other three rivers, although the sensitivity of the river systems to hydro flow modification differs, and for different reasons. The lower Waitaki River was sensitive to the hydro modifications because of the wide braided nature of the river and the rapid spread of introduced vegetation in this river, while there were difficulties in funding the required river management. The lower Rangitaiki River is sensitive to the hydro modifications for different reasons. In this case, it is the vulnerability of the river scheme to piping failures and the closeness of the stopbanks and major assets to eroding river banks.

Contribution Principles

7.12 My assessment of a TPL contribution to the river Scheme is based on a long term operation of the Matahina HEPS, and reflects the impacts and effects of this operation on the river and the management Scheme. The operational regime has varied, but we have historical knowledge of the hydro-power operation and of river behaviour and Scheme management responses over time. I have taken the 'current' regime to be an average over the longer term from the start of operation up to 2006, as per the consent

conditions. That is, prior to the 'rough running' informal agreement, and operation from 2007.

7.13 The impacts of the Matahina HEPS operation on the river downstream, and in particular on river management can not be determined from quantitative analyses. Instead a qualitative judgement must be made based on the nature of river processes and the likely effects of the hydro-power scheme operation on these processes.

7.14 In determining likely effects, an assessment of all potential instabilities and failure modes should be undertaken, given the dynamic character of river processes and the specific nature of the affected river. The river management scheme on the lower Rangitaiki River is unusually vulnerable, and sensitive to losses of soil and vegetative cover from the river banks. Large floods have exposed banks and given rise to channel distortions, which can now be further aggravated by low level flow fluctuations. Expensive repairs and additional works have been undertaken since the 2004 events, including rock lining of river banks and geotechnical stabilisation measures. The higher standard of protection given by these works will, though, reduce the impacts of the hydro-power flow fluctuation, and hence the adverse effects.

7.15 The different types of failures that can occur along the lower Rangitaiki River can be affected by the hydro operation through their effects on the river system and management options, in particular affecting the pre-condition at the time of flood events, as well as vegetation and soil cover on the river banks. The TPL contribution should then apply to all the river management costs of mitigating failures along the lower Rangitaiki River, including flood damage repairs and additional capital costs. The capital costs of rock lining banks and stabilising and de-watering the river berm land will both reduce the failure potential and the adverse effects of the hydro operation. There will be on-going maintenance costs associated with these works, but the overall costs of the river management programme in the longer term should be reduced by the works, which would reduce any percentage contribution from TPL.

7.16 While a TPL contribution could be determined from present river management costs, of maintenance and programmed capital expenditure, actual costs will depend on the pattern of future floods and the effective degree of protection gained from the measures in place along the river. Any fixed contribution should then be subject to

review, if river conditions and actual management expenditure significantly changes (for better or worse).

Contribution Assessment

7.17 I have undertaken a reassessment of this contribution based on effects, and what would be a reasonable proportion for TPL to pay in lieu of mitigation. This recognises that the hydro-power operation can not mitigate the adverse effects. They can only be avoided by the Matahina HEPS operating completely on a run-of-the-river basis, with no reservoir storage for daily generation peaking.

7.18 I have reviewed the basis of the present contribution, and I have reassessed funding proportions. This assessment splits up the Scheme costs into a number of categories, and applies different percentages to these cost categories. The categories and percentages are given in the table of Attachment D, where the three reaches are considered separately. The first set is based on the percentages of the earlier assessment, but spread over the cost categories to include all relevant costs. The second set is my reassessment for the 'current' operating regime, and the third set is for the proposed regime (as I understand it).

7.19 My understanding of the proposed regime is based on the information contained in the Beca Report for the AEE, and the evidence provided by TPL as applicant. As I Have said, I remain unclear exactly how they intend to operate the HEPS under their proposed regime. The most useful information is, though, the plots contained in Appendix D of the Beca Report, which were derived from the hydraulic modelling that Beca has carried out. I refer you to those plots now.

7.20 I would point out the substantial difference between the two regimes, as shown by these plots. The lower flow hydrograph plots (for an average flow of 29 m3/s) takes account of the 'rough running' adjustment to the consent. There is still, however, significant differences from a river perspective.

7.21 I would note that river management involves continual and on-going works and expenditure, and what are called capital works are generally just larger repair or protective measures that are funded over time through loans. Annual maintenance, flood repairs and larger remedial measures following major flood events are all part of the one river management regime.

7.22 No account has been taken of any impacts from changes in the global climate, on either the hydro-power operation or river management. It is, though, likely to have substantial impacts on both over time.

7.23 Referring to the table, I will go through my figures for the 'current' conditions, for the different cost categories. There are three reaches, as has been described by others, and for each reach a different percentage has been used. The cost categories are:

(a) Annual maintenance: This covers planned maintenance works, which are carried out to an agreed programme over the year.

(b) Flood repairs: This covers repairs arising from the more frequent flood events, where the quantum of works can be reasonably estimated from the past by experience.

(c) Major flood repairs: This covers repair or remedial works to re-instate or protect banks and assets following major floods, which are hard to estimate or predict in advance.

(d) Geotechnical repairs: This is a subset of flood repairs, which specifically relate to heave and piping problems that threaten the integrity of stopbanks or other flood defence measures. These repairs do, though, include river bank works, which have mainly been rock linings.

(e) Capital Improvements: This includes works or measures to re-construct, upgrade or otherwise improve the integrity or capacity of the flood mitigation scheme. These measures may be quite different in objective and function.

(f) Scheme management: This is a scheme overhead, which includes, supervision, management and administrative costs.

7.24 The percentages from my assessment, for the operation of the dam as it has mostly been run since its start up, are then the central set of the table. The annual maintenance and flood repairs have percentages of 5, 20 and 30 respectively for reaches 1 (mouth to Edgecumbe), 2 (Edgecumbe to Te Teko) and 3 (Te Teko to Dam). The percentage for reach 1 is half that of reach 2 on the basis that about half of this reach is adversely affected, before tidal influences and the tidal character of the river predominates over hydro fluctuations, and under the 'current' operating regime there

is less effect along this reach. There is a similar proportioning for the other cost categories.

7.25 For the proposed operating regime, including the lower flow, a greater range of peaking, more rapid rise and fall and more peaking oscillation, I have increase the proportion attributable to TPL. The greater effect along reach 1 has then meant a higher relative proportion, but still less than the other two reaches.

7.26 For this hearing I have not included any costs for capital improvements, and the percentages are nominal, as it depends on the nature of the measures. The total annual contribution as I have determined it is therefore exclusive of these costs. I would note that the floodway improvements and controlled spill to the floodway that are proposed can be beneficial in reducing the flood consequences of the hydro operation effects, by reducing pressures in the main channel and hence lowering failure risks.

7.27 The costs in the Table have been based on past expenditure on the lower Rangitaiki River, below the Dam (I refer to Bruce Crabbe's evidence). I have used these costs to determine an average annual expenditure that would occur over the longer term for the cost categories, for the three lower reaches, to give indicative figures.

7.28 The annual average expenditure, including all scheme costs is around $900,000, in present day dollars. Using the approach of the 1998 memorandum, applied to all the scheme costs, the annual contribution would be around $75,000. My assessment for the 'current' consented operating regime of the longer term operation from 1967 to 2007 would be something less than $150,000. For the proposed regime including the greater range of flow fluctuation, greater ramping rates and more peaking, my adjusted assessment would give about $200,000.

7.29 These figures are derived from past expenditure. The percentages would be applied to actual future expenditure, which will depend on the amount of flood damage.

7.30 In determining this proportionality and hence a financial contribution in lieu of mitigation, I would stress that the actual impacts, including both beneficial and adverse effects, can not be quantified. River systems are much too complex and dynamic, and our analysis tools are very simplistic for such systems. A fair and reasonable contribution must be based on a qualitative judgement, but one informed

by an understanding of river processes and the full range of potential effects of hydro operations within this environment.

7.31 This contribution assessment is given to indicate my assessment of proportionality, and the inadequacy of the offered contribution of TPL. It is acknowledged that the offer can not to altered by this Hearing. As there is no way of mitigating the adverse effects, they must be avoided, and I am thus recommending that the operating regime be altered to be more like a run-of-the-river operation.

7.32 This contribution would be to actual Scheme costs, but there would, as well, be a greater residual risk of failures with a non run-of-the-river operation of the HEPS, and the proposed operating regime would increase this risk. An estimate of the economic impact of additional costs and increased risks of flood damage is given in Brent Wheeler's evidence.

8. MONITORING

8.1 If the proposed operating regime is approved, then I think a close monitoring programme should be set up, as part of the conditions of the consent. This monitoring and the following on reviewing should involve a formal inventory and data recording, so that an independent assessment can be made in the future by experienced people independently of the people doing the monitoring and recording.

8.2 I do not accept that the monitoring undertaken to date is of that form, or has been sufficiently recorded, for other people to make an informed assessment on an equal footing with the people collecting the data. I have found the monitoring reports to be not particularly helpful.

8.3 I would thus recommend that monitoring with a formal recording be set up, as I will outline, and that this be undertaken for at least two years under an operating regime like that prior to 2007 to provide a more satisfactory baseline.

8.4 This monitoring should also be integrated with the river system monitoring and asset management and recording of the River Scheme.

8.5 I also think that any review of operating trails or changes in operating regime should be undertaken by appropriately experienced people, working together as a team and independently of the interested parties. While the data will be collected by both BOPRC and TPL, using their own staff or consultants, the review team would collate

and analyse the data and determine for themselves the type of quantitative analyses that would be useful to make an interpretation.

8.6 The monitoring could consist of:

(a) A consistently structured set of river cross sections (for BOPRC and TPL monitoring) based on the character and meander pattern of the river, and adequate for hydraulic modelling of the river as well as indicating channel changes.

(b) An inventory of the erosion hazard along the river, which categorises channel form, channel curvature (or sinuosity), bed materials, bank height, slope and materials, bank and berm cover (vegetation), protection measures in place and type and proximity of assets alongside the river channel. This inventory would be defined in terms of cross section position and river profile distance.

(c) A photographic record of selected sites and eroded banks, located by position and with a log of bank height, slope and materials, with repeat photographs over time of the same bank locations. This photography would be taken at low flows (around 40 m3/s at the Te Teko recorder) and to provide comparable photographs over time.

(d) A number of groundwater monitoring wells at selected sites along the river, with continuous recording of water levels in the wells over periods that cover very low flow and flood periods. These records would be correlated with measurements of water levels in the river adjacent to the monitoring wells. These wells would be located and have a drilling log of materials and soil strength (penetrometer readings).

8.7 I have undertaken this type of erosion hazard inventorying of rivers, based around permanent cross sections as location indicators, for a number of rivers around New Zealand.

9. RESPONSES

9.1 I will now respond to the evidences presented on behalf of TPL that relate to river behaviour, river management issues, failure modes and the effects of the Matahina HEPS. That is the evidence of Graham Levy, Do Van Toan and Don Tate. I will also comment on the report of John Philpott to the Consents Team.

9.2 I would, first, note that some of this evidence relates to effects that are not relevant to this hearing. The matter of a contribution in lieu of mitigation is relevant only in so far as the contribution offered is meaningful and adequate in terms of funds for protection and other measures that would assist in mitigating the adverse effects of the HEPS on river management and the river Scheme.

9.3 My starting point is that both the dam and the flood mitigation stopbanks are existing assets, and are therefore part of the existing environment with respect to this hearing. The matters at issue are the on-going effects of the dam and its operating regime on the one hand, and the operational approach of the river Scheme and the measures required and their costs on the other.

Graham Levy

9.4 The evidence of Graham Levy covers background information on the hydrology of the Rangitaiki River, the Matahina Dam operations and proposed modified operating regime, water levels downstream of the dam and an assessment of contribution to the River Scheme, among other matters. He specialises in water resources, and his hydrology and hydraulic experience includes hydro-electric power schemes. I acknowledge his experience of the Rangitaiki River through the investigations and monitoring he has undertaken or lead for TPL, as he summarises in his paragraph 191. (I will refer to his paragraphs by their number)

9.5 I will respond mostly to his assessment of a contribution to the River Scheme, as he defers to Dr Toan on bank erosion and stability issues [64, and 158 – 160]. I will respond about these issues when I consider Do Van Toan's evidence next.

9.6 I have relied on his evidence, and the Beca Report of the AEE to understand the operating regime of the HEPS and how it has changed over time. Information on the earlier operation of HEPS is also given in the Works Consultancy report of 1988 on "River Bank Stability along the Rangitaiki River". He references this report in this Beca Report.

9.7 Graham Levy has earlier responded to my memoranda (attached to the EHG submission and to this evidence), and he does attach his memorandum of 17 August 2009. This is more about clarification, but I will briefly respond to this memorandum, as it is attached. I would note, though, that he otherwise makes no comment on my

memoranda, and thus does not make any response to my explanations of river processes and behaviour or my assessments about the effects of the hydro operation.

9.8 In understanding the differences between his contribution assessment and mine, I would reiterate that I have based my assessment on an overall long term operation of the Matahina Dam, as run-of-river, single peaking and more recently double peaking. This provides the time span to make a general assessment.

9.9 What I consider the 'current' conditions, from a river viewpoint, excludes, then, the low flow peaking of the 'rough running' operation since 2007. There was no adjustment to the TPL contribution when this change was agreed to, and my understanding is that no consideration was given to an increase in the contribution to the River Scheme at that time.

9.10 What is relevant is that in the first significant floods after this more aggressive regime, of August 2010 and January 2011, there was an unusual amount of flood damage and erosion along the lower Rangitaiki River. I referred to this in my review report of the flood damage and proposed remedial measures following this event.

9.11 A fundamental difference relates to the significance of pre-conditions for flood activity and erosion, and the manner in which river management is undertaken. I agree that the large erosion embayments and significant channel migration takes place in flood events, and this is the obvious visible changes. The important question when considering the effects of the hydro flow modification is how much channel change and erosion, to what degree, and why.

9.12 I will now comment on his paragraphs directly.

9.13 [66] The sinuosity of a river depends on its character and influencing forces, and more sinuous rivers do not necessarily have greater natural bank erosion. The areas of erosion are generally more well-defined with greater channel curvature. The erosion sites/km, of the table in paragraph 80, do not correlate with sinuosity.

9.14 [68] I have commented on the memorandum of BOPRC concerning the 1998 agreement.

9.15 [69] The main cost reason for an increase in the contribution (on his determination) was the much greater actual costs of the River Scheme, not improved accounting.

9.16 [71] I do not accept that the monitoring and interpretations of Beca demonstrates that "the twin peak operating regime would be no greater than the single peak operation." It is one engineering opinion.

9.17 [72 - 74] The only report I have seen on the twin peaking trial is a 2004 report, where comment on the trial was incorporated into a 2 year monitoring summary report. The report itself is very brief and contains only summary comments. There is a list of sites with one-line comments, mostly saying "little change since last inspection". What was looked for and what was seen is not described. There also a series of photographs and some cross section plots of repeat surveys. Many of the photographs show banks very similar to what can be seen along the river now, and like those of my Attachment E. There is no comment referring to what is happening in the hydro fluctuation zone.

9.18 [83 - 87] I understand these comments as a summary of the latest biennial monitoring of the 2010 Beca report. I note the report is dated August 2010, thus I take it that the field inspections were prior to the significant flood event of that month. This report contains further repeat cross section plots and photographs and a similar list of sites with a very brief comment. What is of note from these comments, is the number of sites with frittering, fresh slips and slumping or new erosion. Many sites have also had repair or rock works, and only because of this are stable. The list indicates on going erosion problems with repair works being continually required. As I have mentioned before, it is the gaps and downstream extensions off protection works that are the problems, and it is this that the hydro operation aggravates.

9.19 [125] It is the magnitude, rate and frequency of the hydro peaks that affects the river. A greater range (maximum and minimum flows or levels), greater speed of rise and fall and greater frequency of the peaks are all adverse factors. I repeat it is acceleration/deceleration and the secondary current generation that is of significance, not velocities or mean flows.

9.20 [129] Similarly about this paragraph, and I note my concern about the 2007 relaxation of consent restrictions.

9.21 [159-161] I understand these paragraphs to be the basis of his determination of a TPL contribution to the River Scheme.

9.22 [163] Bank erosion from channel migration gives rise to the highest risk of stopbank breaching (not considering overtopping). I note below that I agree with Don Tate about this.

9.23 [175] I have proposed monitoring conditions, which extend those proposed by TPL.

9.24 [190] This refers to his memorandum of 17 August 2009 [Attachment 12]. I will now briefly comment on it.

9.25 The memorandum provided some information on river morphology and climatic variations, following on from my memoranda, which was helpful. In his section 5.2, my comments apply to all rivers, not just gravel-bed rivers. In 5.3 there is a terminology matter about piping and heave that provides clarification. I do not agree with the description of the 2004 failure given here, and I refer you to Marianne O'Halloran's evidence. I also do not agree with his comments about silt deposition and removal.

9.26 [221] This refers to his contribution memorandum of 25 June 2011 [Attachment 13]. I will now comment of it.

9.27 I agree that a contribution to the stopbank costs should not be included, if this refers to the construction or re-building of the stopbanks themselves. It is measures to protect the stopbanks from breach failures that is relevant. I have commented on floodway improvements in my evidence above.

9.28 I have already responded to the erosion assessment, and that the issue is the **amount** of erosion that occurs in flood events, and what proportion can fairly be attributed to pre-conditions and localised erosion that come from the hydro operation effects.

9.29 I note that he says he will set the contribution to flood damage repairs lower than for annual maintenance works, but in this spreadsheet calculation uses the same percentage. I do not follow his relevance percentages.

9.30 The bank vegetation table does show interesting variations. What type of vegetation exists at sites or along the river is not indicated. Clearly the type, density and vigour of the vegetation is relevant, not just that there is vegetation.

Do Van Toan

9.31 The evidence of Do Van Toan covers background information on the Rangitaiki River and its catchment, river bed and bank erosion processes and associated ground seepage, piping and heave processes alongside rivers, with particular examples on the Rangitaiki River. Much of the geotechnical analyses presented in his evidence is an elaboration of the investigations summarised in Appendix B of the Beca report of the AEE.

9.32 The evidence of Marianne O'Halloran responds to the geotechnical investigations themselves. I will respond to his interpretations in terms of river processes, failure potentials and hence implications for river management.

9.33 He comments at some length on river processes. However, his terminology and approach is not that of river management professionals in New Zealand, and he makes statements that show a lack of understanding of river environments and river dynamics.

9.34 I note his field is geotechnical engineering, with experience in "foundation engineering, heavy duty pavements, land stability, earthquake engineering, retaining walls, deep basements, marine engineering and tunnelling", as stated in his profile on the Beca website. His relevant projects (of 1.3) are not relevant to the river processes and management issues on the Rangitaiki River. The only river erosion work mentioned is for the Patea Hydro Dam. Geotechnical investigations and works for dams, and their protection from river attack are very different to those for rivers and flood mitigation schemes, which cover very long lengths and require a continual, flexible and responsive approach.

9.35 He provides no evidence about the river processes he talks about, even in a qualitative way. I accept that river management is as much an art as a science, and is very much an experience-based field of engineering. Different opinions can be expressed, and are, but they must be based on a body of knowledge gained from the practice of river engineering, and on comparative studies and experience that provides the basis for an engineering opinion.

9.36 In general, his evidence is focused on what happens at specific flows in the river, and on flow velocities and site seepage rates, whereas what is important is the interconnections of dynamic river systems. As I have stated above, it is acceleration and deceleration that is the driving force of erosion and deposition processes in rivers, not

average velocities. Sediment movement, as bed material, is very episodic, and mostly takes place on the rise and fall of hydrographs, and not during peak flows. It is oscillations in flow that is significant, with movement being associated with secondary currents of eddies and turbulence, not primary forward movement.

9.37 He also makes no distinction between the silt of suspended load and the movement of coarser bed material. These are very different processes, with the movement and deposition of suspended silts being quite different to the pulsating step-like movement of gravel bed material.

9.38 At a number of places he makes the comment that silt deposits on the river bank would be removed during the rise of a flood hydrograph, leaving banks with their soil layers exposed as a raw bank. Is he saying that all banks through a river system become raw exposed banks in flood events? This is clearly nonsense. Seepage to or from river channels and their floodplain can take place all along the river channel, and normally only a relatively small length of bank would be in an actively re-worked and exposed state.

9.39 Silts and other finer material (including sands) that are carried in suspension are deposited throughout the river channel, including some deposition in the active channel area of gravel-bed rivers. The spread and depth of finer materials and the nature and type of vegetation that grows in the channel, partly in response to the silt deposition, has a significant effect on the behaviour and condition of rivers. Rivers are intensively utilised by living organisms, especially those adapted to its highly variable and cyclical nature. They are as much formed by biological processes as physical ones, with the influence of plants being most readily apparent.

9.40 His geotechnical analyses are simple models of reality, being based on a 2-dimensional section and assumed soil layers and characteristics from quite minimal soil data. Especially in river systems, these analyses are only indicative, and do not give definitive answers. Careful assessment of the results and interpretation with respect to the wider context of the river environment is essential, for meaningful use.

9.41 It has never been suggested that piping and heave failures would occur during the flows of the hydro peaking cycle. The analyses on these flows are not particularly relevant, and are only useful in showing the general instability and vulnerability of the river banks, and their sensitivity across a wide range of flows.

9.42 He does not describe the most significant process of erosion in a river that arises from the interactive processes of channel migration and sediment transport, where the channel moves through erosion and deposition. This is the most serious threat to the flood defence stopbanks.

9.43 I will now comment on his paragraphs directly, giving his paragraph numbers.

9.44 [2.4 & 2.5] I think there is some confusion of levels, may be between Moturiki datum and the harbour datum. If 0.0 m is mid-tide, then the lowest lying land is lower than +0.5 m.

9.45 [2.7 & other paragraphs] The coarser material of fine gravels found in the ground come from old river channels and overflow areas where the bed material of the river has been deposited. These gravel materials in the river bed (and not on the banks) are not an 'armour' cover protecting underlying finer materials. They are the bed material load that is activated in flood events – generally from a 2 year event magnitude, as he says. Underlying materials may be entrained by local scour processes around channel variations and obstructions. What is conventionally referred to as the armour layer, is a heavier layer of gravel material on the surface of the bed material. This bed material is not a 'protection' layer, but the material moved by rivers in expending their energy (from the down-slope flow).

9.46 [2.9 & other paragraphs] It is the secondary currents of the flood flows that activate erosion and deposition of bed and bank materials. Banks can be undermined by channel migration processes, and then bank slumping is more likely to occur. As I have stated above, there is a cyclical process of deposition on banks, especially well-vegetated banks with tree vegetation, and then collapses.

9.47 [2.10 & other paragraphs] Alluvial deposits are seldom near horizontal, on the contrary they are generally on a slope both out from the river channel and in a downstream direction. Natural levee deposits alongside main river channels are generally formed as lenses, with an inter-layering of fine (less permeable) and coarser (more permeable) materials. It is the concentration of seepage flows in a permeable layer by less permeable layers at the edges of these natural levees that is most problematic from a heave and piping perspective.

9.48 [3.5] The existing stopbanks are generally as stopbanks are now constructed. A cut-off under the stopbank is a very useful measure, which I have used, but is not possible along the lower Rangitaiki River because of the depth of permeable layers and their long paths to their exit areas away from the stopbank. Both river side and landward side layering for extra sealing or weight was used in the Scheme, and is being used in the geotechnical works following the 2004 floods. More intensive measures, such as deep piling, grouting etc are not appropriate to the very long lengths of stopbanks, and would be cost prohibitive.

9.49 [4.2 onward] By vertical erosion I take him to mean reach aggradation and degradation trends through both erosion and deposition within the active channel. These changes do not relate to mean annual flood flows or mean velocities, and in 4.6 he does not say where the velocities are. 4.8 is simply not correct and seems to confuse bed material movement and suspended load. On 4.9, I agree that bed material movement will be generally above the hydro flow oscillation range, if this is his point, but this is not relevant to the siltation or slumping effects of the hydro operation.

9.50 [4.14] Containment and protection measures can increase the potential for degradation, as does a lack of supply of bed material from upstream. The river cross sections do indicate that there has not been much degradation, but there is a trend of worsening asymmetry (with deeper scour holes and relatively higher inner beaches) in some cross sections.

9.51 [4.17 onwards] I agree with his descriptions of 'lateral erosion', which arises from channel migration (4.18 first bullet) and bank collapses (second bullet point). As I have stated, I also agree that rock lining of the banks is very helpful in mitigation the effects of the hydro fluctuations, as well as flood hydrograph flows. I disagree that inside beach deposits are not important, as this deposition occurs in conjunction with outer bank erosion, and puts pressure on the outer bank through the movement of the channel as a whole. I have already commented on 4.23 and the assumed removal of silt on the banks.

9.52 [Section 5] The issue is not that piping or heave failure will occur at hydro fluctuation flows. There is no disagreement about this. I would note that the back analysis of Beca assumed silt cover of the permeable sands [5.6]. This was not stated in section

7.2 of the geotechnical report (Appendix B) of the Beca Report for the AEE. Given his comments about the removal of silt in flood events this seems contradictory.

9.53 [5.12 & 5.13] High exist gradients would give rise to a slow fritter and slumping loss, and hence more vulnerable banks in terms of erosion and seepage inflows. There does not have to be a complete and highly observable slumping and retreat towards the stopbanks for this effect to be present.

9.54 [Section 6 to 6.13] Similarly to Section 5, instability will, of course, be greater in flood events, especially events where there are hydrograph oscillations on the recession, or floods in quick succession. The point is the instability of the banks under all conditions, and hence their vulnerability to the low amplitude high frequency oscillations of the hydro operation. He does accept some slumping from the cyclic operation [6.9].

9.55 [6.14 onwards] The soil profiles in the model of Sullivan breach are very simple, with no cover of finer material anywhere within the channel, on the berm, bank or bed. The section attached to Graham Levy's evidence at least has more soil layers, although they are all shown as horizontal, and the lower land levels away from the river are not shown. The 2004 floods and all the work done since on remedial measures for ground heave and piping failures demonstrates the sensitivity of the river, and the importance of silt and vegetation cover along the river.

9.56 [Section 8] My memoranda, which were attached to the submission of EHG, and are attached to this evidence, summarise the concerns and issues raised by the hydro operation. They are qualitative but are backed by many investigations as well as experience. Any assessment of effect and proportionality will inevitably be qualitative, and in the end any contribution as mitigation can only be determined by agreement between the parties.

9.57 [8.4] The stopbanks are very close to the active river channel, and are most vulnerable from channel migration erosion and deposition processes.

9.58 [8.4] The two site analyses indicate the general instability of the river banks, which is indicative of this river along its lower reaches.

9.59 [8.5 - 8.7] The marginal stability at hydro fluctuation levels show that the river banks are vulnerability to bank collapses, silt and vegetation cover are important, and river

management is all about pre-conditions. The extent and depth of silt deposits and the type, vigour and density of vegetation on the berms and banks is very important. It is not just that there is some sort of vegetation cover. Nature will always attempt to cover bare ground, and only the most active sites remain bare over time. Small gaps and weaknesses in the vegetation, or in rock works, are critical, and large erosion losses often develop from very small and minor openings of weaknesses.

9.60 [8.8] I am not sure what statement of mine he refers to, but the depth and extent of deposits is important for vegetation establishment and vigour, as noted above.

9.61 [8.9 & 8.10] This refers to the existing environment of the dam and the stopbanks.

9.62 [8.11] I have covered this above. It is not about some simple threshold of motion, which then applies everywhere along the river.

9.63 [8.12 onwards] I repeat, it is not about failures at the hydro flow levels, but about some effect on failures from a continuous aggravation at low to moderate flows. I would note that there has been much damage along the Rangitaiki River in the January floods, despite the works in place and the remedial measures post the 2004 events.

9.64 [8.17] This evidence explains the river processes and the reasons for adverse effects from the hydro operation, which can only be done qualitatively. The seepage and stability analyses at 2 or 3 sites is only a small piece in the jigsaw of river behaviour and hence the issues for river management. I would note that there is no discussion at all of river management and the issues that arise in selecting and placing protection works and other mitigation measures.

Don Tate

9.65 I am aware of Don Tate's work in the Manawatu, and I have reviewed and made use of his investigations on stopbank condition, failure potential and river bank stability. I am also aware of his review of stopbank failures in the 2004 events in the Manawatu, as I also undertook an assessment of stopbank failure. This was one of many investigations I undertook following the 2004 floods in the Wellington, Manawatu and Bay of Plenty regions for a range of clients from government departments to councils, companies and individuals.

9.66 His evidence is concise and gives a useful and fair description of stopbank design, performance and failure modes. I also agree with his emphasis, for instance in noting that undermining by river erosion is the most common breach failure, following overtopping in frequency of occurrence in New Zealand [3.3]. He also notes that the "soils in the Bay of Plenty commonly include **lenses** of permeable sands' (my emphasis) [3.4].

9.67 I agree with his comments on stopbank design and performance. There has been a greater realisation of the importance of stopbank foundation seepage and piping or heave failures in recent decades in NZ. However, it has been well recognised for a long time in NZ, and consideration was given to these potential failures in the Rangitaiki River Scheme, as demonstrated by the old BOP Catchment Commission plan, as attached to Graham Levy's evidence [end of Attachment 12], and I refer to Marianne O'Halloran's responses.

9.68 [6.2] I note that an increase in flood levels or flood duration is not the only way stopbank failure risk may increase. A greater variability in flood flows, and floods in quick succession would increase the risk of a breach failure. Similarly increasing flow variations at all stages, especially if continuous, will effect failure probabilities, especially through changes in the condition of the river system, as I have described in my evidence.

9.69 [6.5] I agree that it is a reasonable conservative assumption to exclude a silt cover when investigating seepage risks. The natural cover that is provided in a river is though important, and especially so on the Rangitaiki River.

9.70 [6.8] Problems from ground heave and piping can occur from soil layering and the presence of high permeability layers at all levels of the river channel. There is a complex layering of soils throughout the alluvial deposits of the Rangitaiki Plains. I agree that siltation is a natural phenomenon, but river management techniques, such as establishing vegetation, can be very useful in reducing risks.

9.71 [Section 7] I agree with this section, including that river erosion effects must be largely based on qualitative judgements, although quantitative assessments can be useful. I agree that rock lining is a good solution to the erosion risk and to the hydro fluctuations. I agree that it should be possible to come to an agreement on effects based on both quantitative analysis and sound qualitative judgement.

9.72 [Section 8] I agree that it is the percentage allocation that is most significant. I have commented on future improvements above.

John Philpott

9.73 The report of John Philpott was commissioned by the Consents Section of BOPRC to provide an independent opinion on the proposed changes to the operating regime, the effects on river erosion and Scheme assets downstream of the Matahina Dam, and an appropriate contribution from TPL. He specialises in the field of river and drainage engineering, has worked for the Manawatu-Wanganui Regional Council for 15 years, and has experience on rivers throughout New Zealand.

9.74 I will respond to his assessment of the effects of the Matahina Dam operation. Roger Burchett will respond about the level of contribution. I will again refer by paragraph number.

9.75 In general he accepts my memoranda, and comes to similar conclusions about the effects of the hydro operation and flow modifications. He uses the cost allocation model of EHG to determine an appropriate level of contribution [83], and does consider the overall percentage of 25% to TPL to be fair [89]. This is similar to my assessment when averaged out in a cost weighted manner. He excludes stopbanks, floodways and overflow weirs [82].

9.76 [95] He considers the originally offered contribution by TPL (of $15,000) to be grossly out of date. This has now been increased to about $50,000. He also considers that the Matahina HEPS should contribute to the costs of flood repairs following the 2004 events. I agree with him on both counts.

9.77 [69] I support his comments in this paragraph concerning the Beca geotechnical investigations. I would note though that what is the current operating regime in terms of determining long term effects is not easily pinned down.

10. CONCLUSIONS

10.1 The lower Rangitaiki River crosses an alluvial plain, in a narrow meandering channel, through loose volcanic materials with layers of very permeable sands and less permeable silts and fine materials. The river Scheme stopbanks are vulnerable to channel migration erosion, bank collapses and ground piping and heave failures. River management on this river is especially difficult because of the river conditions

and the close proximity of major assets, with the stopbanks on the natural levee beside the river channel.

10.2 The hydro fluctuations of the Matahina HEPS are particularly aggravating in this river environment, and cause localised bank slipping and slumping, develop gaps in vegetation buffers and at the end of rock linings, while flushing fines from the bank and from behind rock works, destabilising the rock. The continual daily oscillations of this flow give rise to continual flow variations, which generate the secondary currents and turbulence that cause erosion and material re-working in the river.

10.3 The hydro fluctuations also prevent the natural healing and regeneration of the normally long periods of flow recessions down to low flows, and make river management repairs and the re-establishment of vegetation more difficult.

10.4 The hydro fluctuations, thus, increase the likelihood of land loss and stopbank breaching by all the main processes of channel migration erosion, bank collapses and piping or heave failure. They make the river channel and bank pre-conditions before significant flood events worse, and thereby increase the amount of erosion and damage in the flood events.

10.5 The adverse effects of the Matahina HEPS on the river and the management Scheme are substantial, especially downstream of the Dam to Te Teko, but also from Te Teko to Edgecumbe, and to a lesser extent below Edgecumbe.

10.6 I have estimated a funding contribution that TPL could pay in lieu of mitigation of the adverse effects, as a qualitative assessment based on my knowledge and experience of river processes and river management. This contribution would be around 15% as an average for the current operating regime, taken as the long term operation prior to the informal agreement of 2007, and around 20% for the proposed operation of the consent application. Dollar values have been determined, for a set of cost categories, based on present Scheme expenditure, but any percentage contribution should be made in terms of actual costs as they occur.

10.7 In my opinion this is a reasonable contribution, and is probably on the light side, given the sensitivity of the lower river environment and the risks of land loss and stopbank failure. I am more concerned about these risks of failure than a contribution, as it is not practical to undertake the repairs necessary to fully

remediate the effects of the hydro operation in a timely and continuous manner. The aggravation is continual and on going, with constant bank slumping and failures and continual removal of silt cover from the banks.

10.8 My preference is for the hydro operation to revert to a run-of-the-river operation, as it was originally. If the useable or live reservoir storage is to be utilised to meet daily peak power demands, then there should be one peak only per day, with the ramping up and down rates being as for the existing consent. This will still give rise to substantial adverse effects along the lower river.

Gary Williams
G & E Williams Consultants Limited
June 2011

ATTACHMENT A

G & E WILLIAMS CONSULTANTS LTD - Fax/phone (06) 362 6684
R D 3, OTAKI

MEMORANDUM Date: 19 May 2009

To: Robbin Britton

Of: Environment Bay of Plenty

Copy: Bruce Crabbe

SUBJECT: **RANGTAIKI RIVER – MATAHINA CONSENT**

PAGES 1 + 8

Introduction

The resource consent for the Matahina HEPS on the Rangitaiki River expires in November 2009. The power station is now operated by TrustPower Limited [TPL], and a re-consent application is being lodged with Environment Bay of Plenty [EBOP].

As part of this application, an assessment has been undertaken by Beca Infrastructure Ltd [Beca] of the river hydrology, hydraulics and bank erosion effects of the scheme. In particular, they have investigated the effects of the dam and its operation on the river downstream.

The application proposes some significant changes in the operation of the power scheme, to enable a more effective and efficient use of the scheme for power generation, given the variations in power demand and power pricing. This includes more variation in power generation over a daily cycle, with no limit on the number of peaks each day, and increased ramping up and down of the generation flows.

A review of the Beca report has been undertaken for the Operations Group of EBOP, alongside an assessment of stability and erosion processes along the lower Rangitaiki River, and the potential impacts of flow modification by hydro-power schemes. A brief overview has also been carried out of power stations in New Zealand with similar generation variations, and inquiries made about present operations, relevant investigations and funding arrangements.

The impacts of sediment storage and daily flow fluctuations on the lower reaches of major rivers in NZ have been contentious issues for a long time, as they have throughout the world. Comparisons have been made in past investigations of the Roxburgh Dam on the Clutha River, the lower Waitaki Dam on the Waitaki River, the Karapiro Dam on the Waikato River, and the Matahina Dam on the Rangitaiki River.

River Management

The Rangitaiki River flows down the centre of the Rangitaiki Plains, past the townships of TeTeko and Edgecumbe, to an artificial mouth, cut through the coastal sand dunes in 1913. The plains have been built up by alluvial deposition of mixed source material from both greywacke and volcanic catchments. There are extensive peat layers, and a coastal dune frontage that is actively worked and affects the river mouths.

The river has a narrow but pronounced natural levee along its present course, and has naturally migrated across the plains, with old river channels flowing to both the Tarawera and Whakatane River mouths. The volcanic deposits on the plains include highly permeable layers, and there is a high level of interchange between river and ground waters. There are, thus, severe stability problems of ground heave and piping development during flood events, as well as bank erosion and channel migration.

Major flood and erosion mitigation works along the Rangitaiki River were undertaken as part of the Tarawera-Rangitaiki Rivers Scheme, with the original works mostly constructed between 1971 and 1980. Given the natural levee along the river banks, and the intensity of assets on these levees, the stopbanks were sited on this higher ground close to the river channel. Soon after, the Edgecumbe earthquake of 1987 significantly altered ground levels and affected the flood protection structures. Rehabilitation works included extensive stopbank and floodwall raising and reconstruction.

In July 1998 there was a long duration (multiple peak) medium-sized flood flow in the Rangitaiki River, with the peak flow of 465 m3/s having an estimated AEP of around 5 to 10%. This flood event highlighted weaknesses in the flood defenses, with serious bank erosion at bends threatening the river-side stopbanks, and high seepage flows under the stopbanks giving rise to ground heaving pressures on the landward side of the stopbanks. Following this flood event, seepage control works were installed along the stopbanks at Edgecumbe, and some stopbank crest raising was carried out, as well as rock works to protect the river banks from erosion.

The peak flood flow of the July 2004 event was around the design 1% AEP flow, of 780 m3/s. However, there was a breach of the stopbank before the peak, at about a flow of 650 m3/s. The breach occurred because seepage waters under the stopbank gave rise to ground heave beyond the stopbank, and a continual removal of fine materials (by ground piping) caused a back scouring to the stopbank, which collapsed into the scour hole. The breach in the stopbank opened up to be around 100 m wide, with the outflowing flood waters scouring a large hole about 5 m deep at the stopbank and extending about 150 m inland from the stopbank. A large proportion of the river flood flows escaped out this breach, and overflows occurred for several days before the breach was closed off.

The July 2004 event was the largest flood in the Rangitaiki River since the 1944 event, which was of about the same magnitude, and much larger than any other

flood flow since the scheme was constructed. The maximum flood levels were very close to the crest of the stopbanks, even with the large outflow from the breach, and high seepage flows and heave pressures were observed alongside the river. If the stopbank had not breached where it did, then a breach somewhere else would most probably have occurred.

Following the flood event, the cause of the breach was investigated, and a series of geotechnical investigations have been carried out along the Rangitaiki River stopbanks, with remedial measures being implemented as the investigations proceed.

Maintaining the Rangitaiki-Tarawera River Scheme assets, and the stopbanks high enough to contain the design flood flow, has been especially difficult. Soon after the initial scheme works were completed, the Edgecumbe earthquake occurred, and substantial rebuilding works were required. The 1998 flood event showed up weaknesses that required further protection and remedial works. Then the 2004 event has demonstrated that the scheme could not, in fact, pass the design flood flow.

This river scheme is then especially vulnerable, with stopbanks close to the river channel, which naturally migrates, and high seepage rates under the banks giving rise to ground heave and piping.

The present replacement cost value of this scheme is around $60 million. There are, though, expensive on-going repairs works following the 2004 floods, including bank protection and geotechnical stability measures, with around $13 million of capital works programmed over the next 10 years. The annual works maintenance costs is around $650,000, with flood reserves, insurance and project management costs raising this expenditure to over $1 million.

The floods of 1998 and 2004 highlight the pattern of flood events in the Bay of Plenty, with periods of high flood intensity and relatively quiescent periods. This pattern has been related to a climatic oscillation, derived from the cyclical movement of a wind convergence zone in the western Pacific Ocean, called the Inter-decadal Pacific Oscillation [IPO]. The full cycle takes approximately 60 years, with movement one way over 30 years, then back the other way to complete the cycle. A change-over in this movement, to a negative phase with reduced westerlies, took place in the mid-1940s, and back to a positive phase in the late 1970s. The floods of 1998 probably heralded a return to the negative phase, with more easterlies and more flood intensity in the Bay of Plenty.

The Matahina Dam was commissioned in 1967, near the end of a period of high floods, and from the early 1970s until 1998 there was relatively little high flood activity. The original Rangitaiki-Tarawera River Scheme works were also constructed over this quiescent period.

Further high flood activity is to be expected in the coming years, and any increase in rainfall intensities because of a changing world climate would add to this activity.

Beca Report

General

This report outlines the investigations undertaken on the flood hydrology of the Rangitaiki River and the hydrology-related effects of the Matahina HEPS. It reviews the July 2004 flood event and includes an assessment of the causes of bank erosion in the Rangitaiki River downstream of the Matahina HEPS. The proposed changes in the power station operating regime are outlined, and comparisons made with the current operating regime.

The report concludes that "the river morphology effects of the current operation of the Matahina HEPS are minor and can be mitigated." There is considered to be some impact from the daily fluctuations in flow of the hydro-scheme operation, which is "contributing to some extent to the erosion that occurs downstream, principally due to the effects on riparian vegetation." A mitigation of this effect is proposed through a continuing contribution by TLP to river protection costs.

Bank Erosion

The assessment of bank erosion has been carried out in terms of the stability of river banks under the flow conditions of the hydro-scheme ramping. The analyses supporting this assessment are outlined in an attached report on river bank stability, also prepared by Beca.

These analyses consider seepage into and out of the river bank over daily hydro flow cycles and for flood events, at two sites (one above and one below TeTeko), and determine bank stability factors of safety. The high soil permeabilities give rise to low outflow hydraulic gradients, with very little difference from low flows to high flood flows. At one site there would be very little drawdown effect on flow recessions (hydro peaking or floods), due to high permeabilities throughout the bank, and bank stability factors of safety remained around 1 from low flows to high flood flows. At the other site some tighter soils are present, and some drawdown effects in floods reduces bank stability safety factors to significantly below 1.

These results depend on the assumptions made about bank geometry, soil types and permeabilities, and are, at best, representative of river bank stability along the lower reaches of the river. They provide some indicative information about bank stability under the flow variations analysed. They suggest generally marginal bank stability over all flows, and thus a failure propensity at low and hydro operation flows, as well as during flood events. As well, changes in bank stability would mostly arise from changes in soil layers and properties along the river banks, especially permeability, with bank geometry been a more secondary factor (and affected by past failures).

Sedimentation

The report reviews some sediment load estimates for the Matahina dam, and briefly comments on the impacts of sediment trapping. The Rangitaiki River has naturally transported a substantial sediment load from its catchment down to the lower plains, which have been built up by the deposition of this material as a coastal infilling plain since the sea level stabilised at around present levels. The natural trend on the plains would be one of channel aggradation and break-out deposition because of this sediment load.

A comparison of channel cross sections surveyed in 2001 and 2008 showed only local channel aggradation and degradation, and no overall degradation trend. From this it was concluded that "the river gradient [downstream of the dam] is now stable following any degradation after the construction of the Matahina dam." There are a number of repeat surveys of the Rangitaiki River channel, but only from TeTeko to the mouth. Surveys have been carried out in 1987, 1993, 1995, 1999, 2003 and 2004 after the July flood of that year. The later two surveys show a net loss of material from the channel, especially after the 2004 floods, which would have flushed out the lower reaches of the river. Comment on these surveys is given in the NERMN report of EBOP of September 2006.

The trapping of bed load material behind the Matahina dam would have river management benefits in eliminating the natural aggradation that would otherwise reduce the flood capacity of the river channel. It may, though, prevent a recovery of bed levels after the scouring out of large flood events, and over the long term have detrimental effects on bank stability due to channel deepening.

On balance, the sediment trapping would appear to be having an overall positive effect, at least up till the present. During a period of high flood intensity, however, a lack of supply from the upper reaches may start to have more significant detrimental effects, in terms of channel deepening and more active working of the river banks.

Flow Modification

The Matahina dam and reservoir has only a marginal effect on large floods, due to the relatively small size of the reservoir and the small operating range. It is essentially a run-of-the-river scheme, with very short term storage to meet daily variations in power demand.

Reducing flood peaks may have no real advantages, as the flood duration would be extended. A better use of available storage would be to even out flow fluctuations on the flood recession. It is flow variation on recessions that is really aggravating in terms of channel migration and its associated erosion and deposition activity. This would, though, require a drawing down of the reservoir after the flood peak, and a management of (spillway and turbine) outflows based on inflows to the reservoir.

The hydro operation does modify small floods, reducing peak flows, but does not generally have much impact on the overall flood hydrograph.

For the current peaking operation of the hydro station, flow attenuation down the lower Rangitaiki River has been determined by hydraulic modelling. This has been done for a single daily peak and for two peaks in a day. Figures 1 to 6 of the report show the flow variation at a number of locations along the river and the overall level fluctuation down the river. The outflow variations at the dam are also shown for low flow conditions and small to medium flood events, along with reservoir inflow and levels, on Figures 9 to 12.

The flow variation from the hydro operation is generally between 40 and 133 m3/s, and this gives rise to level differences of about a 1 metre or more down to Edgecumbe. The 2 year flood flow, when bed material movement becomes generalised, is about 250 m3/s.

On the basis of the bank stability analyses undertaken, these level fluctuations of the power generation were considered to have no significant erosion effects, from either increases in flow velocities or bank drawdown effects.

The Beca report, in section 7.3.4, comments on the difficulties experienced by EBOP in establishing protective vegetation in the zone of daily water fluctuations of the hydro-power operation. They note the shift to rock linings of EBOP as a consequence of being unable to establish vegetative protection. Their comments are more discursive than explanatory of any cause and effect, but they do conclude that the vegetation suppression effects can be mitigated by a contribution from TPL to EBOP.

Failure Modes

The bank erosion analyses of the Beca report are based on the conditions at the time of the hydro generated flow fluctuations. They do not consider pre-condition impacts, or the aggravation that can be caused by lower level high frequency variations in flow, such as that of the hydro-power scheme. The hydro variations are, in essence, high frequency low amplitude flow variations, which are super-imposed on the lower frequency but higher amplitude variations of flood events.

As well, the Beca report only deals with some of the erosion processes of rivers, and does not discuss the dynamic nature of rivers and river processes. The analyses undertaken are not set within a wider context of the complex variations in river conditions that occur over time, and which affect channel migration and erosion and deposition processes.

River channel and bank pre-conditions prior to a flood event have major impacts on the magnitude of channel movements during flood events, and the associated erosion and deposition activity. The amount of erosion depends more on the pre-conditions of channel shape and bank exposure and flood flow variations (especially above about a 2 year return period flow), than on the flood peak or duration. After a quiescent period, it is the later flood events that, in general, give rise to more activity and cause more damage, not the larger floods. A large flood event will also be much more destructive when it closely follows aggravating small to medium flood events.

The activity of a flood event is closely related to the magnitude and intensity (or number) of rises and falls, and not to maximum levels or velocities. While tractive stresses are still used as an indicator of sediment transport and erosion activity, it is the degree of acceleration and deceleration of flood flows that is much more important. Sediment transport rates are high on the rise and fall of hydrographs and not at peak flows. Bed material transport, especially in gravel bed rivers, is very dynamic and pulsating, but studies indicate a high rate of transport on the hydrograph rise but of short duration, with more transport in total on the recession. Studies of flow turbulence, which is a much better measure of activity than velocity, support this. It is certainly clear from observations of erosion in rivers that the most activity occurs on recessions, and this is partly due to the dynamics of erosion and deposition as the threshold of transport is reached.

Hydro-power generated flow fluctuations can have aggravating effects through low level destabilisation and the maintenance of rawer banks. This gives rise to more adverse pre-conditions. Thus, while there may be very low levels of river activity during the hydro flow fluctuations, and virtually all significant erosion occurs during flood events, the hydro operation can still be having adverse effects.

When considering the river erosion hazard at least three different modes of failure should be taken into account. There is bank slipping due to on-site instability (from water lubrication of soils and draw down water pressures in the bank), which was considered in the Beca report. Of more significance in a river is the erosion associated with channel migration, which is affected by channel shape (asymmetry and mis-alignment), bank cover or strength, and braiding/channel splitting or migration trends. Thirdly, there is piping failure, where material is removed by hydraulic pressures in the ground, and consequential ground collapses occur. This failure mode is especially significant on the Rangitaiki Plains.

Both the channel migration and piping processes can be aggravated by low level flow fluctuations. The stopbank breach in 2004 was generated by a combination of piping development, heave failure and back scouring, and the pre-conditions of the river banks and berms would have had a significant impact on the rate and extent of flood water inflows into the adjacent ground. There is a natural process of silt build up on river banks and then removal of this material by bank collapses or erosion. Hydro level fluctuations could have reduced the amount of silt deposition and increased the removal of silt, especially on the lower bank. The lack of vegetation in the zone of flow fluctuation, would have reduced silt build up, as this vegetation is especially important in trapping silts and buffering flows away from the bank, which increases lower bank deposition.

Matahina Impacts

The present contribution of TPL to river management is based on a study undertaken in 1998, and described in a memorandum of Phil Wallace and Tony Dunlop. The contribution is a proportion of the annual maintenance costs for works along the reach from the Matahina dam to Edgecumbe. The proportion

was based on the amount of buffer vegetation along the river put under greater stress by the hydro level fluctuations. Capital works expenditure was also considered, but was not included in the agreement on contributions.

This study was prior to the flood event of 1998, and maintenance expenditure at that time was relatively low, given a quiescent period for floods. Since then there has been a period of greater flood intensity, including the large flood event of 2004. Both maintenance costs and capital expenditure is now much higher.

The impact of the Matahina HEPS will be different in periods of flood intensity, compared to quiescent periods, while river management programmes and costs will also be different.

The overall impact, including both beneficial and adverse effects, can not be quantified. River systems are much too complex and dynamic, and our analysis tools are very simplistic for such systems. A fair and reasonable contribution must be based on a qualitative judgement, but one informed by an understanding of river processes and the full range of potential effects of hydro operations within this environment.

The same issues arise on other rivers in New Zealand, and what is happening on the lower reaches of rivers with similar hydro generation effects is worth noting. The Roxburgh Dam on the Clutha River, the lower Waitaki Dam on the Waitaki River and the Karapiro Dam on the Waikato River, have similar sediment trapping and flow modification effects as the Matahina Dam on the Rangitaiki River. They are all the lowest dam on the river, with high flow fluctuations for power generation purposes.

There have been many investigations and long debates about sediment transport and flow modification effects on these rivers. In 1992, I undertook a review of all the investigations carried out on the lower Clutha River in relation to the effects of the Roxburgh Dam. I have also been involved in studies and reviews of these issues on the lower Waitaki River.

For the Clutha River, there finally was agreement that the hydro operation affected the river mouths, and the hydro-power authority paid for 50% of the costs associated with maintaining the river mouths. As part of re-consenting of the dam, this contribution was increased to 90%. There have also been contributions to river management costs along the lower Clutha River in the past, but not at present. However, an investigation of sediment and erosion processes downstream of Roxburgh, jointly funded by the hydro and river management authorities, is part of the re-consenting conditions.

For the Waitaki River, the hydro-power authority has made substantial contributions to river management along the lower reaches over a long period of time. This contribution is being revised as part of the consenting of the proposed North Bank Tunnel project, and under the consents for this project the hydro-power authority will take over the management of the river, with the Regional Council becoming essentially a contracted manager of the river.

For the Waikato River, the hydro-power authority does make funding contributions to river management through rates, which covers a number of hydro-generation dams and control structures. The basis of the rating was not elicited. There are no direct contributions relating to the effects of the operation of the lowest dam at Karapiro. Investigations on the effects of hydro ramping were carried out at the time of re-consenting and since, by both the hydro-power and river management authorities. These investigations generally considered tractive forces and on-site bank stability, although some studies of flow turbulence were undertaken. There appears to have been no general agreement on the effects of the Karapiro Dam operation on the river channel and river processes downstream.

A simple comparison of the flow characteristics of these three rivers and the Rangitaiki, is given in the table below.

Description	CLUTHA	WAITAKI	WAIKATO	RANGITAIKI
Q_2(Flood flow)	~ 1150 m3/s	~ 1200 m3/s		~ 250 m3/s
Q_2(hydro modified)		~ 1000 m3/s	~ 400 m3/s	
Typical Ramping	200 - 700 m3/s	200 - 400 m3/s	150 - 375 m3/s	40 - 135 m3/s
Min. ramp flow		150 m3/s	148 m3/s	40 m3/s
Max. ramp flow		~ 500 m3/s	410 m3/s	160 m3/s
Max flow/Q_2	~ 60%	~ 50%	> 100%	60%

The values given in this table are approximate, and taken from a number of different investigations. They depend on locations and may not accurately represent the actual situation. Different reports were not always consistent, and the values have not been checked. The do, though, allow a general comparison.

The last row of the table gives the maximum ramping flow as a percentage of the 2 year return period flow, which is an indicator of when generalised activity and movement occurs in a river.

Very generally, this comparison suggests that the magnitude of the impacts of the Matahina HEPS on river processes is at about the same level as for the other three rivers. The lower Waitaki River was sensitive to the hydro modifications because of the wide braided nature of the river and the rapid spread of introduced vegetation in this river, while there were difficulties in funding the required river management. The lower Rangitaiki River is sensitive to the hydro modifications for different reasons. In this case, it is the vulnerability of the river scheme to

piping failures and the closeness of the stopbanks and major assets to eroding river banks.

There has been a major change in river bank protection measures since the earlier years of the river scheme, from vegetation to rock works. The difficulties in establishing and maintaining vegetation on a critical part of the river banks due to hydro flow fluctuations would have been a reason for this change. However, a vegetation approach may have been inadequate, at least at the more severe bends, during periods of high flood intensity. Rock work repairs and extensions after a large flood event, such as that of 2004, would still, then, have been required, without the aggravating effects of the hydro-power scheme.

Conclusions

The impacts of the Matahina HEPS operation on the river downstream, and in particular on river management,can not be determined from quantitative analyses. Instead a qualitative judgement must be made based on the nature of river processes and the likely effects of the power scheme operation on these processes. The sediment trapping and flow modification of the hydro scheme is far from unusual. On the contrary, it is common on rivers around the world. There have been clear effects on river channels and river processes from hydro-power schemes, including very major impacts. However, the problem is the magnitude of effects and their impact on the river environment and river management programmes in particular cases.

In determining likely effects, an assessment of all potential instabilities and failure modes should be undertaken, given the dynamic character of river processes and the specific nature of the affected river. The river management scheme on the lower Rangitaiki River is unusually vulnerable, and sensitive to losses of soil and vegetative cover from the river banks. Large floods have exposed banks and given rise to channel distortions, which can now be further aggravated by low level flow fluctuations. Expensive repairs and additional works are now required, including rock lining of river banks and geotechnical stabilisation measures. The higher standard of protection given by these works will, though, reduce the impacts of the hydro-power flow fluctuation, and hence the adverse effects.

The present contribution from TPL was based on a vegetation management approach to river management, and an assessed proportion under greater stress because of the hydro operation. This assessment is no longer relevant, given the changes in the river and river management, and the damage caused by more recent large floods, which have necessitated the change in management approach.

Given the type of failures that can occur along the lower Rangitaiki River, and the likely impacts of the hydro operation on pre-conditions as well as vegetation and soil cover on the river banks, a 10% TPL contribution is considered to be on the low side. This contribution should apply to all the river management costs of mitigating failures along the lower Rangitaiki River, including flood damage repairs and additional capital costs. The capital costs of rock lining banks and stabilising and de-watering the river berm land will both reduce the failure

potential and the adverse effects of the hydro operation. There will be on-going maintenance costs associated with these works, but the overall costs of the river management programme in the longer term should be reduced by the works, which would reduce any percentage contribution from TPL.

While a TPL contribution could be determined from present river management costs, of maintenance and programmed capital expenditure, actual costs will depend on the pattern of future floods and the effective degree of protection gained from the measures in place along the river. Any fixed contribution should then be subject to review, if river conditions and actual management expenditure significantly changes (for better or worse).

No account has been taken of any impacts from changes in the global climate, on either the hydro-power operation or river management.

Gary Williams

ATTACHMENT B

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MEMORANDUM Date: 13 October 2009

To: Robbin Britton

Of: Environment Bay of Plenty

Copy: Bruce Crabbe

SUBJECT: **RANGTAIKI RIVER – MATAHINA CONSENT**

PAGES 1 + 4

Introduction

Investigations on river hydrology, hydraulics and bank erosion have been undertaken by Beca Infrastructure [Beca] for TrustPower, as part of the investigations for the re-consenting of the Matahina Dam. The final report of Beca was issued in May 2009. This report included some additional investigations on possible flood attenuation through reservoir level operations and low flow hydraulic modeling, with comment on saline intrusion and the effects of lower flows on water takes. Otherwise the report was essentially the same as the draft of November 2008.

The report does not address the issues raised in the meeting with Beca and TrustPower of 6 May, and which are outlined in my memo of 15 May 2009. Instead, Beca responded in a letter of 17 August, which included comment on matters raised by Brian Kouvelis. I have in turn responded to specific matters in my memo of 28 September 2009.

There are clearly differences of understanding about river processes, failure modes and the impacts of the hydro operation. This memo gives an overall assessment of the impacts of the hydro operation and its adverse effects, noting that the proposed operational changes exacerbate these adverse effects. It should be read in conjunction with my previous memos, with the comment and background information contained in them.

River Management

Management of the lower Rangitaiki River is especially difficult because of its landscape and river character, and the close proximity of assets, including the flood mitigation stopbanks. The protection of these assets requires a continual effort, of channel management and bank protection works, and the changing conditions of the

river channel and its margin vegetation affects the vulnerability of the stopbanks during flood events. Rivers must be managed at all times and through all conditions to ensure that the state of the river channel and its berms, at all times, are adequate to contain the design flood, whenever is may occur, without overtopping or breach failures. The cost effectiveness of this continual management is affected by many factors and variables of the river dynamics and human interventions and alterations of the natural regime. The impact of a hydro operation is not just about the stability of the stopbanks themselves or of the adjacent river bank. There are a number of failure mechanisms that can be affected by changes in the flow regime below flood flows, while the management techniques used and their effectiveness can also be affected.

The impacts of the Matahina Dam have to be considered within this context, of the existing Rangitaiki River, the assets and people at risk beside the river, and the management requirements to maintain a given standard of protection.

There is an acceptance by Beca that the hydro fluctuation affects the growth of vegetation on the bank, above normal low flow levels, over the height of the fluctuations. They do not, though, seem to accept that the deposition of silts and fine material on the banks (and in bank vegetation) is also affected, within the fluctuation zone or below it. There is agreement that the costs of river management varying over time, with a significant oscillation between periods of more flood activity and quiescent periods, which is related to the climatic variations of the Inter-decadal Pacific Oscillation.

Matahina Operation

The Matahina Dam is the lowest hydro-generation dam on a significant New Zealand river, with the lower reaches below the dam crossing valuable floodplain land, with high valued assets. These assets, and the people living on the floodplain, are protected by a complex scheme of flood defense and erosion mitigation measures. The dam is operated to meet daily variations in power demand, which imposes a high frequency if low level (or amplitude) variation on the river system.

There are similarly sited and operated hydro dams on the Waikato, Waitaki and Clutha rivers, which also have valuable floodplain land below them, protected by river management schemes. The Rangitaiki River is smaller than these rivers, but the hydro ramping range of the Matahina Dam is of similar relative magnitude and significance as that of the lowest dam on these rivers, particularly the Waitaki and Clutha.

The proposed changes in the operation of the Matahina Dam increases the number and range of the hydro-induced flow fluctuations. This is made clearer by the addition to the Beca investigations, of the hydraulic modeling of Appendix D of the May report. The rate of ramping up and down is increased, the range of water levels fluctuations is marked increased above Edgecumbe, and the number of large variations in level is also increased.

The reasoning behind this change in operation is not clear from the Beca report, but presumably is proposed to increase the ability of the hydro operator (TrustPower) to match power demand and supply peak loads. This was the reason for the greater variations in flows and river levels on the Clutha, Waitaki and Waikato rivers in the past. These variations were reduced because of concerns over the impacts on river management and the erosion and flooding hazards downstream.

The proposed changes for the Matahina Dam reverses this trend, and significantly alters the hydo-imposed flow and level variations down the river. The Beca report essentially dismisses any impact from these changes, despite being in an adverse direction in terms of river management, presumably because they see very little impact from the hydro operation anyway.

There is a long history of investigations and negotiations on the impacts of these dams and their hydro operations on the river downstream and their protection schemes (see my memo of 15 May). In all cases, the hydro authorities have made some operational alterations and/or funding contributions in recognition of adverse downstream effects, albeit begrudgingly or without necessarily accepting these effects.

River Systems & Failure Modes

River systems are highly dynamic and changeable systems, and it is very difficult to determine (and especially quantify) direct cause and effect linkages. For this reason they are, though, also highly responsive systems, which continually change and alter their behaviour, as the many influencing forces on these system themselves vary. There are complex interactive linkages between the hydrologic regime, sediment transport, channel activity and migration, and vegetational changes along rivers.

The major activity in rivers, especially of the physical processes – of sediment transport, erosion and deposition, channel migration, siltation and the removal and spread of vegetation – takes place during flood events. However, the pre-conditions – of channel form, vegetation and cover materials – have a significant influence on the nature and extent of the flood activity. Just because the linkages are not direct and event specific does not mean they do not exist or are unimportant.

I do not, therefore, accept the conclusions of the Beca report, or of their letter of 17 August. In my opinion their logic is simplistic, and misses the most important aspect of river systems, which is their dynamic inter-connections and responsive sensitivity. The orientation of a single tree prior to a flood event can make the difference between no bank erosion at all and a severe loss and significant change in bend curvature of the river after an event.

The geotechnical investigations they undertook are informative of the sensitivity of the river to bank failures and piping development and heave failure at or beyond the stopbanks. The very low safety factors of the slope stability calculations over the full range of flows, including the hydro operation flows, indicates a high vulnerability to bank collapses. The main influence on bank stability was, in fact, the materials present and their layering and hence permeability differences.

The vulnerability to piping and heave failure has been made only too clear, and this arises from layers over the full height of the river channel, including the hydro operating levels, not just the upper bank part. The channel and bank cross sections attached to the Beca letter of 17 August are misleading in their simplicity (of uniform layers) and the lack of fall away from the stopbank on the landward side. The older (Catchment Commission) plan was much more informative, and this section showed that the potential heave area was at about the low flow water level in the river channel.

When considering the river erosion hazard at least three different modes of failure should be taken into account. There is bank slipping due to on-site instability (from water lubrication of soils and draw down water pressures in the bank), which was considered in the Beca report. Of more significance in a river is the erosion associated with channel migration, which is affected by channel shape (asymmetry and misalignment), bank cover or strength, and braiding/channel splitting or migration trends. Thirdly, there is piping development and heave failure, where material is progressively removed by hydraulic pressures in the ground, and there is a consequential heave and flow break out. In each case, induced erosion or scour can then remove or collapse the stopbanks.

I agree with the description in the Beca letter of 17 August of the 2004 failure as a combination of piping development and ground heave, with back scouring to the stopbank. However, other aspects of their explanation are not accepted, and their comment on the development of the large scour hole being due to the return flows to the river is completely contrary to the evidence. This analysis of the failure is important, as an understanding of the processes of failure are fundamental to any realistic assessment of the effects of the hydro operation.

Matahina Impacts

The hydro operation can, and in my opinion does affect all three of these failure modes. The hydro fluctuations have aggravating impacts on steep raw banks, affecting healing processes after bank erosion, reduce channel edge vegetation and the cover of fine materials on the river bank. At the same time, they inhibit management use of vegetation and bank shaping to reduce erosion vulnerability. The relatively long periods between significant floods is very important in establishing protective vegetation and allowing re-shaped banks to settle down and then vegetate. The constant flow fluctuation of the hydro operation has a very adverse impact on these management operations and the natural recovery processes they depend on.

The deposition of the suspended load as siltation on the banks and berms of the river channel is important in terms of a fine material cover, which supports vegetation colonisation and growth. The vegetation then increases the deposition on flow recessions. The hydro fluctuations, with the continual flow acceleration and deceleration they generate, affect this deposition and vegetive growth, reducing both vegetation and the sealing up of fine deposits. This in turn has an influence on the

in-ground water pressures during floods, and hence bank stability and piping development and ground heave failure away from the river channel.

There is an especially high risk of failure from piping and ground heave along the lower RangitaikiRiver, and adverse impacts on the natural bank seal that forms from fine river deposits is a serious matter. The 2004 flood failure clearly demonstrates this vulnerability, and geotechnical measures to reduce this risk are being implemented at large cost. This risk is a fact that must be considered when assessing the impacts of the Matahina Dam hydro operation.

It is the loss of fine covering material (with and without vegetation) that is important from a permeability (and hence piping or heave failure) perspective. There can also be complex cumulative effects, as bank slumping occurs, banks become over-steep, there is less vegetation more likely to be removed by undermining and further bank slumping, and less bank cover deposition, which is also more likely to be removed. The channel conditions along the lower Rangitaiki River are especially adverse in this regard, where a well-defined meandering channel has been contained, and this has given rise to steep banks and accentuated channel asymmetry. The hydro scheme, clearly, did not cause this, but this condition makes its operation a more sensitive matter, and more likely to be detrimental from a river management point of view.

Beca do accept that the dam gives rive to less deposition of silts and sands on the river banks. I do not, though, agree that this material would all be very loose and easily removed in the initial stages of a flood event. There is a complex take-and-put movement of material on the banks and bed of the river during floods, and the prior conditions do make a difference.

There has been some assessment of degradation trends below the dam, and Beca are now recommending five-yearly cross section surveys downstream of the Matahina Dam, to monitor for channel degradation trends over periods of different flood intensities. Concerning this monitoring, I would note that the degree of section asymmetry (depth beside outer bank and height of opposite beach) is important, as well as the overall bed degradation.

A visual comparison of cross section multi-plots of the 2003, 2004 and 2009 surveys from cross section 58 to 65 does show a developing asymmetry close to the dam, especially from XS 61 to XS 64. This additional asymmetry is certainly detrimental from a bank erosion/protection point of view.

Conclusions

The impacts of the Matahina Dam on river processes downstream, and hence on the security of the stopbanks and the effectiveness of protection measures, can not be quantitatively determined. Even the linkages are not easily described or defined because of the complexity of the natural processes at work and the sensitivity of the system to many different influences.

Any assessment of adverse impacts must be qualitative and hence based on informed experience. It depends on an understanding of the natural system, its linkages and feedback responses, and the degree of importance or influence from the different potential factors or forces at play.

In my opinion, the Beca assessment is inadequate, misleading in its interpretations and emphasis, and incorrect in its conclusions. There are clear processes, which are part of the whole river system, by which the low level high frequency flow fluctuations of the hydro operation can adversely affect both the security provided by the river scheme, and the effectiveness of its management efforts. The flow fluctuations are of a similar relative magnitude to other hydro dams, where there have been adjustments made or compensatory payments because of downstream adverse impacts.

There has, as well, been no real assessment of the additional effects of the proposed more adverse operating procedures.

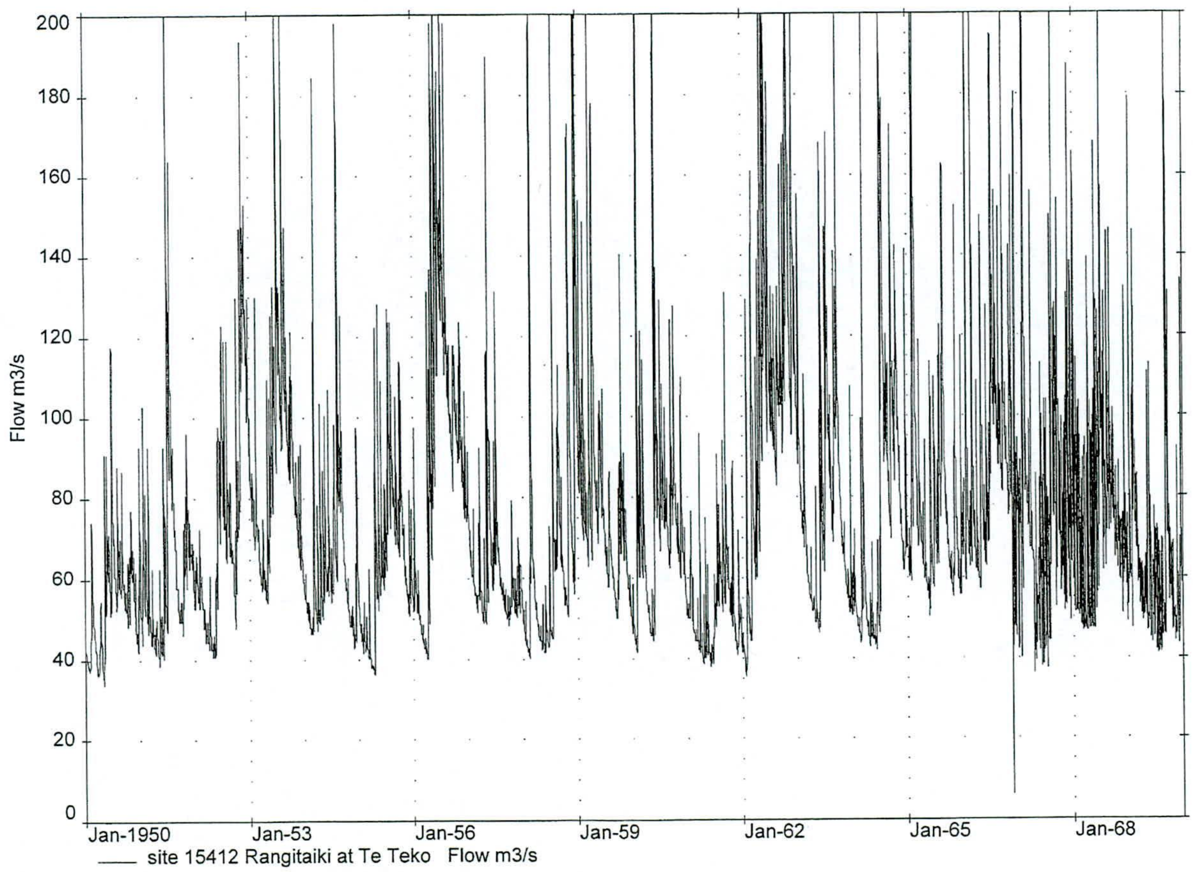
In my opinion, there is a clear case of adverse effects, which TrustPower should address, and in a real and substantial way. I would also recommended that the less restrictive operating regime not be approved, unless there is a recognition of the need for additional compensation for the more adverse impacts on river management of this operational change.

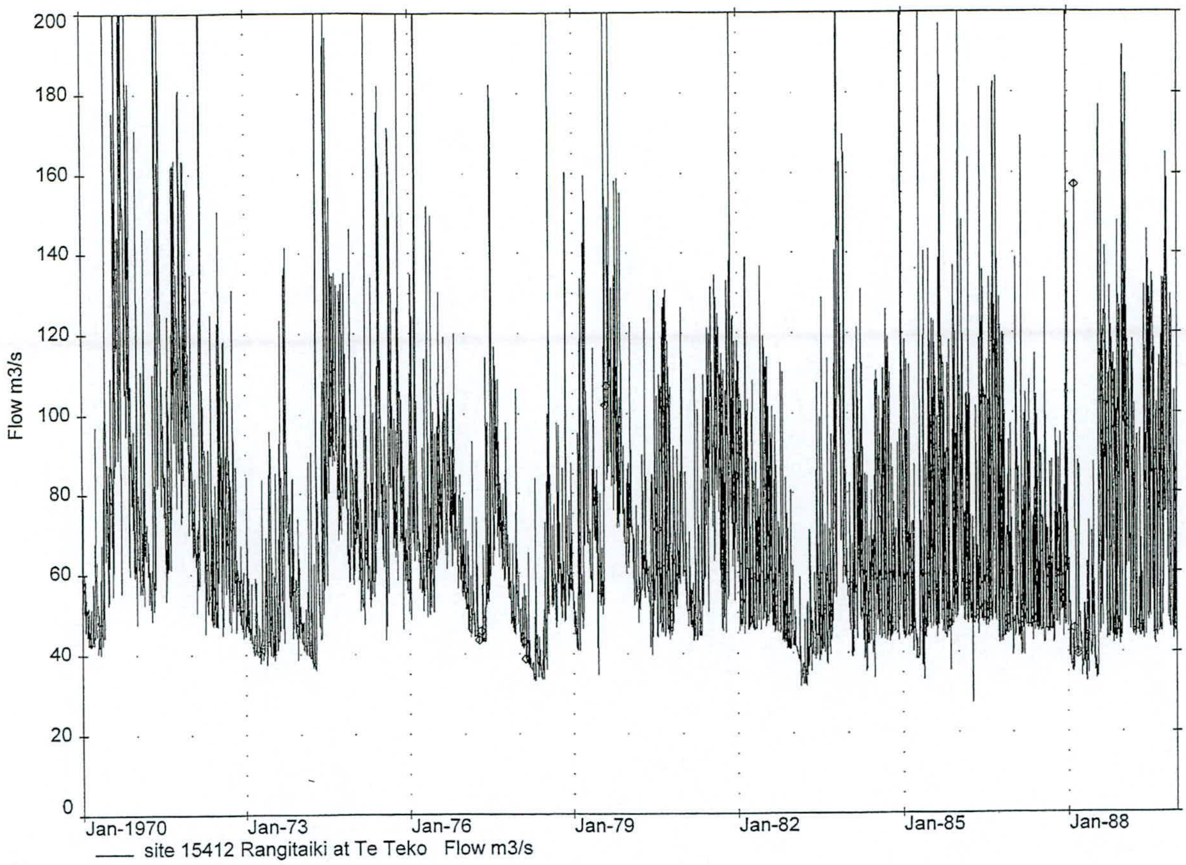
Gary Williams

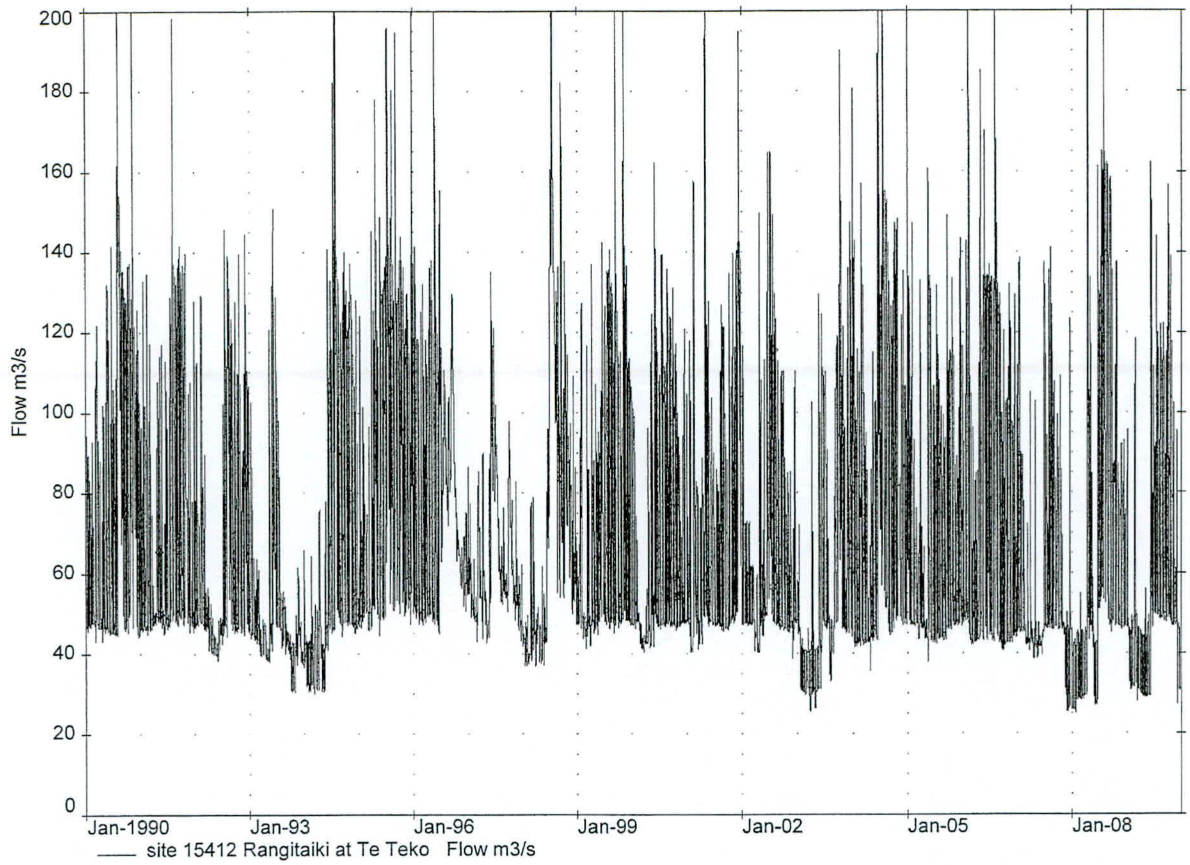
ATTACHMENT C

Flow hydrograph plots from the TeTeko recorder on the Rangitaiki River.

- ☐ 1947 – 1966 (pre Matahina HEPS)
- ☐ 1967 – 1986
- ☐ 1987 – 2006
- ☐ 2007 – present (note change in low flow regime)




200
180
160
140
120
100
80
60
40
20
0
Flow m3/s
Jan-1970
Jan-73
Jan-76
Jan-79
Jan-82
Jan-85
Jan-88
site 15412 Rangitaiki at Te Teko Flow m3/s


200
180
160
140
120
100
80
60
40
20
0
Flow m3/s
Jan-1990
Jan-93
Jan-96
Jan-99
Jan-02
Jan-05
Jan-08
site 15412 Rangitaiki at Te Teko Flow m3/s

ATTACHMENT D

ESTIMATES of TRUSTPOWER CONTRIBUTION to RANGITAIKI RIVER SCHEME

COST CATEGORY	REACH	ANNUAL AMOUNT ($)	ORIGINAL BASIS (1998)		REVISED BASIS (CURRENT)		TPL PROPOSED	
			%	$	%	$	%	$
Annual maintenance	1	$75,000	2.5	$1,875	5	$3,750	10	$7,500
	2	$80,000	10	$8,000	20	$16,000	25	$20,000
	3	$60,000	20	$12,000	30	$18,000	40	$24,000
Flood repairs	1	$25,000	2.5	$625	5	$1,250	10	$2,500
	2	$25,000	10	$2,500	20	$5,000	25	$6,250
	3	$25,000	20	$5,000	30	$7,500	40	$10,000
Scheme management	1	$12,000	4	$480	7.5	$900	10	$1,200
	2	$12,000	8	$960	15	$1,800	20	$2,400
	3	$12,000	8	$960	15	$1,800	20	$2,400
Major flood repairs	1	$50,000	5	$2,500	5	$2,500	10	$5,000
(10 year + [2004, 2010/11])	2	$150,000	7.5	$11,250	15	$22,500	20	$30,000
	3	$75,000	10	$7,500	20	$15,000	30	$22,500
Geotechnical repairs	1	$180,000	5	$9,000	10	$18,000	17.5	$31,500
(50% river bank works)	2	$120,000	10	$12,000	17.5	$21,000	25	$30,000
	3	$0	7.5	$0	15	$0	17.5	$0
Future capital improvements [1]	1	$0	2.5	$0	5	$0	10	$0
	2	$0	5	$0	15	$0	20	$0
	3	$0	7.5	$0	20	$0	25	$0
TOTALS		**$901,000**		**$74,650**		**$135,000**		**$195,250**

NOTES: 1 Future improvements would have to be assessed individually, depending on their objectives and functions

Reach 1 = Mouth to Edgecumbe; Reach 2 = Edgecumbe to TeTeko; Reach 3 = TeTeko to Matahina Dam

ATTACHMENT E

Photographs taken of the banks of the Rangitaiki River, in July 2011

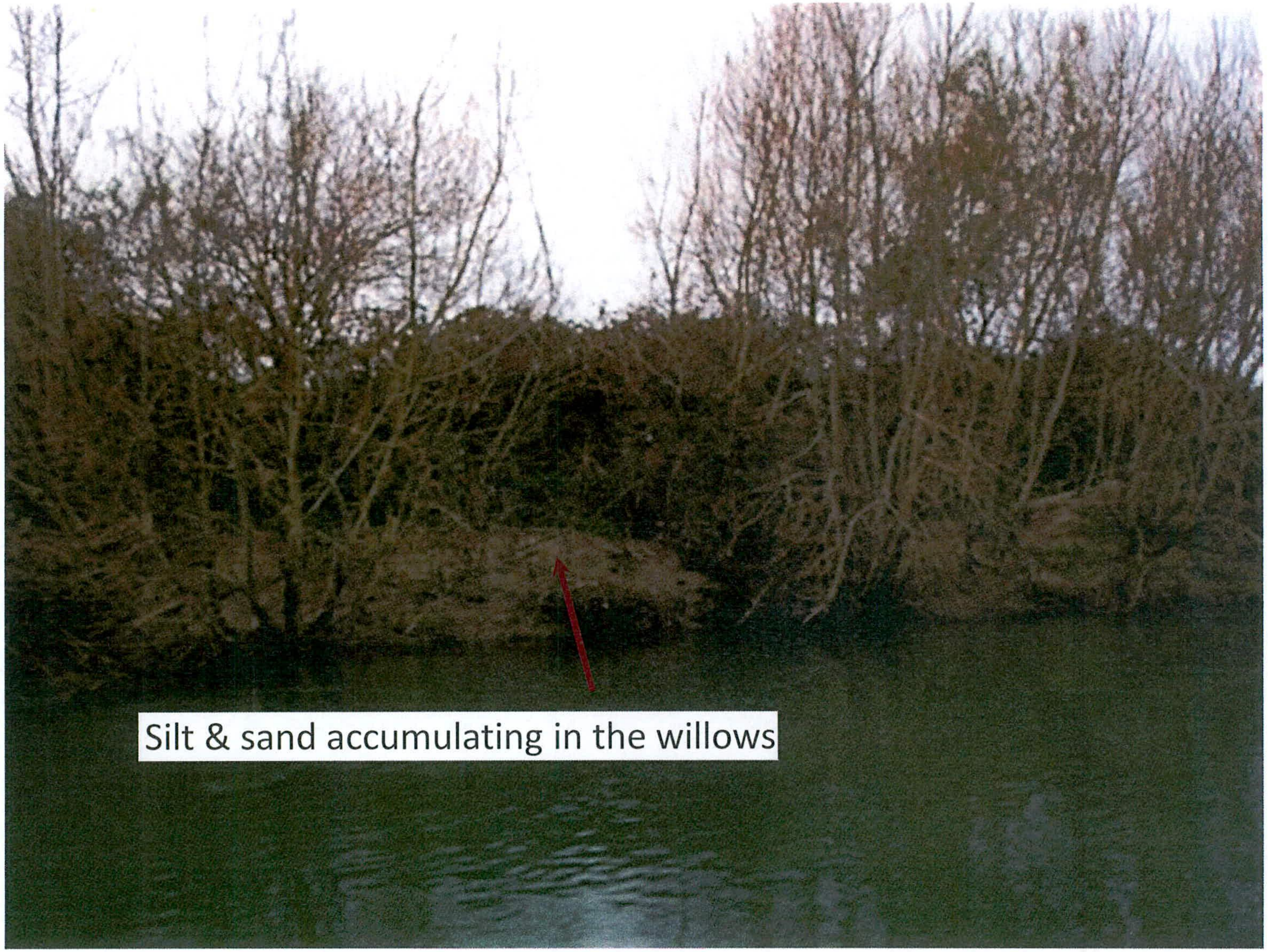
Rangitaiki River Site Visit

3 July 2011

SILTATION

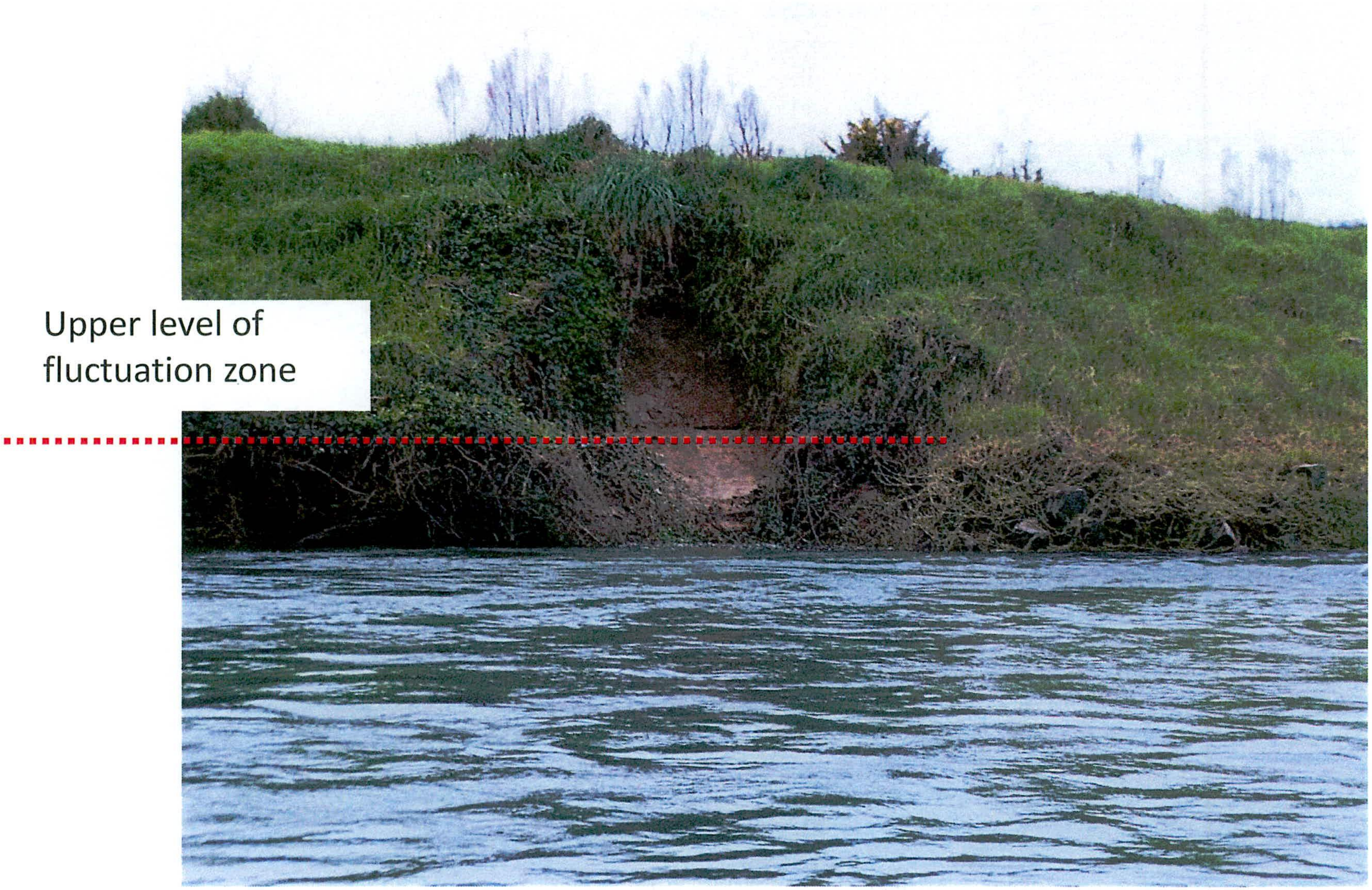
SILTATION

SILTATION

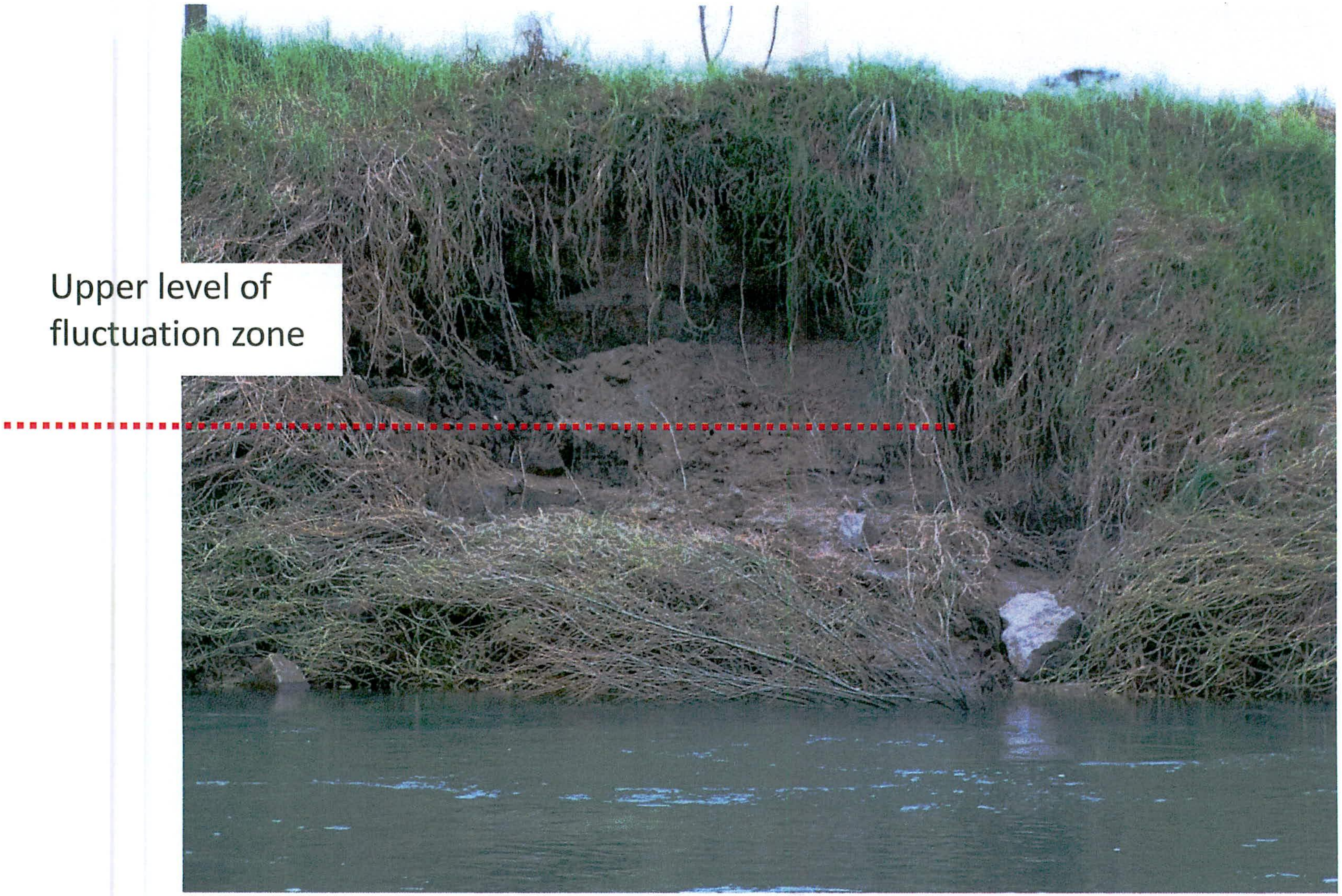


SILTATION

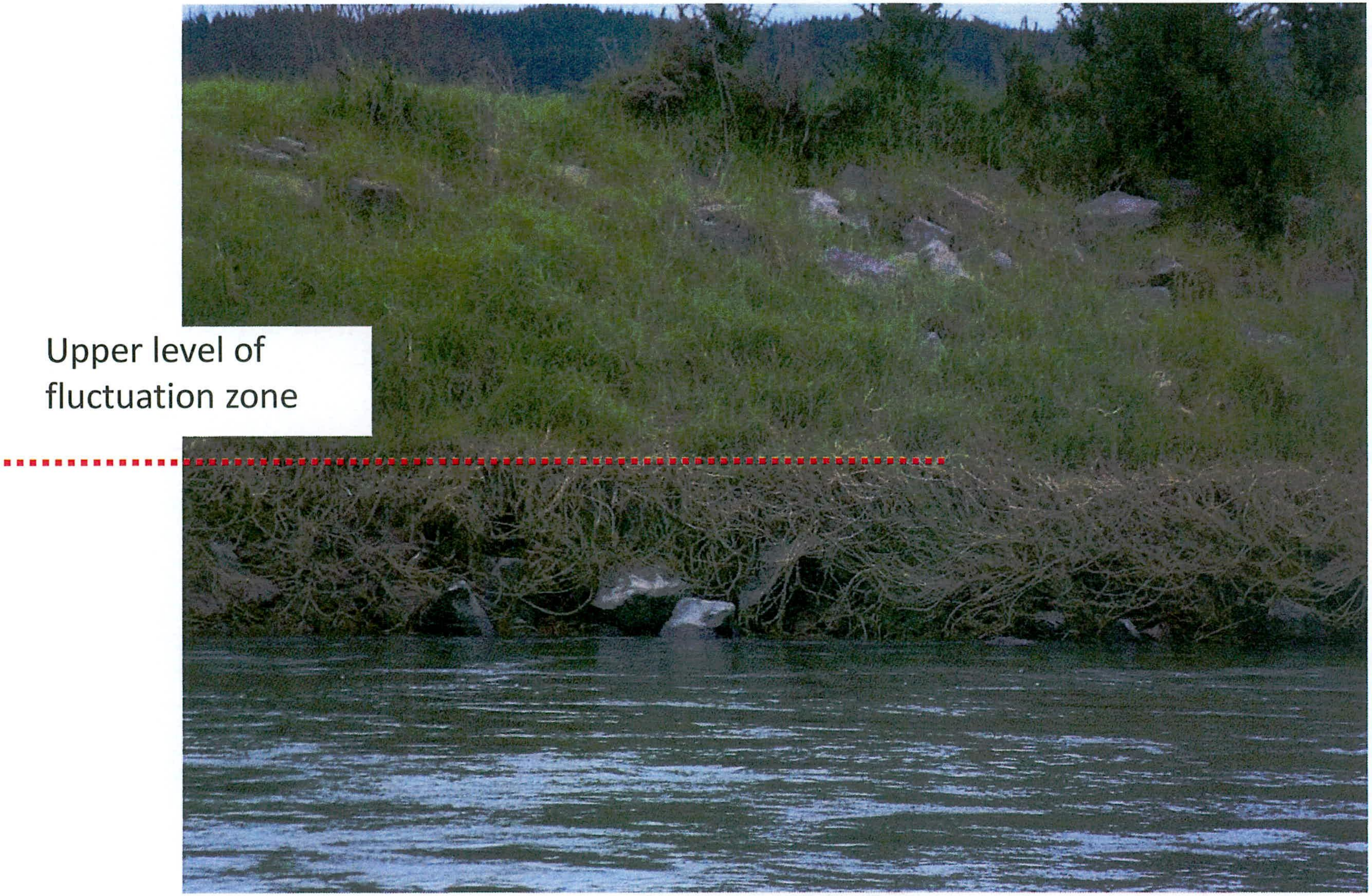
ROCK LININGS



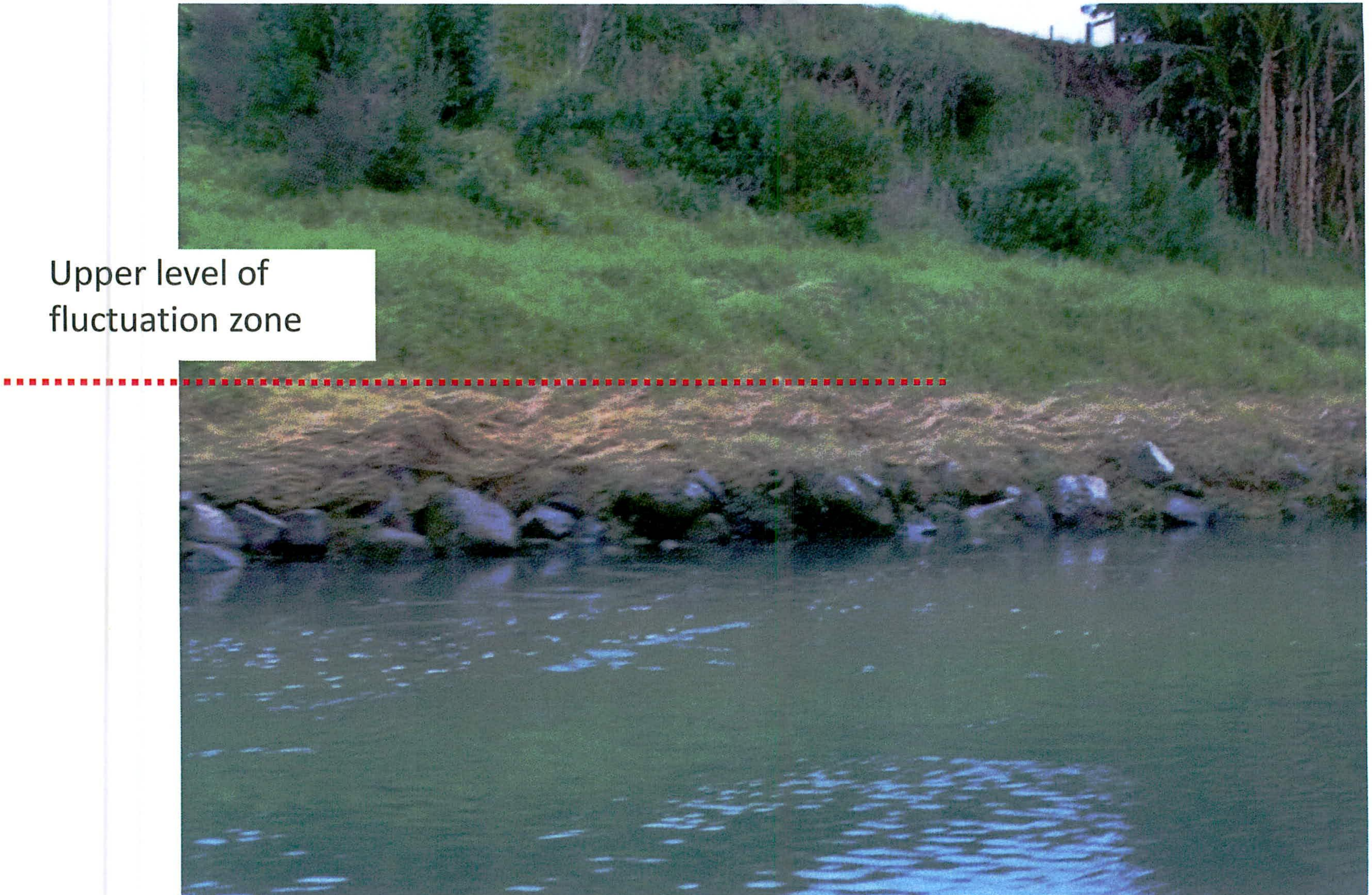
ROCK LININGS



ROCK LININGS



ROCK LININGS



ROCK LININGS

ROCK LININGS

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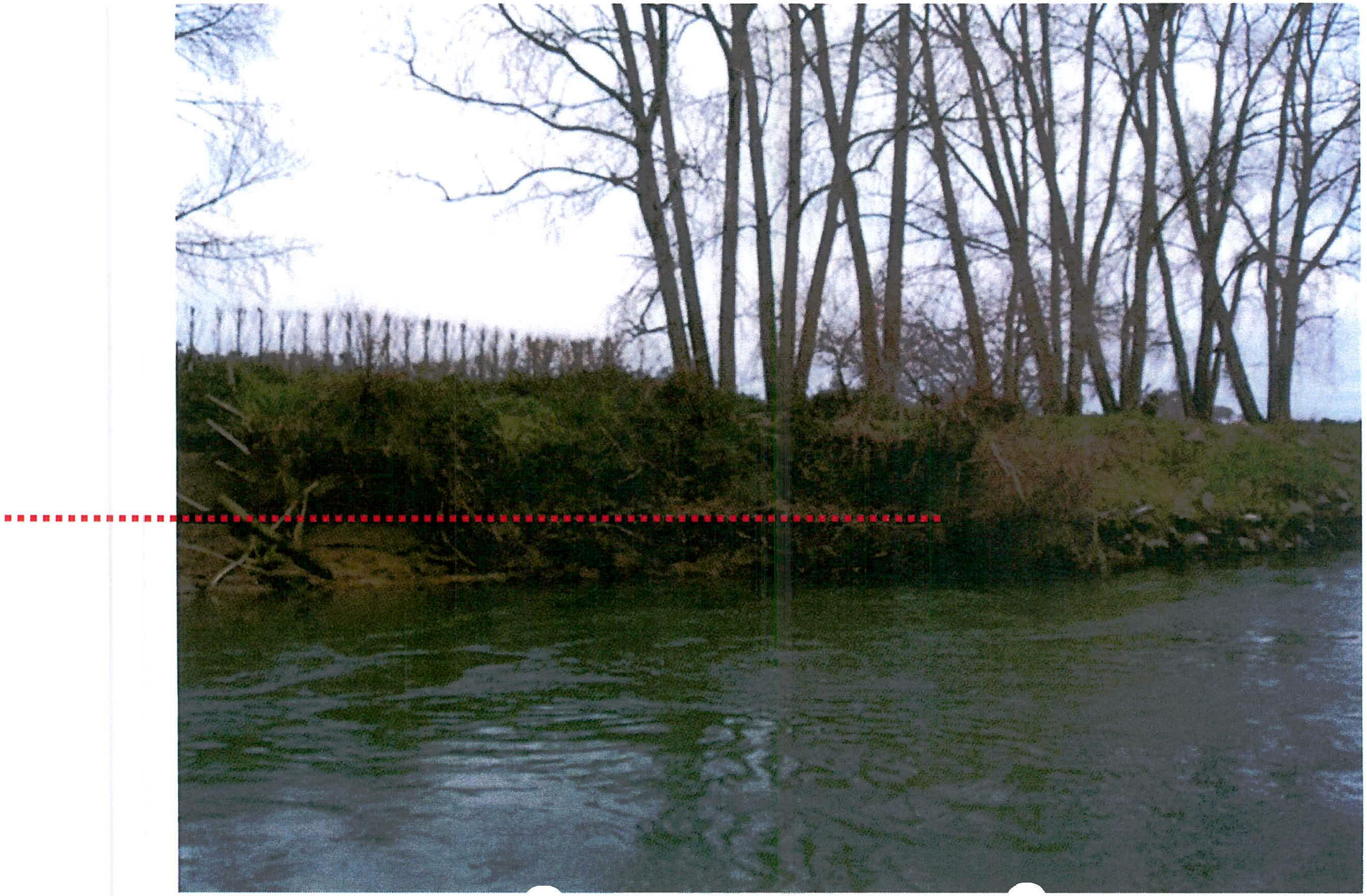
ROCK LININGS

EROSION at end of ROCK LINING



EROSION at end of ROCK LINING

SAMPLE SITE

Upper level of
fluctuation zone

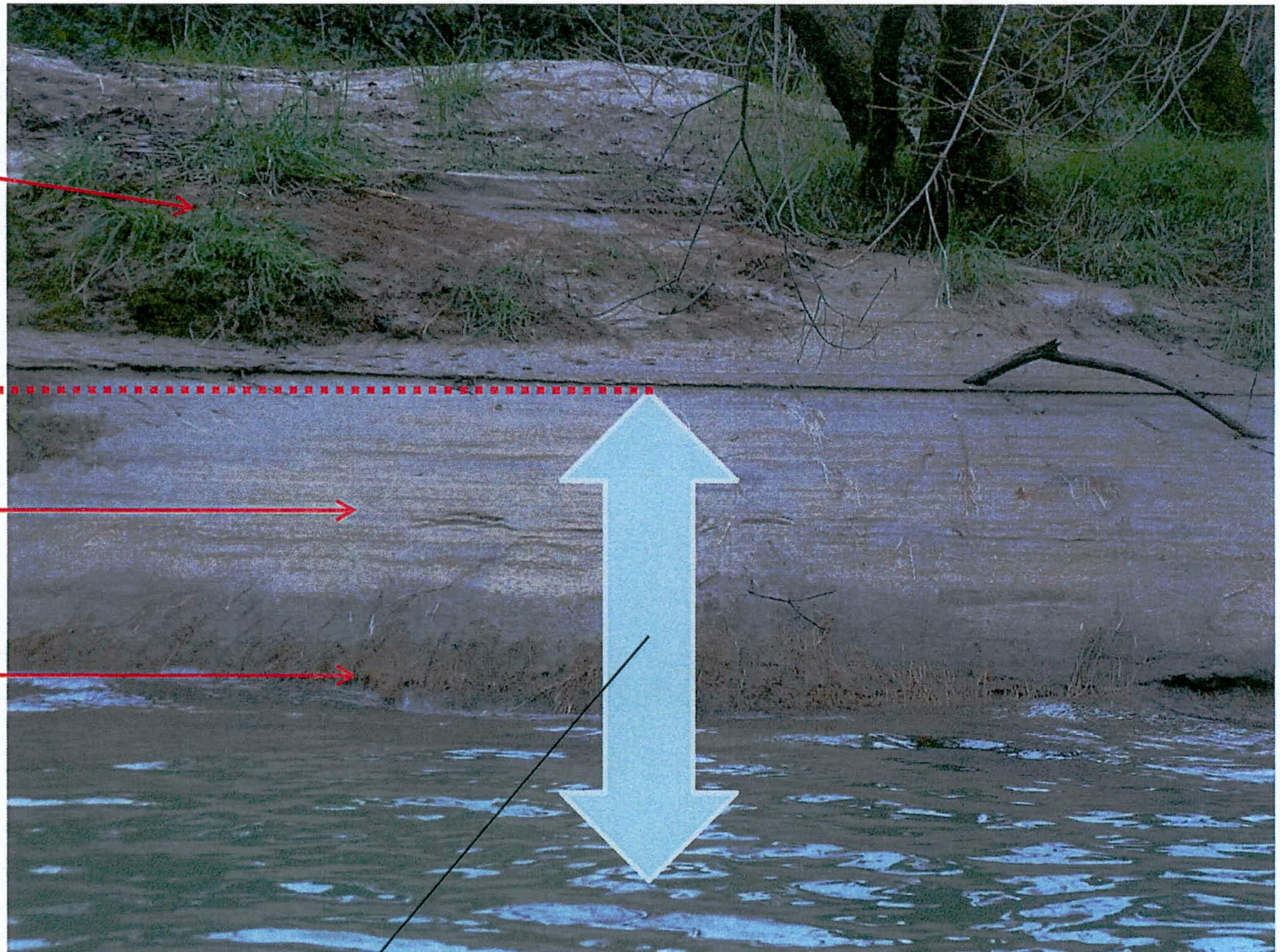
DETAIL of SAMPLE SITE

Some vegetation

Upper level of
fluctuation zone

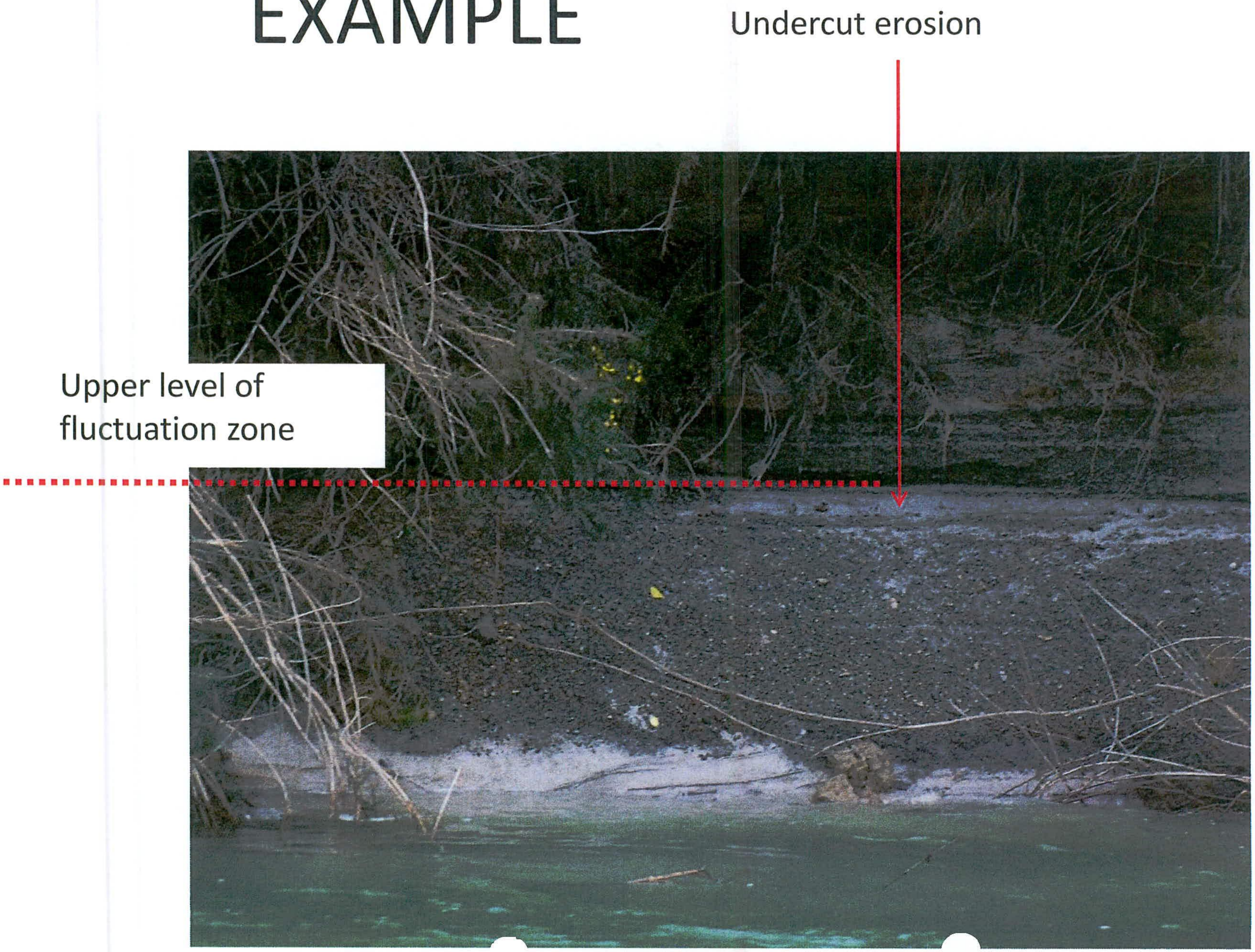
Little to no
vegetation

Willow roots
exposed

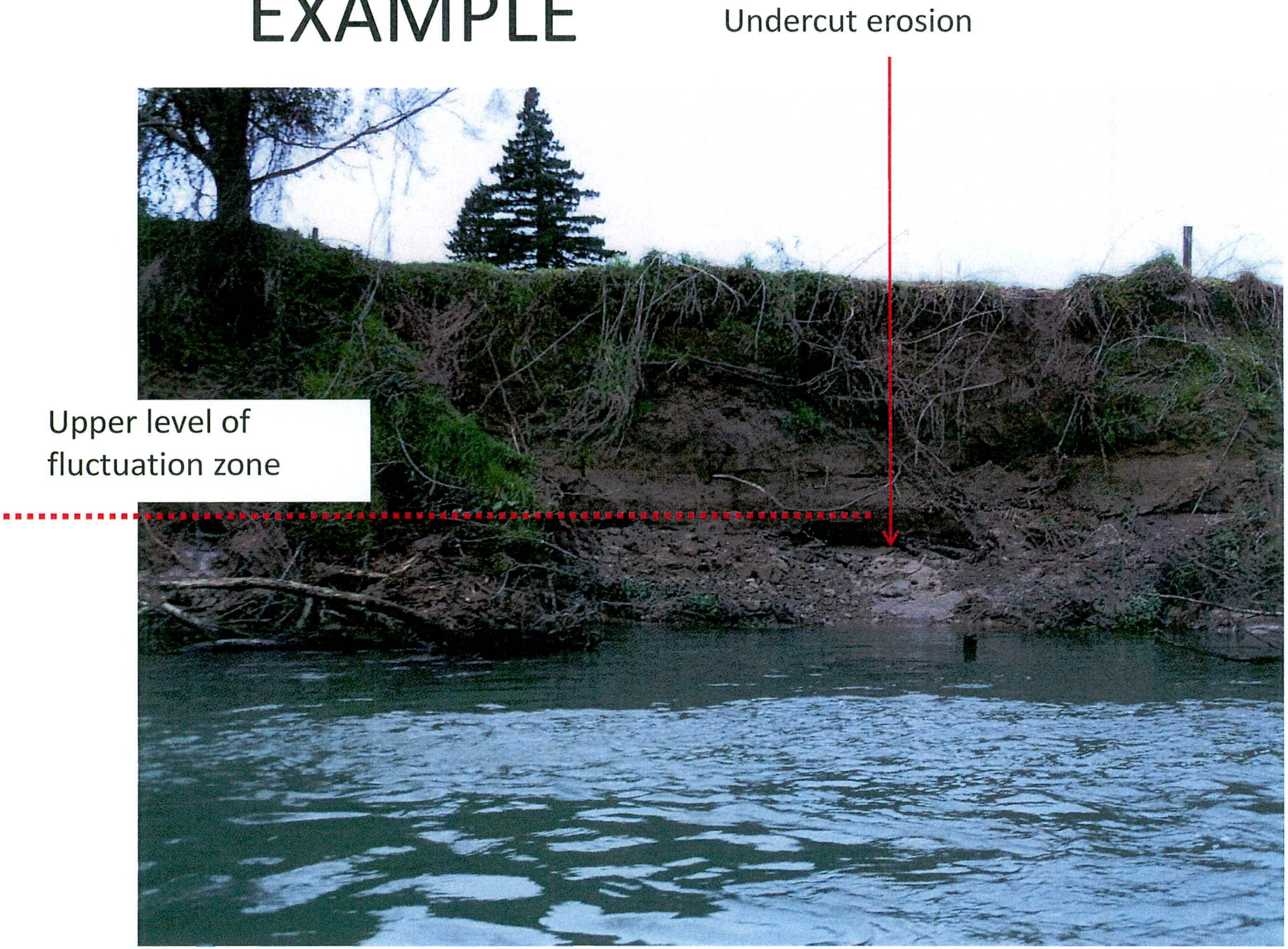


Fluctuation zone

EXAMPLE



EXAMPLE



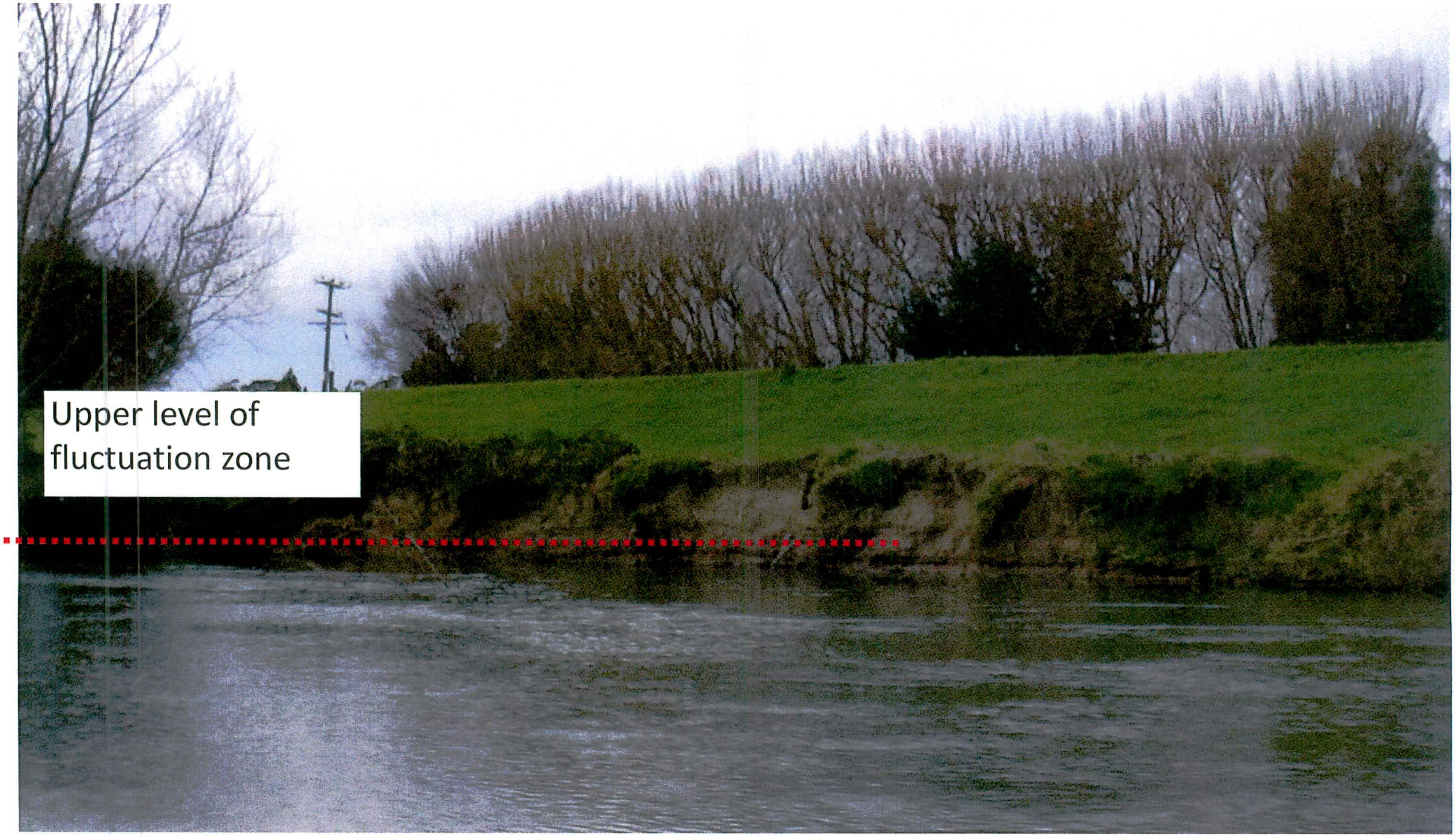
EXAMPLE

Upper level of fluctuation zone

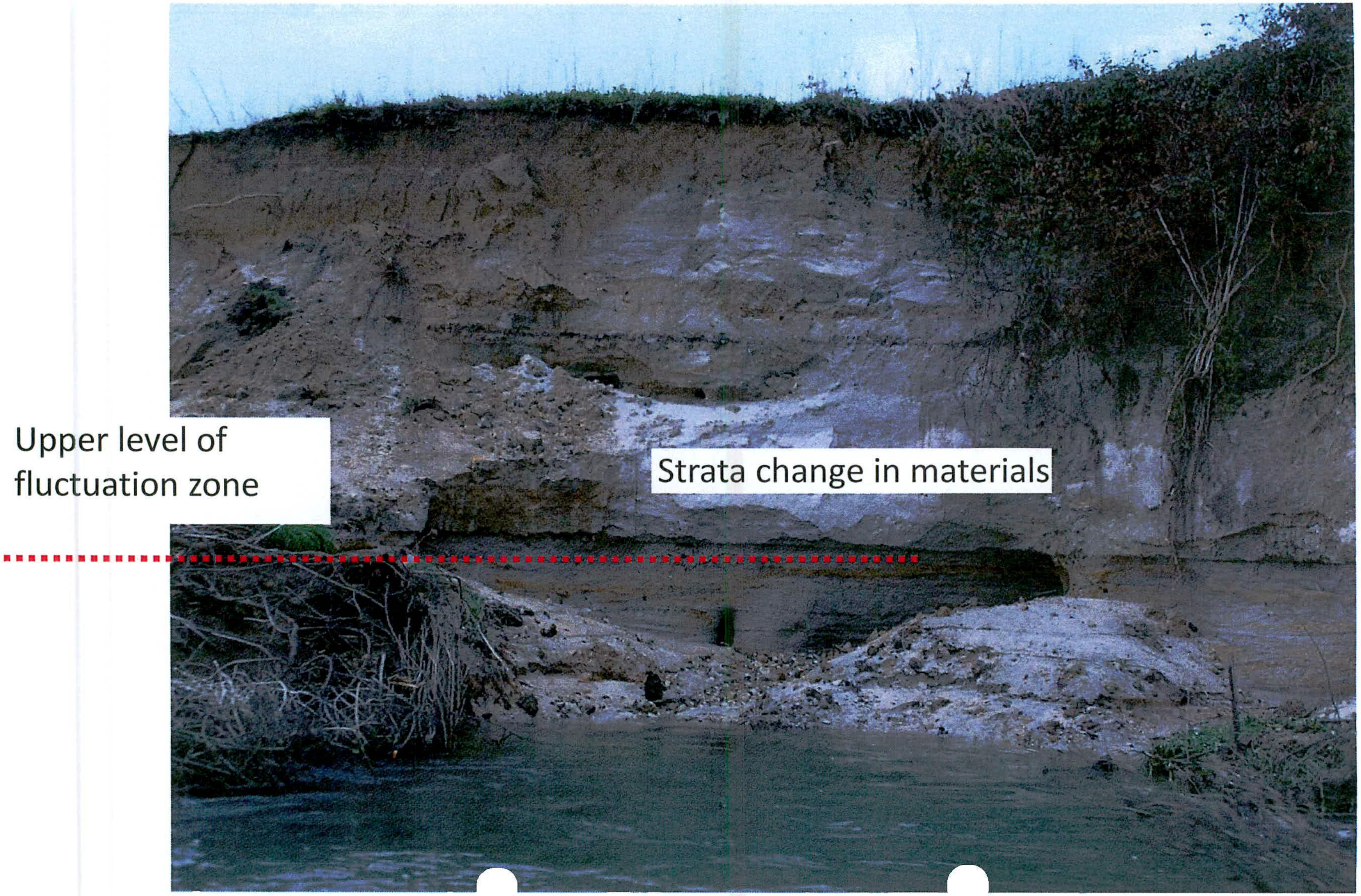
Still wet as level fluctuates down

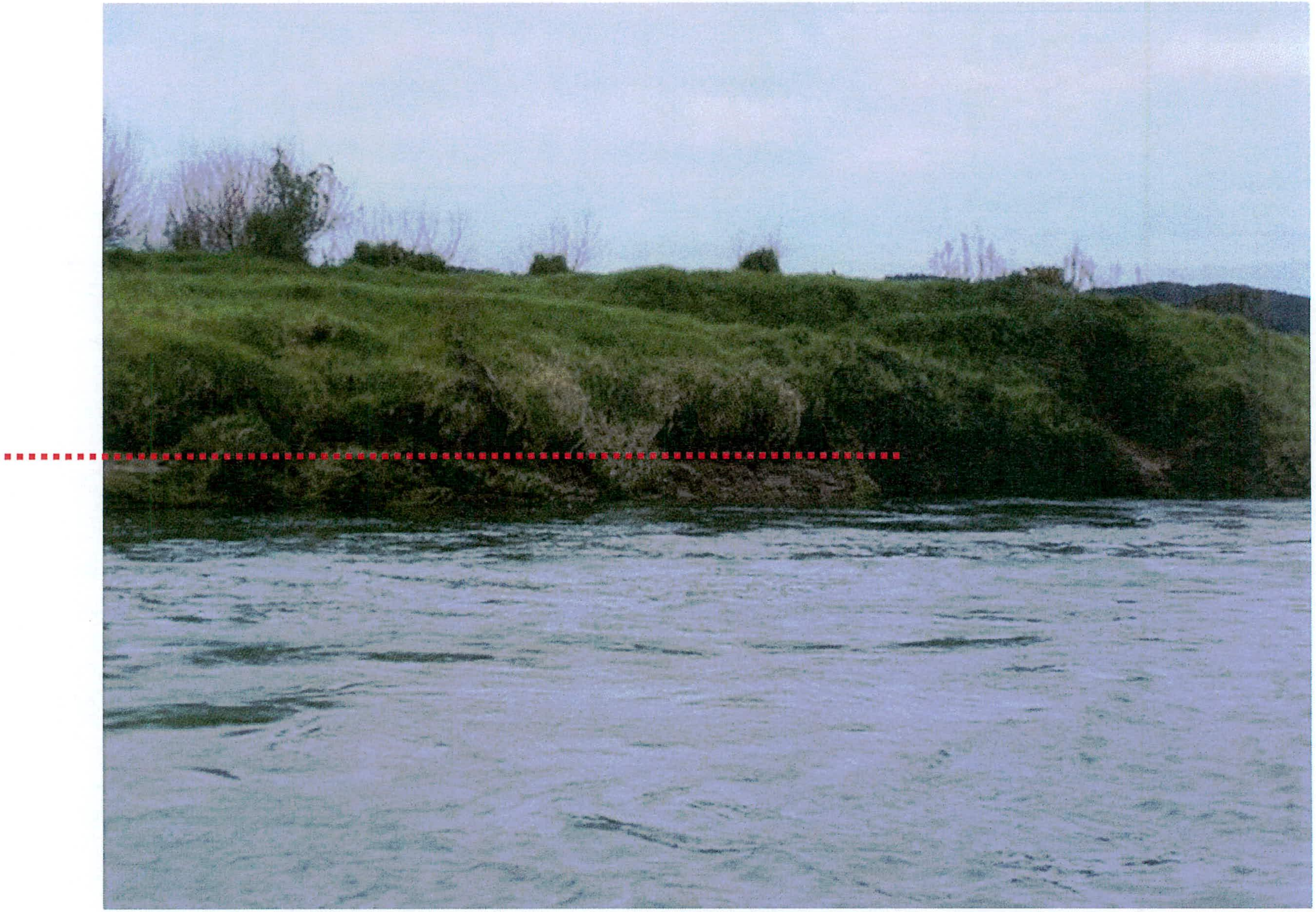
EXAMPLE

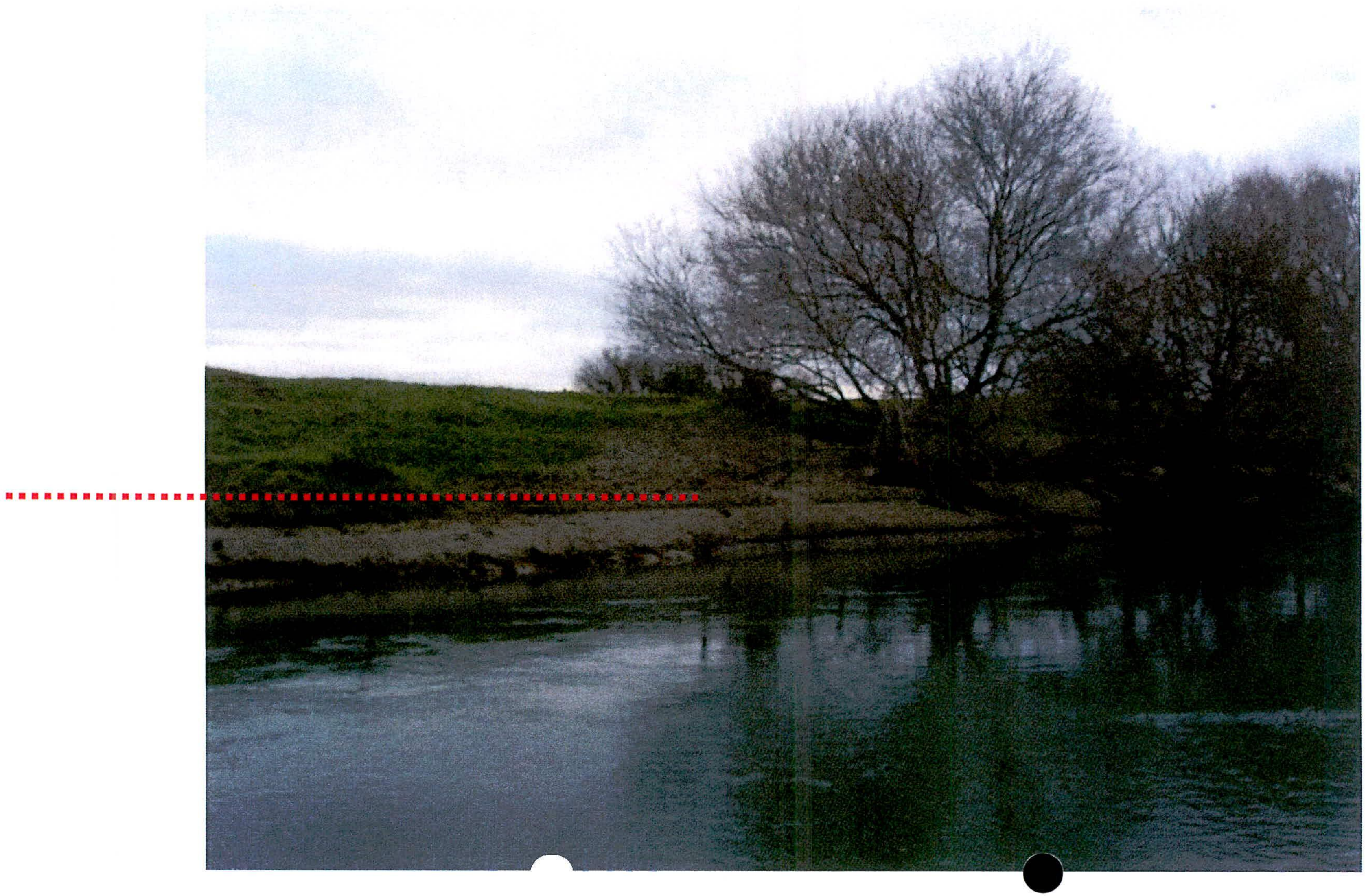

Upper level of
fluctuation zone
Rock work eroded out of this section

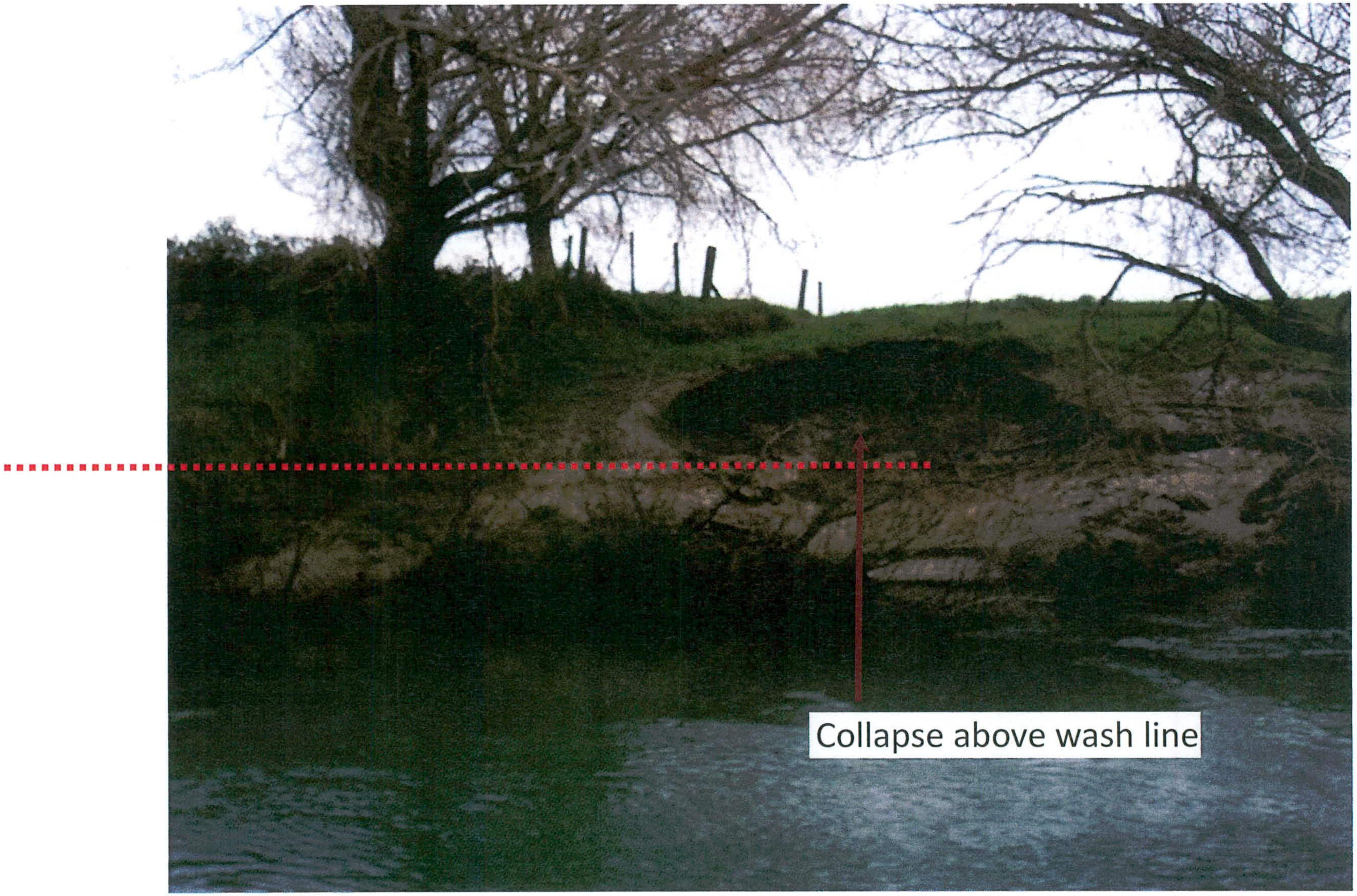

Upper level of
fluctuation zone


Upper level of
fluctuation zone


Upper level of
fluctuation zone
Strata change in materials

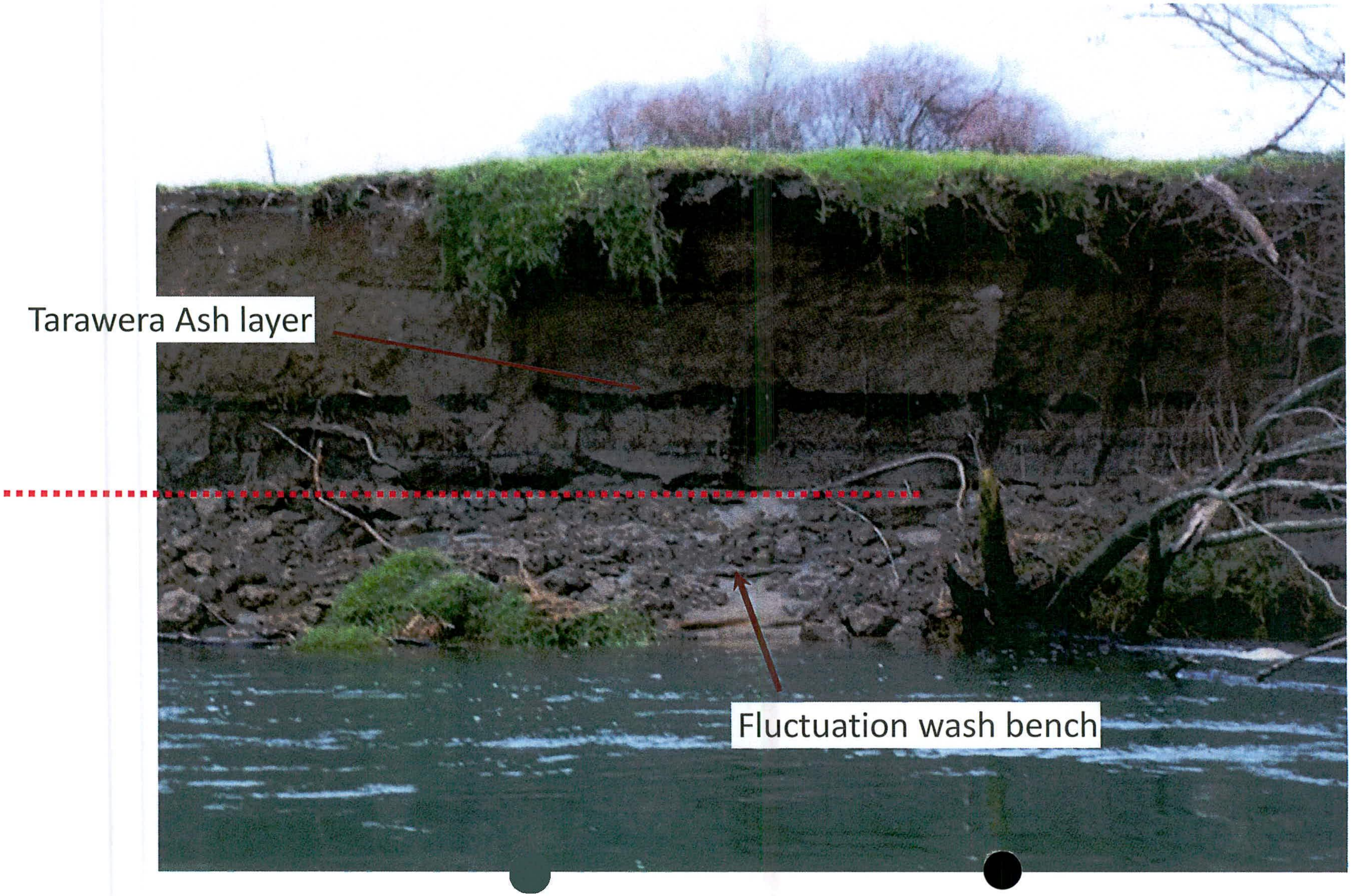


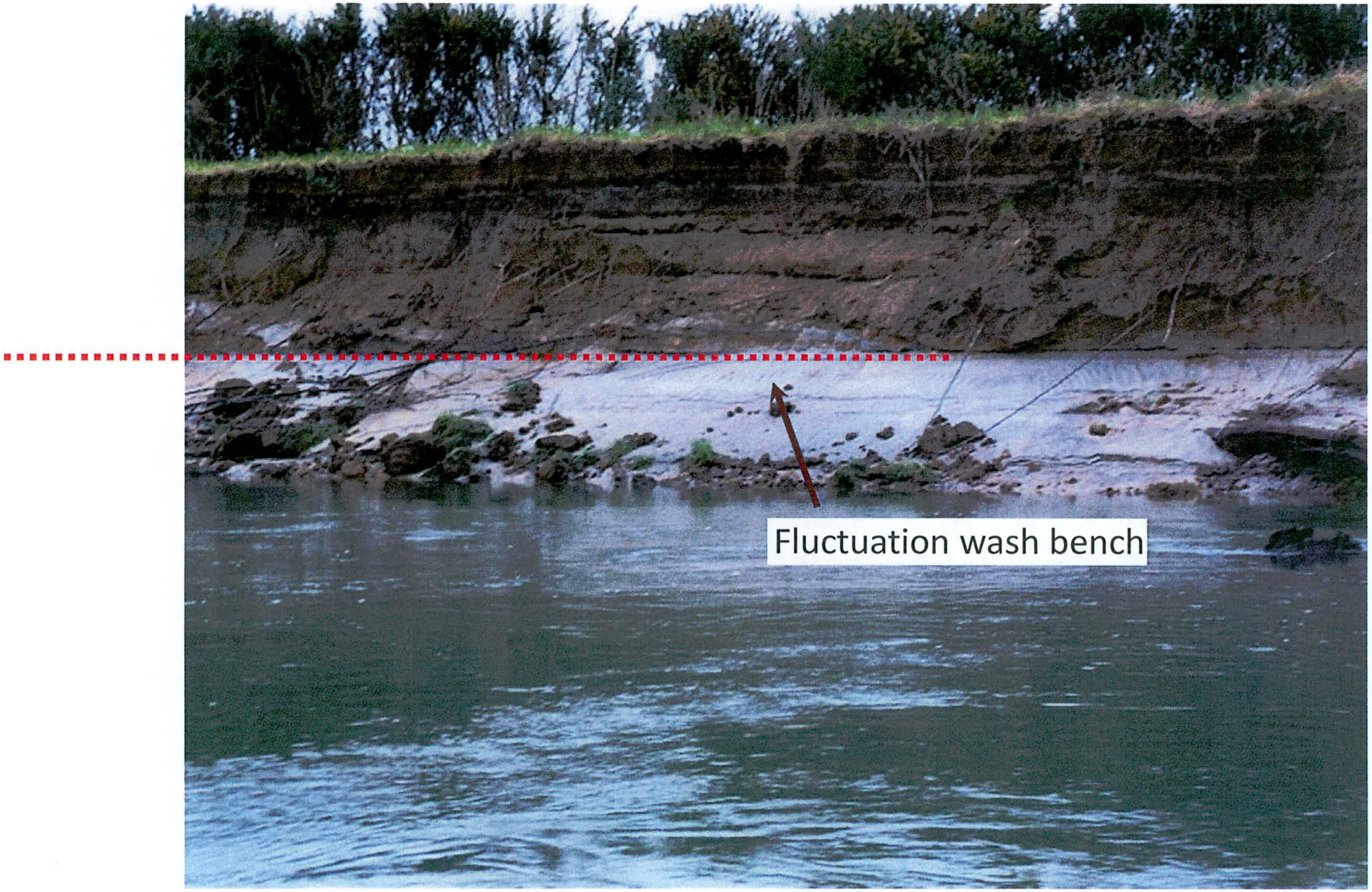



Collapse above wash line

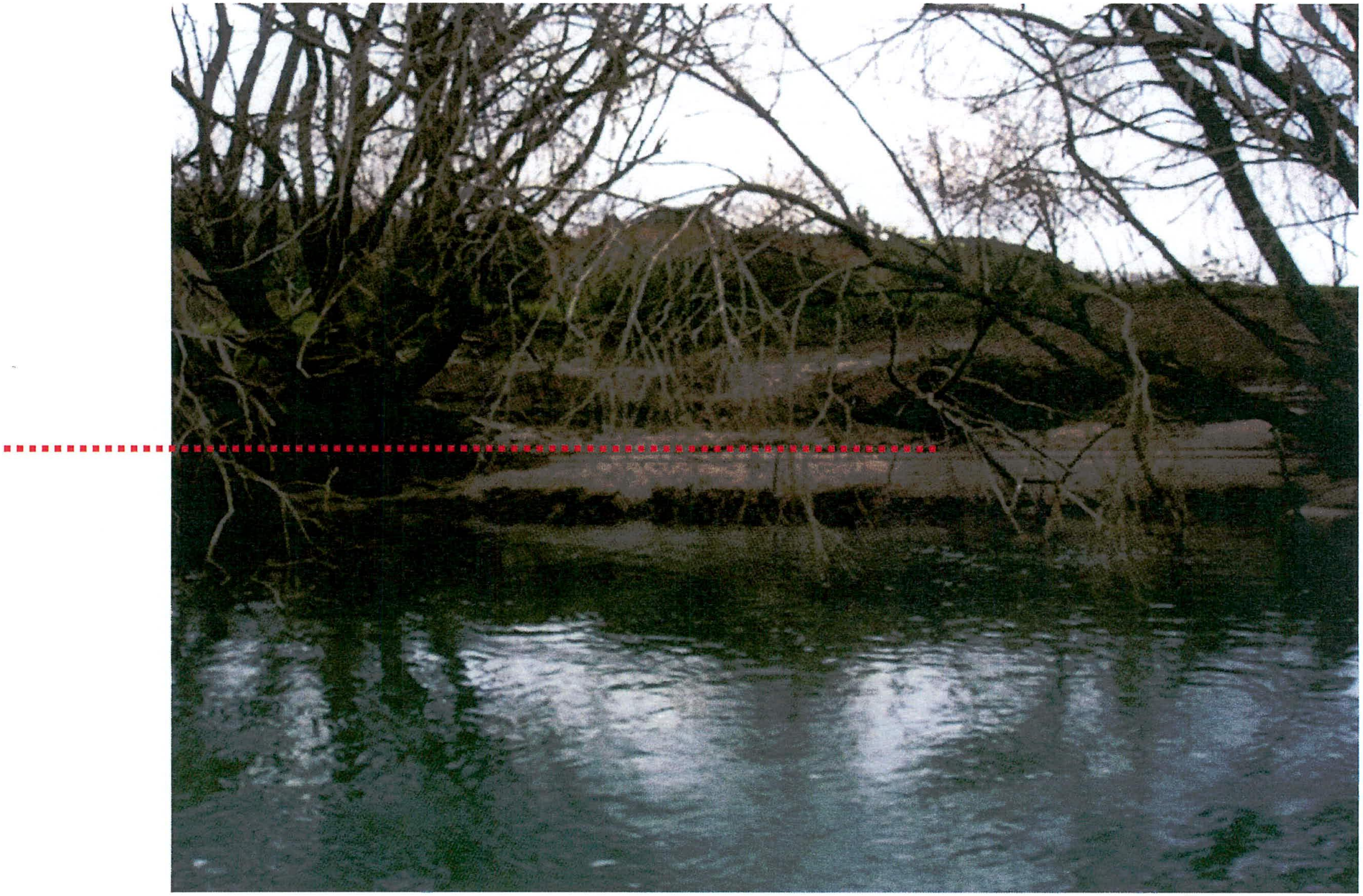

Fluctuation wash bench

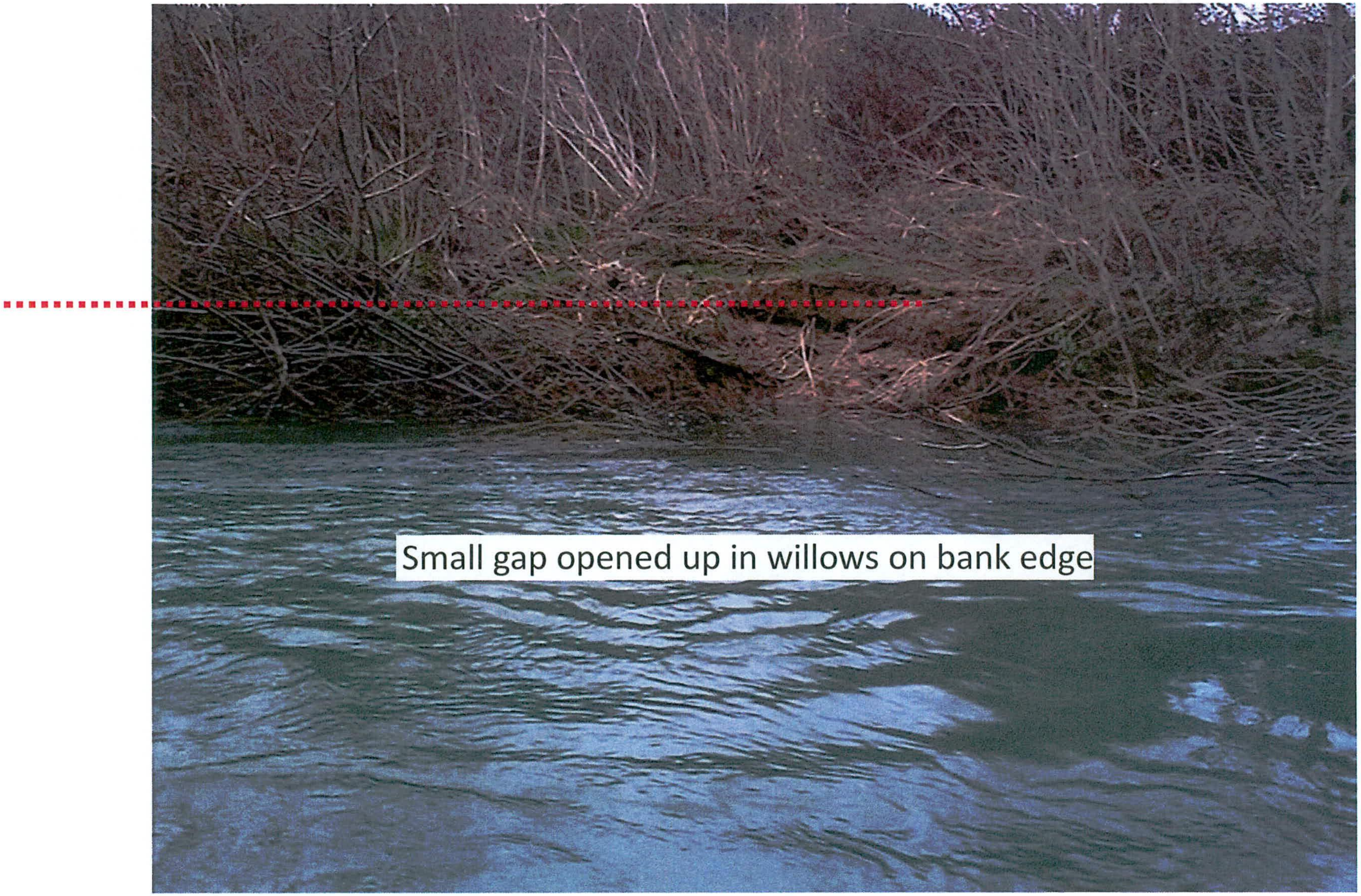
Gas Pipeline Crossing


Tarawera Ash layer
Fluctuation wash bench


Fluctuation wash bench


Upper level of
fluctuation zone




Small gap opened up in willows on bank edge

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of an application by **TRUSTPOWER LTD** to the **BAY OF PLENTY REGIONAL COUNCIL** for water permits associated with the operation of the Matahina Hydroelectric Power Scheme

STATEMENT OF EVIDENCE OF ROGER BURCHETT

1. INTRODUCTION

Qualifications and experience

1.1 My name is Roger Burchett. I am a self employed electricity generation business engineering consultant.

1.2 I am a civil engineer and a member of the Institute of Professional Engineers New Zealand (MIPENZ). I gained professional engineering status by way of cadetship and passing entrance examinations set by the Society of Engineers (London) in 1981.

1.3 I have almost 40 years experience in the investigation, design, construction, operations, maintenance, management and governance of power generation facilities, both in NZ and overseas. I was the CEO of Kaimai Hydropower from 1994 to 1997 when I joined TrustPower to establish their Generation Division which I managed until 2002.

1.4 In my role as Generation Manager for TrustPower I led the due diligence team in the purchase of Matahina Powerstation from the Electricity Corporation of New Zealand in 1999, so I am familiar both with the powerstation and the environment in which it sits. In recent years I have completed numerous feasibility studies for power generation in New Zealand and am consequently familiar with the present generation industry and electricity market.

1.5 I specialise in the modelling of generation business and in this regard spent 18 months as an expert witness to the International Court of Arbitration during 2004 to 2005.

Involvement in project

1.6 I was engaged by the Bay of Plenty Regional Council ("BOPRC") Environmental Hazards Group ("EHG") in September 2010 to assist in their negotiations with TrustPower Ltd ("Applicant") relating to mitigation for the effects and potential effects of hydro operations on the Rangitaiki River below Matahina Powerstation.

1.7 The EHG have submitted in opposition to a number of conditions sought by the Applicant, in particular low flows, peaking and ramping rates which adversely affect river bank stability and river protection works managed by them. The EHG were seeking to address these issues outside of the hearing process, via an agreement with TrustPower, to compensate for the ongoing effects and increased risk of damage to the river banks and flood protection works due to hydro operations.

1.8 In this regard I developed a methodology for apportioning costs associated with river protection work; the objective being to find a fair and reasonable apportionment of between the Applicant and targeted ratepayers who fund most river bank and flood protection costs. This initiative is outside the compass of the RMA process and the EHG was hopeful that a separate agreement could be reached with TrustPower.

1.9 Agreement has not been reached and the EHG therefore requested that I prepare and present evidence in relation to operations and the appropriateness of the contribution offered by TrustPower in the light of work I have undertaken in the negotiation process.

Expert Witness Code of Conduct

1.10 I have been provided with a copy of the Code of Conduct for Expert Witnesses contained in the Environment Court's Consolidated Practice Notes 2006. I have read and agree to comply with that Code. This evidence is within my area of expertise, except where I state that I am relying upon the specified evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Purpose and scope of evidence

1.11 The purpose of my evidence is to comment on operational issues, describe alternatives available to the Applicant to avoid effects caused by low flows, and comment on issues relating to monetary mitigation methods.

1.12 Specifically, I will:

(a) Explain why it is appropriate that water flows be measured in units of water flow and not units of electricity (Section 3).

(b) Describe alternatives available to the Applicant to avoid the "rough running range" and comment on operating constraints (Section 4).

(c) Describe the benefits of peaking to the Applicant (Section 5)

(d) Describe why the 72 hour envelope is too permissive and comment on the EHG's submission for a more restrictive operating regime (Section 6).

(e) Comment on the adequacy of the mitigation proposed by TrustPower to mitigate effects of hydro operations on river banks and associated flood protection works (Section 7).

(f) Comment on value at risk during flood management (Section 8).

1.13 My evidence needs to be considered alongside the evidence of:

(a) Mr. Bruce Crabbe who is describing the river protection scheme and the costs associated with that scheme.

(b) Mr. Gary Williams and Dr. Marianne O'Halloran who are providing expert evidence on the effects and potential effects of hydro operations on the integrity of river banks and river protection works.

(c) Mr. Colin Meadowcroft who is providing evidence on flood management issues.

1.14 A summary of my key points is set out in Section 2.

2. SUMMARY OF MY EVIDENCE

2.1 In my opinion consent rules and all measurements of water flows should be in cumecs and not units of electricity because the conditions are regulating

water flows and not electricity output; further that there needs to be simple and transparent operating measures.

2.2 In my opinion there are a number of alternatives available to the Applicant to avoid effects of the 'rough running range" on their turbines and therefore the need to avoid the "rough running range" is not sufficient justification for the flow regime sought.

2.3 In my opinion operating constraints currently applied to Matahina are typical to generous for a powerstation in a sensitive environment.

2.4 In my opinion the main if not only beneficiaries of a more liberal peaking regime are TrustPower's shareholders, noting that peaking does not increase generation output but only increases output price.

2.5 In my opinion the 72 hour window is too permissive and constraints on peaking and peaking amplitude to reduce effects can be applied without compromising the national benefit of Matahina. The constraints recommended in evidence for the EHG are consistent with relevant National Policy Statements.

2.6 In my opinion a fixed contribution toward the cost of effects of hydro operations is unsuitable due to unknown nature and quantum of effects over time, and annual agreement over quantum will be problematic. My view is that any mitigation contribution must take account of unknown future costs and that it is possible to assign percentages to defined categories to determine an annual cost allocation over a long term period.

2.7 On my calculations the value at risk resulting from flood management protocols sought by the EHG is minimal.

3. UNITS OF FLOW

3.1 This section of my evidence addresses the appropriate units of measurement for measuring flows and the issues which may arise if TrustPower's (the "Applicant") approach to using units of electricity to measure water flow is adopted.

3.2 The application to renew resource consents for the continued operation of Matahina Powerstation ("Application") and supporting reports use both "cumecs"[1] and "MW"[2] to describe water flow in the river. The conditions

1 Cumecs = cubic metres per second or m3/s

proposed by the Applicant use "MW" as the primary measurement of water flow. This consent is however about water flow in the river so should be measured only by units of water flow and not use units of electricity to measure water flow; MW's do not flow down the river and river gauging stations (including derived inflow calculations) do not measure in MW's.

3.3 It is essential that rules, inflows and outflows are measured in cumecs. This is the only way that operation and compliance will be transparent and available to the other river users including EHG. This is because there is significant non-linearity between flow in and power out of a water turbine, over both the flow range of the turbine and the level range of the lake. The application shows the correlation between cumecs and MW varies overall by up to 21%.[3]

3.4 The proposed MW flow conditions are constructed to reduce the Applicants exposure to electricity output bidding accuracy risk by masking this risk with an imprecise flow measurement. The use of MW to describe flow also allows for further exploitation of low flows with improved plant efficiency. In this event whilst the proposed 20 cumec low flow may not be reduced the 5 cumec margin advised in the AEE certainly will be[4].

3.5 There is however no difficulty in water flows being measured in a water flow unit such as cumecs. This is because output of water turbines is controlled by a governor which adjusts water flow through the turbines in response to a number of possible conditions. For turbines not managing system frequency or load these conditions are water level (reservoir or tailrace), water flow or electrical output. The Applicant is using load setpoints (electrical output) as the governing condition so the turbines deliver exactly the MW they have contracted to deliver to Transpower[5], with the inconsistency of the cumecs to MW relationship resulting in variable discharge for each MW setpoint. As above however generation water flow for each MW setpoint can vary considerably as both output and lake level change, and for stakeholders such as the EHG this consent is about river flows.

3.6 I also note that assessment and understanding of data given in the AEE and supporting reports is made difficult by the use of both cumecs and MW to describe flow. Whether deliberate or not this leads to confusion.

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2 MW = Megawatts or 106 watts
3 BECA River Hydrology, Hydraulics and Bank Erosion Report; Table 1
4 BECA River Hydrology, Hydraulics and Bank Erosion Report p 3
5 The NZ Grid operator

3.7 It is also important to be able to benchmark outflows to inflows for compliance, transparency and public accountability. In his evidence Mr Meadowcroft addresses the need for an inflow recorder and as with any flow recorder it will be rated in cumecs.

3.8 The consent conditions drafted by TrustPower are difficult to understand with operations constrained by a series of formulae and a reference table to convert to flow. This will make monitoring of compliance almost impossible. As Matahina is operating in the public domain conditions need to be measurable by the public and there is no reason why commonly understood units can not be applied.

3.9 In my opinion consent rules and all measurement of water flows should be in units of water flow and not units of electricity because conditions of consent are regulating water flow and not electricity flow.

4. LOW FLOW REGIME - ALTERNATIVES TO ADDRESS THE ROUGH RUNNING RANGE AND OPERATION CONSTRAINTS

4.1 The Application is to reduce the minimum flow in the river from 40 m^3/s to 20 m^3/s (unless inflows are less than this). This section of my evidence describes alternatives to requiring a low flow regime to avoid rough running and comments on operating constraints.

Alternatives to address the rough running range

4.2 The Application and supporting reports use the "rough running range" as one of the main justifications for a low flow regime[6]; however there is no assessment of the many alternatives available to the Applicant to avoid this problem.

4.3 The Application states the turbines have a rough running range between 12 and 18MW when they are subject to cavitation damage[7]. It is not unusual for Francis turbines[8] to cavitate at low load and this damage is repaired by welding infill on a periodic basis. In my experience as Generation Manager for TrustPower I am aware that historically this has been the method of managing this problem at Matahina.

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6 AEE p13, BECA River Hydrology, Hydraulics and Bank Erosion Report; p42, etc Evidence of Lilley Section 3

7 BECA River Hydrology, Hydraulics and Bank Erosion Report; p2

8 Reaction type water turbine as installed at Matahina

4.4 If the cost of periodic repair is of concern to the Applicant there are a number of other alternatives available to provide required outflow. These include:

(a) Low pressure release. Matahina has a gated spillway where it is possible to release low flow down the spillway at all times during normal operations as the spillway crest is lower than the operating range[9]. It would also be possible to fit an auxiliary gate within one of the main gates to provide low flow discharge without operating a main gate.

(b) High pressure bypass. A bypass pipe could be run from one of the penstocks through a pressure dispersion valve to discharge low flows directly into the tailrace. This is a common arrangement including at the Applicants Flaxy and Patearoa powerstations.

(c) Auxiliary plant. Matahina already has a small auxiliary turbine but this is too small to provide the required flow. It would be possible to install a suitably sized turbine for the "rough running range", which would need to have a capacity of 20MW.

(d) Turbine modification. The main turbines at Matahina had identical runners but turbine runners are replaced periodically and they do not need to be identical. One turbine could be fitted with a runner that is suited to operating in the "rough running range"

(e) Runner coating. As cavitation and erosion are widespread problems with hydro turbines there are a lot of base materials and surface coatings that have been developed to address these problems. Coatings range from ceramics to advanced plastics and are in common use. Aniwhenua powerstation upstream from Matahina also has cavitation issues and uses runner coatings.

4.5 These alternatives all have a cost to the Applicant that it is seeking to avoid with the low flow regime applied for. The Application concedes both existing and proposed operations have adverse effects on river bank stability generally summarised as: *"the sites are marginally stable during current and proposed operating regimes; the current and proposed ramping regimes lower the factor of safety by up to 10%...."*[10] The Applicant can avoid these effects by using one of the alternatives available to them to avoid the "rough

9 Tonkin & Taylor Report Table A1, spillway crest RL 64 masl, Operating range RL76.2~73.15 masl

10 BECA River Hydrology, Hydraulics and Bank Erosion Report p12

running range". Given that the "rough running range" is 12 to 18MW[11] or 33 to 50% load on the existing units[12] in my opinion a runner upgrade on one unit would be the best option.

4.6 Evidence for the Applicant presented by Mr. Lees states the current value of Matahina is over \$240M[13] and that the total cost of a new runner would be in the order of \$2.375M[14]. With modern computational fluid dynamics (CFD) capability the design of turbine runners is very accurate and the doubts expressed on this possible upgrade by Mr. Lees[15] are not, in my view, valid.

4.7 TrustPower's NZ operations generated 2,286GWh for the year ending 31 March 2011 earning revenues of \$213,208,000[16]. Their average costs of generation were \$14/MWh[17] giving an average unit price for electricity generated of \$79/MWh[18]. The unit price for Matahina will be higher due to its size and peaking value but even at this average value net electricity profit is 290,000MWh[19] = \$22,910,000 say \$23M per year plus revenues earned from spinning reserve operations.

4.8 In my opinion an investment of \$2.375M to remedy a problem with a long life cycle asset earning 10 times that amount every year is immaterial and clearly TrustPower does not need a low flow regime to avoid this problem.

4.9 The Applicants web site on 29th May 2011 states "Consistent with TrustPower's drive to optimise water to power conversion efficiency consideration is being given to the feasibility of re-engineering existing turbines....." If the Matahina turbines are upgraded with new runners[20] there will be an opportunity for the Applicant to address the "rough running range". Normally optimisation of efficiency will be focussed on the higher end of the turbine output curve and will certainly make that turbine less resistant to low flow operation, however in light of the Applicants concerns over "rough running" a runner could be fitted that suits the operating range.

4.10 Strategically it appears that the Applicant is seeking to get a low flow regime in place which will then allow them to install new runners that optimise

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11 BECA River Hydrology, Hydraulics and Bank Erosion Report p 2
12 Based on output of 36MW per unit; ref Lees paragraph 4.9
13 Lees paragraph 4.4
14 Lees paragraph 5.28
15 Lees Paragraph 5.30
16 TrustPower Annual Report 2011
17 TrustPower Annual Report 2011
18 Reported transfer price is \$82/MWh so my estimation is probably conservative
19 Average annual output for Matahina given on TrustPower's web site
20 The rotating part of a water turbine

efficiency at high output. This will add considerable value to their assets at Matahina and in my view is a likely driver for the low flow regime sought.

4.11 In my opinion there are a number of alternatives available to the Applicant to avoid their rough running problems and therefore the "rough running range" is not sufficient justification for the low flow regime sought.

4.12 In this regard I also note in the evidence of Mr. Lilley that TrustPower could "(operate) *for extended periods at none or minimal output.........and would induce periods of 7-10 days of constant nil or minimal discharge*".[21] This discretion relies on the recent declaration of the Environment Court but is totally inconsistent with reasons given by TrustPower for a low flow regime.

Operating Constraints

4.13 The second reason given for a low flow regime is that current operations are too constrained by conditions of consent.

4.14 In evidence for TrustPower given by Mr. Lilley he describes Matahina as the *"most constrained hydro-electric scheme TrustPower owns"*[22] and then goes on to describe the constraints of residual flow and ramping times over which TrustPower has no operational discretion.

4.15 Whilst the ratios given by Mr. Lilley are no doubt correct he has omitted one vital component which is that Matahina has a low capacity factor[23] compared to the other stations he draws on for comparison. The reason for this is that Matahina was designed, as a component of a state owned network, to provide spinning reserve and voltage regulation as well as power generation. For this reason its turbines are large relative to mean inflow, it is capable of motoring with the turbines "blown down"[24], is capable of very rapid load acceptance and most importantly is consented to react to system emergencies.

4.16 TrustPower are seeking continuance of system emergency response conditions and I agree this is appropriate.

4.17 Every hydro powerstation I have been involved with is constrained in some way by regulations or conditions, generally including residual flow and

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21 Lilley paragraph 3.29
22 Lilley paragraphs 3.4 to 3.7
23 (actual output / potential output based on capacity)
24 Inlet valve is closed and compressed air is used to depress tail water so the runner can spin in air at rated speed

ramping rates. The $Q_5$7-day low flow for a river is commonly used as the low flow requirement and the AEE gives this as $38m^3/s$, so the $40m^3/s$ constraint is typical, and powerstations with a low capacity factor do take longer to ramp up or down. But this is normally a trade off for other benefits such as described in paragraph 5.3 and as applies to Matahina.

4.18 The extent to which conditions constrain operations vary from powerstation to powerstation but are always designed to sustain the ecological, environmental and amenity values of the rivers they exploit. Minimum flows are often referred to as "Environmental Flow" and ramping constraints are used to provide public safety and erosion control.

4.19 The issue of reduced efficiency at low lake levels has been raised in evidence as a further need for flexibility. In every powerstation with storage capacity output is proportional to head and flow and in this case using design and head flow data[25] output varies by 5% over the operating lake level range. The other side to this is however that stored water is normally used at a much higher price and as output efficiency drops slightly price efficiency increases more.

4.20 What TrustPower are seeking to do with low flows and faster ramping rates is simply to enhance their ability to exploit both head and storage. In my opinion this will certainly increase the average $/MWh value of generation and may slightly increase output but the motivation is purely business driven and needs to be weighed against effects to the river as described by Mr. Williams and Dr. O'Halloran.

4.21 In my opinion operating constraints such as currently apply at Matahina are typical for the avoidance of environmental effects.

Demand side management

4.22 Although probably not an alternative a company selling electricity wants to get too involved in, in a national context and promoted by the Government's Energy Efficiency and Conservation Authority (EECA) if retailers were to use metering and price signalling to promote more efficient use of electricity there would be reduced need for peaking.

25 Tonkin and Taylor Table A1

5. BENEFITS OF PEAKING

5.1 The Application seeks a less restrictive operating regime to "greatly assist TrustPower to better meet the varying demands for electricity".[26]

5.2 Peaking does not increase the output of a hydro station (in fact it may slightly reduce it) but it does significantly increase the value of that output. Turbine output is proportional to water head and flow so if the lake is kept at a higher level as would be the case with a non-peaking or run of river powerstation it follows that output increases. This is the same reason for the 3GWh/yr gain[27] stated in the Application.

5.3 The NZIER Report promotes the benefits of electricity generated by Matahina in a national context however these benefits exist and the effects of a multiple peaking operation can only be assessed against incremental benefit. The only incremental national benefit is increased output due to the lake being kept higher which is estimated at 3GWh/yr or an increase in output of 1% which is insignificant. The incremental value of carbon avoidance[28] for the flow regime sought is only $1,800 per year.

5.4 The real benefit of the peaking regime sought is increased profits for the owners of Matahina. This results from:

(a) enhanced ability to capture or avoid high market prices;

(b) enhanced ability to firm variable output within the TPL generation portfolio;

(c) enhanced ability to exploit grid services especially spinning reserve.

5.5 Both Mr. Williams and Mr. Philpott's evidence is that the Rangitaiki River is in very sensitive geological formations, that the existing twin peaking regime has adverse effects on river banks and that the proposed regime will exacerbate these effects. The BECA studies confirm this with conclusions that *"The sites are marginally stable during current and proposed operating conditions"* and *"The current and proposed ramping lower the factor of safety by up to 10%".*[29]

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26 AEE paragraph 3.1b
27 NZIER Report p 24
28 Based on 400kg/MWh for gas displacement
29 BECA Matahina HEPS Rangitaiki Hydrogeology and Riverbank Stability paragraph 8 p 12

5.6 With the current twin peaking regime TrustPower currently enjoys peaking value however engineering advice from Mr. Williams, Dr. O'Halloran and Mr. Philpott is that even this is having adverse effects.

5.7 I would expect the incremental value of peaking and portfolio firming to be in the order of 10% revenue gain when compared to run of river operations. Referring to the electricity value I estimate in paragraph 4.7 this indicates the value of peaking to TrustPower is in the order $2M per year or $70M over the life of the consent sought. This represents a benefit to TrustPower's shareholders, but in the context of contribution to the national electricity market there is insignificant benefit as only much the same volume of electricity is generated. If a more restrictive peaking regime is applied it may reduce this marginal value but will not reduce generation output.

Balancing wind generation

5.8 The AEE comments on the need for flexibility to compensate for the variable output of wind generation. I agree that wind turbines have variable output and any grid system that includes wind generation needs the ability to firm this variability to demand.

5.9 In my experience wind generation tends to realize less than average market price. This is because wind generation is uncontrollable and there tends to be a stronger correlation between the times of wind output and times of low market price. As a significant part of TrustPower's generation portfolio is wind power any ability to balance wind variability will be material to them. Wind and storage hydro are very complimentary in this regard.

5.10 In a national context however this balance is not as significant. With the development of wind power globally there has been a lot of work done to determine the maximum amount of wind generation a grid system can accept and this threshold is generally quoted at 20% energy ratio. In New Zealand over the last decade both the Transpower as national grid operator and the Electricity Authority have continued similar studies with similar results. I am involved with an island grid system where we currently run 45% wind penetration.

5.11 There is currently 615MW of wind capacity installed in New Zealand supplying about 4% of system demand[30] so at this stage well below the threshold where integration support is required. A recent study by Professor

30 NZ Wind Energy Association website

Goran Strbac for Meridian Energy concludes that by 2020 and with 2000MW of wind capacity installed a cost of only $2 to $3 per MWh will be required for wind support.

5.12 In my opinion the main if not only beneficiaries of a peaking regime and particularly the more liberal regime sought are TrustPower's shareholders.

6. OPERATING CONSTRAINTS – 72 HOUR ENVELOPE

6.1 The Application is for a flow regime that uses a 72 hour rolling average to cap peaking. TPL evidence is that this provides a constraint on peaking however it is constructed in a way that permits prolonged low flow.

6.2 It is difficult to obtain precise figures from the AEE and supporting reports because of the paucity of detail and because graphs are used rather than tables. For this reason check calculations are not precise but give a good indication.

6.3 Electricity prices are driven by supply and demand in the wholesale electricity market where generally highest prices are during week days. A peaking station will then reserve water during weekends and at night to use that stored water during week days, being the most likely times of peak demand or high market price. In the case of TrustPower which transfers most of its generation internally to its retail arm the same operating regime applies as they minimise spot price exposure and firm the uncontrollable output of their wind generation.

6.4 It follows that the logical operating scenario within the 72 hour envelope will be to have relatively high outflows on Mondays and Fridays with low flows during the intervening weekend and weekday nights. This provides the best economic return with operations managed to provide maximum storage and maximum peaking capability. This is the way TrustPower operate now whenever possible as confirmed by flow recordings at Te Teko attached to Mr. Crabbe's evidence.

6.5 Live storage capacity of the reservoir is given as $6.6Mm^3$.[31]

6.6 Mean inflow is given as $71m^3/s$ with a median inflow of $62m^3/s$.[32] For hydro operations then at mean inflow the reservoir has about one day's storage capacity with no outflow.

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31 BECA River Hydrology, Hydraulics and Bank Erosion Report p18

6.7 The Applicant's Constraint Window[33] indicates a peaking flow window of 105m³/s under the present regime, and that a 3 day rolling average outflow of about 60m³/s is required to have the same benefit under the proposed regime. It is assumed that the 3 day rolling average applies to the following day.

6.8 For example at the given mean inflow the following scenario is possible, assuming peaking is done during 16hrs each weekday and water reserved at other times to maximise price benefit. This scenario is well within the given reservoir capacity and maintains the lake at a constant weekly level of 75m, meaning there is reserve capacity for additional opportunity benefit. With a mean daily outflow of 59m³/s there would be 1.8 peaks/day ramping from 42m³/s to 150m³/s which is similar to average existing operations. With 140m³/s mean daily outflow there would be 4 peaks/day ramping from 108m³/s to 150m³/s which is similar to the proposed operations described in the AEE.

Week Days	W	T	F	S	S	M	T
Mean daily outflow m³/s	59	59	140	20	20	140	59
3 day rolling average outflow	73	86	59	86	73	60	60
Inflow m³/s	71	71	71	71	71	71	71
Daily water balance m³/s.hrs	288	288	-1,656	1,224	1,224	-1,656	288
Weekly water balance m³/s.hrs	0						

6.9 This illustrates that with average inflows the 72 hour envelope gives the Applicant the ability to have 2 days continuous low flow followed by flows varying from 20 to 150 cumecs on a daily basis for the rest of the week, with storage in reserve to exploit price opportunities as they arise.

6.10 The "worst case scenario" tabled by Mr. Levy[34] shows outflow being held at 25m³/s for 4½ days. This flow rate is less than the minimum 7-day low flow recorded in the river[35] and shows that proposed operations will result in extreme flow events downstream of Matahina.

32 BECA River Hydrology, Hydraulics and Bank Erosion Report p12
33 BECA River Hydrology, Hydraulics and Bank Erosion Report Fig10a p43
34 Tabled Document 8
35 BECA River Hydrology, Hydraulics and Bank Erosion Report Table 7 p 13

6.11 I have considered the evidence of Mr. Williams, Mr. Philpott and Dr. O'Halloran regarding the effects of peaking, and in my view the 72 hour constraint is unnecessarily permissive.

6.12 The evidence of Mr. Williams and Dr. O'Halloran prefers run of river operations so as to avoid hydro effects on the river but if peaking is permitted one constrained peak per day is all the river can tolerate. They also opine that generation flow should always exceed $40m^3/s$ unless inflows are less than this when generation flow should equal inflow, and that peaking should be limited to one peak per day with amplitude linked to inflows This is practicable from an operational perspective.

6.13 If effects due to the amplitude of fluctuations are to be reduced, these can be regulated by limiting the outflow change in any one peaking cycle. At present this is nominally 110 cumecs maximum change and the Application seeks a maximum of 130 cumecs change, but this could be constrained to a lower number to balance benefit to TrustPower with effects on the river. In evidence presented by Mr. Crabbe level recordings at Te Teko during operations to the "Informal Agreement" referred to in the AEE show level variations around 1.5 meters due to hydro operations. In my experience this is an extraordinary range of fluctuation to be permitted in a river especially where there is public recreation.

6.14 In my view a condition limiting daily peaking excursions to 2 x average daily inflow for the previous day would be a simple constraint that would still give TrustPower operational flexibility whilst reducing effects on the river as described in Mr. Williams evidence. Under this regime if inflows are at the EHG preferred peaking threshold of $40m^3/s$ then a peak excursion of $80\ m^3/s$ (more than the capacity of one machine) would be permitted and if inflows were at the historic mean of $71m^3/s$ this would rise to $142m^3/s$ or nearly full capacity of the powerstation.

National Policy Statement issues

6.15 The National Policy Statement for Renewable Electricity Generation contains a number of policies to be recognised making decisions on consent conditions that are more restrictive than current operations. In this regard my comments on relevant policies are:

(a) Policy A a). Neither run of river or single peaking operation will reduce the generation capacity of Matahina so its capacity to reduce

greenhouse gas emissions is not compromised. A more restrictive operating regime only affects the average price for power generated.

(b) Policy A b). The EHG are not opposed to continuance of the system emergency response conditions as they exist so the contribution of Matahina to security of supply is not changed.

(c) Policy A d). The recommendation of Mr. Williams and Dr. O'Halloran for a more restrictive operating regime is consistent with a need to reverse environmental effects.

(d) Policy B a). A more restrictive operating regime does not compromise generation output and the same resource is still available to TrustPower. Policy B b). Any energy loss attributable to flood management will be very small and is consistent with Policy A d).

6.16 Also material in this regard is the need for inflow recording as described by Mr. Meadowcroft to properly compare outflows to inflow.

7. **ASSESMENT OF PROPOSED MITIGATION CONTRIBUTIONS**

7.1 Whilst all effects of hydro operations on river banks and protection works can be avoided by return to run of river operations, the AEE concludes the only mitigation possible is by way of contribution toward the cost of effects. I agree with this proposition provided the quantum of the contribution is appropriate.

7.2 In pre-hearing negotiations I developed a "live" model concept which was proposed by the EHG to align any mitigation contribution to the actual cost of effects over a long consent period during which time external influences, such as climate or catchment change which although assessed by the Applicant as negligible, may also eventuate. It is accepted that in the context of a hearing this methodology cannot be applied unless TrustPower agrees, albeit that as Mr. Philpott comments *"The dynamic nature of the model..........is in my opinion an excellent method of ensuring a fair contribution is made".*[36] This model appears complex but is in fact a simple way of allocating and forecasting costs over time.

7.3 The live model has a scaling mechanism to index current costs and operations to the proposed regime. Mr. Philpott opines that this is too severe

36 Evidence of John Philpott paragraph 100

in the version he was given, so should be removed and the model used in a reactive way. I agree that the cost of effects can be addressed retrospectively and to this end both Mr. Philpott[37] and Mr. Levy[38] agree there will need to be an annual reset based on actual costs. But Mr. Williams has advised EHG, based on graphs appended to the BECA River Hydrology, Hydraulics and Bank Erosion Report as Figures D1 to D12, that the new flow regime has markedly more flow fluctuations of greater amplitude in reaches 2 and 3. So whilst Mr Philpott recommends this scaling up be removed and a higher base cost applied to *"...recognise there will be some increase in cost"*[39], in my view it is necessary to have a mechanism that links cost to effects under both the existing and proposed regimes.

7.4 All the mitigation analysis is based on status quo operations and current costs. As given in the evidence of Mr. Crabbe these costs can be expected to rise due both to insurance issues and increasing work required to manage flood risk. The evidence of Mr. Williams and Dr. O'Halloran is that this increased work requirement is directly related to peaking.

7.5 Taking account of the views of both Mr. Williams and Mr. Philpott I have reduced the scaling component in the model but believe it needs to remain to address the concerns of Mr. Williams. Using the existing consent conditions and given average daily peaking[40] as a baseline and comparing these parameters to the proposed average daily peaking[41] and time with generation flows below 40 cumecs,[42] the reduced scaling increases the EHG weighted average contribution for proposed operations by 11%.

7.6 Trying to negotiate a mitigation package pre-hearing has not succeeded and one of the key objectives of a "live" model was to avoid having to revisit this argument on an annual basis. In my view it is essential to have mitigation and/or conditions that will allow the parties to have a good working relationship through the consent period rather than a dysfunctional association.

7.7 Both Mr Williams and Mr Philpott conclude that the current annual payments made by the Applicant towards the mitigation of effects on the river have become very inadequate.

37 Philpott paragraph 132
38 Levy Appendix 13 p 6
39 Philpott paragraph 110
40 Given as 1.5 per day in the BECA reports and 1.8 per day in the Ryder report for the same measurement
41 Given as 2.4 per day
42 Given as 30% in BECA River Hydrology, Hydraulics and Bank Erosion Report Figure 18 p 49

7.8 The effects of hydro operations are not discrete so the fair allocation of costs is more qualified than quantified. Calculations by Mr. Levy, Mr. Philpott and Mr. Williams are all based on 2008 Asset Management Plans for river protection work.

Scope of Effects

7.9 There are three elements to river protection works being:

(a) Routine Operations and Maintenance which includes river monitoring, management and administration, insurance and a contribution to a flood reserve fund which is the first call for funding flood damage and is in effect the cost of minor flood repairs.

(b) Flood damage repairs. Minor repairs are normally funded from reserves and deemed to be maintenance but major damage is funded by loans and deemed to be a capital item.

(c) Capital improvements. This includes improvements to both natural and constructed elements of both river banks and stop banks as defined in paragraph **Error! Reference source not found.**.

7.10 The river system is divided into reaches number from the river mouth. Subject reaches are:

(a) Reach 1 - Thornton to Edgecumbe

(b) Reach 2 – Edgecumbe to Te Teko

(c) Reach 3 – Te Teko to Matahina

7.11 These reaches are all about the same length. There are 9 river reaches and 1 canal reach in the Rangitaiki – Tarawera Rivers Scheme.

7.12 The Applicant maintains effects are limited to Reaches 2 and 3 but both Mr. Williams and Mr. Philpott agree that effects continue into Reach 1 with lesser impact. I note that Dr. Toan in response to questions from the Commissioners indicated that 5% of the costs of river bank works in Reach 1 could be attributable to TrustPower.

Routine Operations and Maintenance

7.13 Both Mr. Levy and Mr. Philpott use the ratio of maintenance costs for the 3 reaches below Matahina to the total maintenance costs for Rangitaiki –

Tarawera Rivers Scheme (the "RTRS") to establish a proportion for each reach for the allocation of EHG routine costs. In the version given to Mr. Philpott, Mr. Levy has further discounted some costs and excludes Reach 1. This is different to Mr. Williams' approach which splits relevant administration costs equally between each of the 9 reaches (all being similar length) with half this per reach amount applying to the affected part of Reach 1. I do not disagree with the indexed approach for apportionment but I do not agree with further discounting used by Mr. Levy in the version given to Mr.Philpott.

7.14 The engineering experts have used the EHG's 2008 Asset Management Plan[43] firstly to derive relevant costs and then to determine an appropriate allocation based on their experience of cause and effects. This is summarised in the table below for routine operations and maintenance for the current operating regime. Note this table is based on current EHG costs which are expected to rise both as a result of effects of the informal agreement and the proposed flow regime. Only Mr. Williams has provided a view of how increased effects should translate into allocation as given in the "proposed" column below; but Mr. Philpott opines that the proposed regime will exacerbate negative impacts[44] and as his current allocations are similar to those of Mr. Williams it is reasonable to assume his view on proposed effects may be similar.

Routine Operations and Maintenance	Philpott	Levy	Williams Current	Williams Proposed
Allocation of total routine costs to Reaches 1,2,3,	15.9% 16.7% 8.8%	15.9% 16.7% 8.8%	14% 14% 7%	n/a
Qualified allocation to TrustPower Reach 1 for Routine Maintenance and Administration	10% 10%	0% 0%	5% 7.5%	10% 10%
Qualified allocation to TrustPower Reach 2 for Routine Maintenance and Administration	30% 30%	15% 7.5%	20% 15%	25% 20%
Qualified allocation to TrustPower Reach 3 for Routine Maintenance and Administration	30% 30%	25% 7.5%	30% 15%	40% 20%
Weighted average allocation to TrustPower	19%	8%	17%	23%
Dollar value (2008)	$47,363	$27,674	$56,000	$76,250

43 Current at the time of application but now superseded
44 Williams paragraph 16

7.15 It appears that Mr. Levy has undertaken no assessment of his own regarding the allocations to TrustPower. This is consistent with comments in his Appendix 13[45] and the notation on his spreadsheet model which is "...*"Percentage to TrustPower" uses the mid range previously proposed by EBoP"*[46] The qualified allocation of Mr. Philpott and Mr. Williams clearly assigns greater effects closer to the dam which is logical but they also consider Reach 1 is affected albeit to a lesser degree (i.e. only the upstream part).

7.16 Whilst there is close agreement between Mr. Philpott and Mr. Williams on the percentage, the reason there is a dollar difference is due to the treatment of input costs. Mr. Philpott omits flood reserve charges on the basis that he is unsure how this fund is applied[47] saying that only costs should be used[48] and Mr. Levy's evidence does the same thing but on the basis that flood reserves will result in "double counting".[49]

7.17 Flood reserves are kept in a separate account within the BOPRC and are the first call to fund flood damage, with additional finance as required for major events presently being funded by debt. As such reserves are only a prepayment method used to smooth damage repair costs over time and there is no possibility of "double counting" with correct accounting, which would simply be TrustPower contributing its share of additional finance as required. Flood reserves are essential to dampen the temporary nature of flood repairs over time for rating purposes and simply result in lower funding requirements for specific flood damage, noting flood reserves are depleted before additional funding is sought. In my view flood reserves should be included as this will reduce administration and can be considered as ongoing minor flood repair costs.

7.18 The main reason that the percentage proportion given by Mr. Levy is lower is that he finds the contribution by TrustPower for annual maintenance should be 15% for Reach 2 and 25% for Reach 3 but then halves this proportion for administration and flood reserves. As he apportions costs per reach on the basis of work done it seems illogical to then halve that proportion for administration of that work. Mr. Williams also reduces the percentage allocated to scheme administration but in my view a normal business practice

45 Levy Appendix 13 p 5
46 Levy Appendix 13 p 7
47 Philpott paragraphs 97-99
48 Philpott notation on spreadsheet summary page
49 Levy paragraph 194 a)

would be to have these proportions the same, e.g., if the TrustPower maintenance component is 20% of the total maintenance cost then the administration of that maintenance should also be 20% of the total administration cost.

7.19 If reserves are added to Mr. Philpott's calculations at the same ratio he uses for other contributions his weighted average increases to 23% and contribution for Routine Management, Operations and Maintenance increases to $58,123. The reason the % to $ ratio is slightly different to EHG is due to slightly different views on erosion related costs where Mr. Philpott excludes fencing but the EHG see stock exclusion as relevant to erosion control.

7.20 It is important to bear in mind these cost assessments are based on EHG's 2008 AMP and that as BOPRC is a member of the Local Authority Protection Program (LAPP) these costs will rise materially because of Christchurch earthquake liability within the LAPP, and with the current state of river banks as evidenced by photographs taken on 3 July 2011 and included in the evidence of Mr. Williams maintenance costs will grow.

Flood Damage Repair and Capital Improvements

7.21 There is debt accrued (over and above reserves expended and now depleted) repairing damage caused by major flood events in 2004, 2010, and 2011.

7.22 There is also debt accruing for a program of capital improvements that will increase the resistance of river banks and flood protection works to flood events. These works include the strengthening of foundations under stop banks and diversion capacity to reduce the pressure on stop bank (including their foundations) during flood events.

7.23 Both Mr. Williams and Mr. Philpott agree these works will mitigate the effects of hydro operation so TrustPower should contribute, and Mr. Levy says that *"the TrustPower contribution be calculated on the actual cost of works..."*[50] Both Mr. Levy and Mr. Philpott were given a breakdown of the existing debt that is relevant to hydro operations in Reaches 2 and 3, and have used this information.

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50 Levy Appendix 13 p 5

7.24 The issue here is what proportion of this debt is attributable to hydro operations and the views of the parties given below. The Williams columns are for the current flow regime and the proposed flow regime.

2004 Event	Philpott	Levy	Williams Current	Williams Proposed
Reach 1	n/a	n/a	5%	10%
Reach 2	30%	10%	15%	20%
Reach 3	30%	12.5%	20%	30%
2010/11 Events				
Reach 1	0%	0%	5%	10%
Reach 2	25%	10%	15%	20%
Reach 3	?	12.5%	20%	30%
Capital Improvements (erosion protection)				
Reach 1	10%	?	5-10%	10-17.5%
Reach 2	10%	10%	15-17.5%	20-25%
Reach 3	10%	12.5%	15-20%	17.5-25%

2004 Flood Damage

7.25 From the above table Mr. Levy considers TrustPower's liability for 2004 flood damage is $163,898; Mr. Philpott calculates their liability at $458,617.

7.26 Mr. Philpott considers the TrustPower contribution as a debt and calculates an annuity of $32,540pa being *"loan repayment at 5% over 25 years"*, Mr. Levy uses the same approach with a 4% interest rate to arrive at an annuity of $10,489. Both use an amortization methodology to calculate this and I agree this provides a fixed annual sum to repay the calculated debt over 25 years.

2010/11 Flood Damage

7.27 These events are recent and repair costs are still being finalised. Since numbers were issued the total cost of repairs to reaches 2 and 3 has been reduced to $1.1M and I have applied this value to the allocations given.

7.28 On this basis Mr. Philpott calculates the TrustPower contribution at $275,000, Mr. Levy at $116,804.

7.29 Using the same amortization basis to repay this over 25 years the annuities are $19,512 for Mr. Philpott and the EHG and $7,475 for Mr. Levy.

Combined Major Flood Damage

7.30 Mr. Williams has combined the cost of these events with a qualified allowance for future events giving an annual contribution of $40,000 compared to $17,946 for Mr. Levy and $52,052 for Mr. Philpott.

Capital Improvements

7.31 All three experts agree that TrustPower should contribute to relevant capital improvements, but Mr. Levy has omitted any contribution from the annual sum offered by TrustPower. In this context only strengthening of river banks or natural components of stop bank areas should be included, and any work on the constructed portion of stop banks or works that do not relate to hydro operations should be an EHG only cost.

7.32 I agree relevant capital improvements should be on a case by case basis but a percentage could be agreed at this stage which would avoid the need for future negotiations between the parties.

Escalation and interest rates

7.33 Mr. Levy proposes a fixed contribution with PPI escalation[51]. Historical evidence shows however that this index bears no relationship to growth in scheme costs where there is cost growth as well as inflationary movement.

7.34 In my opinion any contribution which properly mitigates the effects of the Application must be linked to actual costs on an annual basis. An inflation adjusted annuity will not do this and it is unrealistic to fix either interest or growth rates over a long term contract for cost recovery.

7.35 Initial calculations by EHG show an interest rate of 8%. This was used as the long term discount rate in a Discounted Cash Flow (DCF) method and although higher than the current rate the EHG currently pays[52] it was used to reflect a likely move to more commercial rates over time, noting that the model at this stage is totally forecasting and intended to be overwritten with actual data every year to become an actual/forecast model. The rate of 11.5% referred to by Mr. Levy[53] comes from a very early loan repayment

51 Levy paragraph 195. Presumably the PPI to be used is the construction index
52 EHG borrows internally from the BOPRC as rate marked to Government Bond Stock
53 Levy paragraph 194 c)

estimate by the EHG which comprised 5% principle and 6.5% interest as was applicable at the time.

Conclusions on mitigation offered

7.36 I have adjusted the EHG model as described in paragraph 7.3 and in the table below compare the total annual contribution as presented by Mr. Philpott and Mr. Levy and Mr Williams. The reason the number in the Philpott and Williams columns are different despite similar inputs is mainly because of the calculation methods used (amortization and discounted cash flow). This is of no consequence if actual costs are updated annually but the DCF model is more adaptable and has better forecasting capability. There does not seem to be any provision for inflation of routine costs in Mr. Philpott's calculations. It is accepted these methods cannot be incorporated in a condition of consent unless proposed by TrustPower however there is a real need to link any contribution to actual mitigation required over a long time period.

<table>
<tr><th>YEAR</th><th>Philpott</th><th>Levy</th><th>Williams Current flow regime</th><th>Williams Proposed flow regime</th></tr>
<tr><td>Year 1</td><td>$120,204</td><td>$51,520</td><td>$135,000</td><td>$195,250</td></tr>
<tr><td>Year 2</td><td>$134,394</td><td>$52,767</td><td colspan="2" rowspan="4">Adjusted annually to actual costs including interest and inflation</td></tr>
<tr><td>Year 3</td><td>$144,824</td><td>$55,352</td></tr>
<tr><td>Year 4</td><td>$144,824</td><td>$59,468</td></tr>
<tr><td>onward</td><td>Adjusted annually to actual costs including interest and inflation</td><td>Indexed to PPI and recalculated each year based on actual costs</td></tr>
</table>

7.37 In the table above only Mr. Williams makes provision for future flood events. Bearing in mind there will be floods in the future in my view as it would be sensible to provide for contingent events. As actual costs are intended to be included at the end of each year there is always an ongoing reconciliation to actual.

7.38 Whilst the views of Mr. Philpott and Mr. Williams are very similar on known costs there are a number of dissimilarities with the contribution proposed by TrustPower. Engineering advice given to the EHG is that the TrustPower

offer is inadequate and a fixed contribution simply will not reflect future uncertainties both for effects and environmental change. This is the reason a live model approach was proposed to TrustPower and is endorsed by Mr. Philpott.

7.39 By way of comparison the EHG model produces the following results assuming the average number of peaks daily increases to 2.4% and for 30% of the time generation flow is less than $40m^3/s$. This includes a contingency for future flood events and uses BOPRC long term interest rates.

	Interest Rate	Current Flow Regime	Proposed Flow Regime
Year 1	5%	$174,752	$193,392
Year 2	5.5%	$185,774	$199,602
Year 3	6.5%	$195,918	$216,816
Year 4	7%	$204,314	$226,108

Evidence of Dr. Layton

7.40 In response to questions from the Commissioners Dr. Layton gave replies to which I respond as follows where they are relevant to my evidence.

7.41 With reference to the EHG model Dr. Layton cautioned against the use of long term modelling due to unreliability on future variables. I agree but presume Dr. Layton has not seen the EHG model which is clearly an actual / forecast format where actual numbers replace forecast numbers at the end of each year and forecast numbers are updated periodically. This provides for cost allocation that is based on actual costs over time but also provides a forecast on future costs. In my view this is a useful feature for longer term planning.

7.42 Dr. Layton found the 8% discount rate used by EHG as described in paragraph 7.36 unrealistically high. I have now received advice from the BOPRC on interest rates they use for strategic planning and note these increase from 5% in 2012 to 7.5% in 2016 staying at that level thereafter.

7.43 Dr. Layton commented that comparing capital value was not appropriate for determining an allocation. This proposition was put to TrustPower in the course of pre hearing negotiations which are outside the compass of the hearing process and in the absence of better information was proposed as a

commercial arrangement for rights to EHG assets that would allow TrustPower increased profitability. In an ex hearing context any basis to which both parties agreed could be used.

7.44 Dr. Layton opined that benefits to TrustPower translate to benefits to local consumers. In fact there are very few TrustPower consumers in the local area but in any event the price to most consumers is driven by retail competition and in my experience increased profits are not passed on unless retail competition forces this.

7.45 Dr. Layton was asked if contributions should be made in respect of major flood events in 2004, 2010 and 2011. The essence of evidence by Mr. Williams, Mr. Philpott and Dr. O'Halloran is that hydro fluctuations have for some time caused preconditions that make the river more susceptible to flood damage. As this damage is repaired using rock lining the risk to the river becomes incrementally less as the river more resistant to hydro operations. To this extent TrustPower is able to benefit from work that has been done however it is funded and I concur with Mr. Williams and Mr. Philpott that it provides value to the Applicant that should be accounted for.

7.46 Dr. Layton was asked if the value at risk for lowering lake levels to provide flood attenuation could be calculated. He advised this was complex and simulation modelling would be needed. This is the methodology I use in Section 8 below.

Opinion

7.47 The scope of my evidence is not to comment on the allocations qualified by the engineering experts but rather to assess fair compensation for effects based on their views. In my opinion:

(a) Both the quantum and nature of mitigation offered is insufficient to address the costs and risks the EHG must manage; and

(b) Any mitigation package must be linked to actual costs over time; and

(c) It would be prudent to use a long term model and include an allowance for any less restrictive operations that may be consented.

(d) It is common ground that RTRS costs can be divided into 3 categories, viz.,

(i) Routine Expenditure

(ii) Repair of periodic major flood damage

(iii) Capital improvements that enhance river bank stability (including natural banks underlying stopbank construction.

7.48 I believe that a percentage allocation can be assigned to each of these categories for each of the subject reaches, and that the quantum needs to be assessed against the flow regime permitted.

8. POTENTIAL ENERGY LOSS DURING FLOOD MANAGEMENT

8.1 I have been asked to comment on the potential loss to TrustPower if the lake is lowered to manage a pending flood and the flood does not eventuate, with particular reference to the 300 m^3/s threshold for flood management.

8.2 In his statement of evidence Mr. Lilley describes a 300 m^3/s event as relatively frequent having occurred 21 times in the last 60 years. In response to questions Mr. Lilley advised commissioners that in the worst case scenario (lake fully dewatered with no flood eventuating) the maximum loss would be 1.4GWh per event.

8.3 Mr. Meadowcroft is seeking the 300 m^3/s flood management threshold to reduce the risk of flood damage downstream of Matahina and in doing so moderate the consequences of hydro operations on river works. Mr. Meadowcroft is confident that with adequate flood prediction the incidence of "false alarms" will be very low.

8.4 I have assumed "very low" to be a most likely loss 0.2GWh over a range of loss from 0 to 1.4GWh per event with an average recurrence interval of 2.86 years, using the $79/MWh unit price estimated in paragraph 4.7 to assign average current unit value. Simulation modelling of this data gives a mean annualised value at risk of about $10,000. Each event will have a different value depending on price profiles at the time but this is a long term average further to which I note that periods of high rainfall are also likely to be periods of low price.

Roger Burchett
July 2011

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of an application by **TRUSTPOWER LTD** to the **BAY OF PLENTY REGIONAL COUNCIL** for water permits associated with the operation of the Matahina Hydroelectric Power Scheme

SUPPLEMENTARY STATEMENT OF EVIDENCE OF ROGER BURCHETT

1. My name is Roger Burchett. I am an engineer advising the Bay of Plenty Regional Council's Environmental Hazards Group. My qualifications and experience are as set out in my evidence in chief.

Purpose of evidence

2. The purpose of this supplementary evidence is to address the question from Commissioners to Dr. Wheeler asking "what is the value loss to TrustPower if twin peaking is constrained to single peaking as per the EHG submission".

Background

3. The revenue assessment given in paragraph 4.7 of my main evidence is cursory and only intended to put the cost of a runner upgrade into perspective and to compare the parsimony relief sought by the EHG to the value derived from Matahina by TrustPower. This is because the data needed to do detailed analysis is available only to TrustPower and commercially sensitive.

4. Both Dr. Wheeler and I use data in the public domain but from different sources so inevitably have slightly different estimates. For example Dr. Wheeler uses 275GWh/yr output given in TrustPower's AEE while I use 290GWh/hr given on their website. Dr. Wheeler then assumes his number is gross but I do not. TrustPower simply do not provide sufficient data to address this question in detail.

15. With multiple peaking the lake is recharged more than at present during the weekends and at night (due to the low flow regime) and during the week will tend to be kept at a higher average output with small (10-20MW) peak ripples throughout the day. With the faster ramping rates sought output can be ramped up and down within minutes to match half hourly price signals. TrustPower will still have the ability to single or double peak to best match output to their system and multiple peaking will be possible over a longer time duration. In qualified opinion is this will have much higher marginal value compared to the difference between single and double peaking.

16. Based on the above my qualified assessment is that twin peaking adds value (otherwise TrustPower would presumably not have obtained the 2003 twin peaking variation) but this value is small compared to value gain through multiple peaking.

Quantified Assessment of value change

17. In my main evidence (paragraph 4.7) I have estimated the average net energy price for the TrustPower generation portfolio from data in their 2011 Annual Report. This portfolio is comprised of storage hydro, run of river (RoR) hydro and wind power so will contain an element of peaking value which overall I estimate to be in the order of 5%. This then indicates a run of river unit price around $75/MWh. Using output given in the AEE and assuming this to be net output (by reference to output given on their website) the run of river export energy value of Matahina is 275GWh x $75/MWh = $20,625,000.

18. I have no way of estimating the spinning reserve value of Matahina but as it is designed for this mode and used in this mode I would expect spinning reserve to add at least 10% to the energy value giving a total yield of $22,687,500p.a. under RoR operation. Note the spinning reserve value does not change with different peaking scenarios.

19. Due to the high plant capacity to lake capacity index single or twin peaking is limited to daily rather than seasonal value.

20. Based on my qualified assessment my "best guess" is:

    a. Single peaking will add about 6% to RoR energy value
    b. Double peaking will add about 7% to RoR energy value
    c. Multiple peaking with low flows and rapid ramping will add about 10% to RoR energy value

21. Whilst power prices have enjoyed rapid escalation over the last decade this will slow down and I use 4%pa as the PPI to calculate present value over 10 and 35 year consent periods.

22. Compared to the current twin peak consent my indicative estimate is then:

a. Value loss for reducing to single peak
    i. $206,250 p.a.
    ii. $$1,672,872 10 year PV
    iii. $3,849,576 35 year PV

b. Value gain for multi peaking
    i. $618,750 p.a.
    ii. $5,018,617 10 year PV
    iii. $11,548,729 35 year PV

Roger Burchett
Thursday, July 07, 2011

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IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of an application by **TRUSTPOWER LTD** to the **BAY OF PLENTY REGIONAL COUNCIL** for water permits associated with the operation of the Matahina Hydroelectric Power Scheme

STATEMENT OF EVIDENCE OF PHILIP BRENT WHEELER

1. INTRODUCTION

Qualifications and experience

1.1 My name is Philip Brent Wheeler. I am an Economist and acting as advisor to the Bay of Plenty Regional Council's Environmental Hazards Group ("EHG").

1.2 I hold the degrees of B.A., Post Grad Diploma in Arts (1st Class hons.) (1976) and have a Ph.D in economic geography (1980), both from the University of Otago. I have worked in local and regional government and for central government for the N.Z. Treasury. For the last 19 years I have run an economics and financial advisory company.

1.3 I was a member of the 1991 Review Group for the Resource Management Act 1991 ("RMA") and have provided expert evidence over many years to local government hearing committees, the Environment Court and its predecessor, the Planning Tribunal, as well as the High Court across a range of matters involving local government and the RMA and its amendments, several of which focussed on water resource issues.

1.4 Specific experience I have which is relevant to these proceedings includes:

(a) My core work as an economist assessing costs and benefits of resource use (including resource consents and applications for

Newmont Waihi over a 10 year period) membership of the 1991 Resource Management Bill Review Committee, cost benefit analyses for several resource consents in Auckland City in respect of outdoor advertising, waterfront tourism development and for Waitakere City, assessments of roading and related proposals.

(b) Work as Deputy City Planner at the Palmerston North City Corporation (1981 - 1987) and Deputy Regional Planner for the Manawatu United Council (1981 - 1987).

(c) Appointment as a director of Watercare Services Limited from (1992 - 1995).

(d) I was a member of the three person task force which implemented the split up of the former Electricity Corporation of New Zealand into the three state owned generators – (Genesis, Meridian and Mighty River Power) and I was the capital markets advisor in the Electricity Distribution Reform Unit (1991 – 1993).

(e) For the past eight years I have been chair of Fertco Limited, a niche agricultural nutrients and fertiliser manufacturer and distributor and during my time at the Treasury worked on the privatisation and sale of State owned irrigation companies to farmer and like interests.

Involvement in Project

1.5 I have been asked by the Environmental Hazards Group ("EHG") of the Bay of Plenty Regional Council ("BOPRC") to consider the likely economic effects of the regime proposed by TrustPower Limited (TPL), the applicant, on river management having particular regard to the likely effects related to existing and future flood protection works in the catchment.

1.6 I have also been asked to comment on the analyses produced by the NZIER in respect of these matters along with any other matters of relevance.

Expert Witness Code of Conduct

1.7 I have been provided with a copy of the Code of Conduct for Expert Witnesses contained in the Environment Court's Consolidated Practice Notes 2006. I have read and agree to comply with that Code. This evidence is within my area of expertise, except where I state that I am relying upon the

specified evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Purpose and scope of evidence

1.8 The purpose of my evidence is to provide an analysis of the costs and benefits of the proposed changes to status quo operations and activity sought as part of the re-consenting of activity associated with the Matahina dam.

1.9 Specifically, I will:

(a) Address the context for my assessment (Section 2).

(b) Provide an overview of the aspects of the proposal relevant to my assessment (Section 3).

(c) Describe my analysis (Sections 4 to 11) with specific analyses of costs and the physical environment (Section 5) and benefits (Section 8).

(d) I then set out conclusions (Section 12).

2. **THE CONTEXT FOR MY ASSESSMENT**

2.1 The lower catchment of the Rangitaiki River and its natural flood plain is home to a population of some 9,000 people. Agricultural production and related activity located in the area make a significant contribution to the district and regional economy and the area is characterised by a well-developed social and economic infrastructure supported by the physical infrastructure typical of such communities.

2.2 The behaviour of the river regime and its processes brings various costs and benefits to this community. These take many forms such as the opportunities providing for agricultural production, residential occupation and recreational activity. Such opportunities are accompanied, however, by the threat of flood and the costs of managing the river regime such that the community and its assets are protected.

2.3 Alterations in the river regime and its processes therefore have the potential to impose material economic impacts on the community. Those impacts fall within the type of impact recognised as requiring consideration under various sections of the RMA and the Regional Plan.

2.4 The river and the Matahina Dam is of course a resource in and of itself with its primary economic contribution to date being the generation of hydroelectric power (HEP) through the generating operation of TPL. That operation produces benefits (electricity, employment, expenditure on inputs and returns on capital) which are valuable.

2.5 Alterations to the river regime have the potential to enhance such benefits. These impacts also fall within the type of impact recognised as requiring consideration under the RMA.

2.6 It should also be stressed that costs and benefits both include non-monetary as well as monetary factors. Thus comfort taken by consumers from security of electricity supply can be a benefit just as anxiety caused by fear of flood may be a cost. While such benefits and costs are difficult to quantify that is not to deny their existence.

2.7 At present, all of these costs and benefits co-exist in a particular mix arising from historical development of human activity and its interaction with the physical environment over a period of time.

2.8 The purpose of the economic analyses is to throw light on the impacts of the alterations proposed in the application.

3. THE PROPOSAL

3.1 The TPL proposal, background to it and related detail is described fully in the Officer's report. For the purposes of the economic analyses I have undertaken the relevant aspects of the application are the proposals to:

(a) Allow for 'peaks' in the dam operation when inflows to Lake Matahina are equal to or greater than 20 cumecs;

(b) Allow for the ability to 'peak' as required;

(c) Establish a Constraints Envelope that defines the operation of the HEPS when inflow to Lake Matahina are equal to or greater than 20 cumecs;

(d) Allow the 'ramping down' rate to be at a constant 30 cumecs per hour; and

(e) Allow the 'ramping up' to be at a maximum of 97 cumecs per hour.

3.2 I understand that the applicant intends to the proposed new regime to minimise the impacts of the operation on the environment.

4. APPROPRIATE ECONOMIC FRAMEWORK

4.1 This section will address the appropriate framework for considering the likely impacts of the Applicant's proposal.

4.2 That framework consists of the conventional cost benefit schema used by economists applied in the context of the relevant aspects of New Zealand wholesale and retail electricity markets, the place of TPL in that market and the likely effects of their proposals in the physical, social, economic and environmental context in which those impacts will be felt.

4.3 The most important element of the cost benefit framework as applied in this context is its notion that all proposals are likely to have both benefits and costs of some kind. What is critical however is the extent to which those benefits exceed the costs and, to the extent that can be determined, by how much.

4.4 While the immediate focus of the application is the Rangitaiki catchment, the surrounding district and the Bay of Plenty Region, the nature of the electricity markets in New Zealand mean that the national context is also important for the reasons set out below.

5. LIKELY IMPACTS ON THE PHYSICAL ENVIRONMENT

5.1 This section addresses my reading and understanding of the likely effects of the applicant's proposal in respect of how it will alter river processes which have or are likely to have impacts from an economic perspective, both in terms of costs and benefits as these concepts are dealt with under various relevant and applicable parts of the RMA.

5.2 In arriving at conclusions in respect of likely impacts of the changes sought by the applicant I have read and considered:

(a) The various reports produced by Beca Infrastructure Limited;

(b) The BOPRC Planning Officer's report;

(c) The evidence of Mr Bruce Crabbe, Mr Gary Williams and Mr Roger Burchett for the EHG; and,

(d) The various versions of the independent report commissioned by the BOPRC and produced by Mr John Philpott consulting engineer.

5.3 The primary and potentially most substantial impacts appear to be concerned with effects on hydrology, river morphology and process and the relationships between these factors and likely future river behaviour, flood effects and hazards along with the totality of the ecosystems involved.

5.4 I discuss the various assessments of these below.

5.5 In addition, there appear to be related concerns about aquatic life, recreational opportunity, cultural effects, abstraction impacts, vegetation effects and climate change.

5.6 Assessments of these concerns and their implications is contained in the Applicant's documentation and evidence and in the Officer's report. While not belittling the significance of these matters, I note that these do not form a major focus of my economic assessment and I regard them as having been dealt with adequately in the Officer's report.

River Process Impacts

5.7 In assessing the likely impact of the proposal, the Beca report notes that issues to be considered include changes in the fluctuation levels of the river, the effects of sediment entrainment on river bed levels, flood impact duration and frequency, bank erosion effects during flooding, and bank erosion exacerbation caused by the inability to establish vegetation on banks and through riparian planting.

5.8 Mr Williams, assessing likely impacts on behalf of the EHG, considers that in amongst these and other impacts there are a number of different failure processes that can give rise to breaching / failure of the stopbanks; his expert opinion is that the effects of the hydro peaking on the river banks and channel conditions adversely impacts on the likelihood of all of these failure processes.

5.9 The Beca report concludes, in respect of the matters they raise and assess, that these impacts either do not represent a material departure from the situation which currently prevails, or are minor, are in some cases beneficial (for example in respect of river bed levels), or are already mitigated satisfactorily. In some cases (for example, problems related to lack of

vegetation on banks), the Beca report notes that TPL accepts the need for further mitigation.

5.10 Mr Williams' assessment is that the Beca analysis is minimal, especially in respect of the engineering interpretation of findings and that the proposal raises very serious concerns for the integrity of the scheme and the management of the river to mitigate its erosion and flooding hazards.

5.11 Mr Philpott has undertaken an independent evaluation of the effects of the proposal and the assessment undertaken by EHG and TPL and concludes that:

> *"there is no doubt that there is a negative impact on the Rangitaiki River arising from existing operating regime of the Matahina Scheme and that the proposed changes to the operating regime will not only continue to cause these negative impacts but will increase them."* (para. 16).

5.12 Considering each of the statements, I conclude that Mr Philpott's conclusion provides the most appropriate point of departure for any economic analysis.

5.13 In addition, I note that:

(a) All parties accept that the scheme has since its inception imposed costs of various types through its impact on the catchment;

(b) There are likely to be beneficial physical impacts in the catchment (examples might be better control of minor floods, improved availability of information for river behaviour monitoring and generation of valuable economic and other opportunities) but the costs of physical effects remain a significant concern;

(c) There have been extensive protection and related works undertaken as part of the Rangitaiki Tarawera Rivers Scheme to provide protection from flood hazards. Most of these flood protection and flood mitigation works have been undertaken since 1998. TPL has not contributed to such works, other than the small annual payment agreed in 1998. These works provide mitigation for the impacts of the Matahina dam on downstream flood risk;

(d) Such mitigation activity, for example the flood protection and river bank works, has involved and continues to involve costs of an operating and a capital nature; and,

(e) There has been acceptance of the above to the extent of an historic (1998) cost sharing arrangement having been devised and implemented by the parties.

5.14 The critical issues with the current proposal then seem to me to be:

(a) Mr Philpott's conclusion that the proposal will "not only continue to cause these negative impacts but will increase them"; (para. 16).

(b) Mr Williams' conclusion that the negative impacts will have adverse effects on the "likelihood of failure processes". (para. 10).

6. IMPACT MITIGATION COSTS

6.1 Flood hazard has been an issue in the Rangitaiki catchment, particularly in the floodplains downstream of the Matahina dam for some years and arises as a result of naturally occurring rainfall, runoff and river processes. Various flood protection works have been developed over the years to address this issue. The impacts related to the Matahina HEP scheme operations to date have likely exacerbated flood risk. The flood protection system which now exists downstream of the Matahina dam forms part of the Rangitāiki – Tarawera Rivers Scheme (RTRS).

6.2 At a governance level, the scheme is managed by the Bay of Plenty Regional Council Environmental Hazards Group with community input via the Rangitaiki-Tarawera Rivers Scheme Liaison Group.

6.3 The development and maintenance of the RTRS involves a series of complex operating and maintenance procedures as well as a capital works programme designed to meet agreed flood protection objectives and safety standards.

6.4 I have examined both the calculations and rationale behind the cost of these operations and capital works. There is some difficulty in estimating the additional costs which the proposal is likely to impose because of the uncertainties about:

(a) The number of "peak flows" which TPL is likely to run. I understand that this is not as yet precisely clear to TPL and is unlikely to be until some experience is developed; and,

(b) As a consequence the future operating costs of the rivers scheme are difficult to estimate with credible or useful levels of precision.

6.5 Accordingly I have proceeded to provide a range of cost estimates for the rivers scheme operating costs as follows

(a) At present the annual operating costs for the RTRS scheme (as advised by Mr Crabbe) is some $1,125,000 p.a.;

(b) I have calculated what the annual cost would be if the proposal was to add 5%, or 10% or 15% or 20% to existing costs and set these numbers out as a means for providing a range of estimates.

(c) These are shown in the following table:

Operating costs estimates at different levels		
	Annual Addional Cost	
Current	$ 1,125,000	
Increase	Additional p.a.	In Perpetuity
5%	$ 56,250	$ 1,125,000
10%	$ 112,500	$ 2,250,000
15%	$ 168,750	$ 3,375,000
20%	$ 225,000	$ 4,500,000

6.6 Costs are expected to escalate over time but for the purposes of the cost benefit comparison to be made below I have ignored such escalation for both costs and benefits because providing all streams of costs and benefits are treated identically in this respect (thus benefits from TPL's activities are not escalated either). This allows needless complexity to be avoided.

6.7 Expressing the annual costs as a present value, I have used the current 10 year government bond rate of some 5% to capitalise annual costs. The rationale for this is that the costs will be incurred regardless of TPL revenue in any given year and is a fixed rather than variable commitment[1].

6.8 The result is a present day value of some $22.5m for the operating and maintenance costs of the RTRS mitigation scheme.

6.9 In addition to this, the expected capital cost of $6.5m needs to be considered. Given that the payments are to be spread over five (5) years the same discounting process shows the present value of capital commitments to be $5.63m.

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1 In this sense the cost is being discounted at the "riskfree rate" because there is no risk that the costs will not be incurred. The 10 year rate is an accepted proxy for the riskfree rate (rate source National Bank as at June 2011).

6.10 Existing debt commitments (built up from past repairs and capital work occasioned by previous floods and like impacts) has been omitted from the costs. The reason is that while these will have to be paid they are not attributable to changes sought through the application.

7. POTENTIAL FOR MAJOR FLOOD PROTECTION FAILURE

7.1 In addition to concerns about stability of banks, impacts of changes in fluctuation levels and like river process and hydrological impacts, I note that members of the EHG qualified in engineering and hydrological matters and their advisors have expressed concern that exacerbation of existing impacts is likely to lead to an increased risk of significant stop bank and protection works failure. Evidence presented and referred to above reflects those concerns.

7.2 Apart from the specific process related reasons for this possibility, it is important to appreciate that with the deterioration in the "base conditions" – such as the deterioration experienced to date - the risks originally associated with impacts apply thereafter to a new, even more sensitive base and are thus exacerbated.

7.3 The result of failure would be inundation of the Rangitaiki floodplain with related losses. Drawing on recent Ministry of Agriculture and Forestry work on climate change, Mr G. Williams[2] estimated production and flood damages to agricultural land on the Rangitaiki Plains (as well as other floodplains around New Zealand).

7.4 Annual agricultural revenue from the Rangitaiki Plains was estimated at over $200 million. The estimated flood damage to agricultural land from a single over-design flood event was estimated at around $150 million. This included only the direct economic losses and not indirect effects. Indirect and induced losses may be estimated using multipliers and once adjusted by 25% as a conservative factor to remove the effects of double counting opportunity costs from the raw multiplier of 2.27,[3] provide an estimate of direct, indirect and induced (i.e. total costs) costs of:

$$\$150m \times 2.27 = \$340.5m \times (1 - .25) = \$255.4m$$

2 See also Statement of Evidence by G. Williams for the present hearing.
3 From the Brent Wheeler Group 2010 input output multiplier database updated annually.

7.5 This is an estimate of the costs should a stop bank and associated works failure occur. There is of course no certainty that such an event will occur. What can be said, in the light of the engineering evidence and advice is that:

(a) There is, under the existing arrangements a non-zero positive probability of a failure; and that,

(b) The proposal is likely to increase the adverse impacts which could lead to such a failure.

7.6 Given the great uncertainty surrounding prognostication in areas such as these coupled with the necessary absence of data, there is an understandable reluctance amongst professionals to place probabilities around such events. Prudence suggests caution in estimating the probabilities and thus the likely costs.

7.7 The statements of evidence provided by Mr Williams and Mr Philpott, however, discuss increases in risk which are material. A typical benchmark for "materiality" is 5%[4].

7.8 We are therefore dealing with a probability of failure which is already material and positive, and is estimated to likely increase. In my view, this suggests that a minimum value at risk can be given, as a certainty equivalent (probability of an event occurring times the impact of the event) of 10% of the total cost (5% existing plus 5% increase on the now deteriorated base) likely to be imposed by stop bank failure.

7.9 This gives:

10% x $255.4 = $25.554m

7.10 Summing the estimates of mitigation costs therefore provides a present day value total as follows:

(a)	Operating costs	Varies from $1.125m to $4.500m
(b)	Capital costs	$ 5.63m
(c)	Value at risk from failure	$25.55m
	TOTAL	Varies from $32.3m to $35.7m

4 Typically used as a rule of thumb in accounting and finance amongst other disciplines.

7.11 From an economic perspective then, the issue to be addressed is whether the benefits of the proposal offset the costs implied by these conclusions.

8. LIKELY IMPACTS ON THE ECONOMIC ENVIRONMENT

8.1 This section will address my understanding of the likely effects of the applicant's proposal from an economic and commercial perspective having regard to consumers, the owner and producer TPL and the wider economic and policy context involving local, regional and national impacts to the extent that these are or might be material.

8.2 In arriving at conclusions in respect of likely impacts in these areas, I have read the statements and reports prepared by:

(a) The Applicant;

(b) The BOPRC Planning Officer's report;

(c) The New Zealand Institute of Economic Research (NZIER); and,

(d) The various reports produced by Beca Infrastructure Limited, particularly where they address economic and commercial matters.

8.3 There are likely to be both economic costs and benefits arising from the proposal. Physical impact factors likely to lead to costs have been outlined above.

8.4 The net economic effect of the proposed modified operating regime is expected to be:

(a) Potentially an additional three (3) GWh per annum in output; which is,

(b) An increase of 1.13% on the existing net 265 GWh[5] present annual average generated by the Matahina scheme.

8.5 The NZIER report, in assessing the scheme as a whole (i.e. not just the incremental gains sought in the present application) sets out what it considers to be the main benefits of the Matahina HEP scheme as being:

(a) Creation of a valuable commodity (electricity) from a naturally renewable resource (water);

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5 Transmission losses and other factors reduce installed capacity of 275 MWh to an estimated 265 MWh.

(b) Avoiding the need for some higher cost thermal generation at the margin, with reduction in associated combustion emissions, including greenhouse gases;

(c) Wider consequences for the electricity supply system and the availability of electricity to consumers across the system (e.g. geographic spreading of climate/storage risk);

(d) Creation of recreational opportunities such as inland navigation and lake fishing, and creation of new amenity characteristics in its neighbourhood; and,

(e) Expenditure impacts from employment and purchases in the local economy.

8.6 In addition, I note the following potential benefits dealt with only indirectly in the NZIER report:

(a) The potential to enhance the wealth of TPL shareholders and thus the more efficient use of capital for the owners (Infratil and the Tauranga Energy Consumer Trust);

(b) The lowering of financial risk for the TPL shareholders and better assurance of security of electricity supply; and,

(c) The potential gains to TPL consumers through enhanced ability of the company to maintain and possibly improve customer services and their security.

8.7 I note that the ability of the company to perform strongly in areas of service provision – notably under conditions of stress such as flood or other natural disaster (for example, ability to continue to provide electricity during times of disaster) is connected to mitigation and the costs imposed through physical impacts of the HEP schemes it operates and possibly the present proposal.

8.8 I deal with each of the potential benefits in the following sections.

Creation of a Valuable Commodity

8.9 There is in my opinion little dispute over the notion that additional electricity supplied at competitive levels of price and service (essentially assured by market pressures and processes rather than the specifics of this proposal) is valuable in the light of expected growth in quantity demanded.

8.10 Of greater interest is the extent to which the current proposal (as opposed to the Matahina scheme itself) adds to such production and value particularly relative to alternatives. As noted by the NZIER, the entire existing operation at Matahina is small on a national scale at some 0.7% of national generation output capacity. The amended flow proposal involves increasing generation by an estimated 3 GWh or 1.13% per year over an unknown time period.

8.11 The NZIER makes several important points about the likely impact of increased output:

(a) The output increase is small and should be seen in the context of the national market where a variety of complexities (notably network effects) make precise observations about impacts simplistic;

(b) It is unlikely that consumers (anywhere including locally or regionally) would notice perceptible changes in prices as a result of either the existence of the present operation or expanded output arising from the proposal; and,

(c) What can therefore be said and supported is that the output will contribute to overall provision and may improve cost efficiency of supply which is valuable on a per unit basis but is not large in terms of overall impact.

8.12 I agree with these points and note in addition that these very points tend to nullify their claims regarding "avoided costs" as follows.

Avoided Costs

8.13 The NZIER report suggests that the small increase in output understates the benefit of the expansion which will arise through the proposal in three main areas:

(a) Because the Matahina scheme is "in place" capital invested, in it is now sunk and it therefore faces a low Short Run Marginal Cost ("SRMC") in its operation. In particular, the costs it faces are lower than those of alternatives which involve building new plant or systems where cost of capital has to be recovered;

(b) The most likely alternatives – coal fired and thermal based generation – involve significantly higher SRMC profiles than those faced at

Matahina and are thus less efficient and less valuable to their owners (lower producer surplus); and,

(c) Both the coal and thermal alternatives generate carbon emissions significantly in excess of the Matahina expansion option. Such emissions increase the national liability in respect of current and expected future international commitment to greenhouse gas reduction.

8.14 These arguments and their material relevance all rest on the assumption that without the additional output from Matahina there will be some switching within the system viewed as a whole to either the thermal or the gas fired alternative.

8.15 In my view, as a generalisation, such arguments are correct but only where:

(a) Material and significant increases in demand are likely to be seen; and,

(b) There are significant capacity constraints at the required level of demand within the existing system such that quantity demanded cannot be met by existing capacity; and,

(c) Other growth alternatives such as HEP expansion or increased management efficiency regimes by other HEP generators are more costly than coal or gas alternatives; and,

(d) Price changes would not emerge such that non-gas and non-thermal options became competitive; and,

(e) Other low SRMC alternatives such as wind (including TPL's own wind alternatives) generation are infeasible; and,

(f) No combination of these alternatives was able to prevail ahead of gas and thermal options; and,

(g) That the Matahina option is, uniquely, able to offer the only alternative to gas and thermal.

8.16 It is, in my opinion, equally plausible that, faced with increased demand in the competitive generation market, generators other than those operating gas fired and thermal systems and contemplating loss of market share would face

strong and growing incentives to respond through the several means open to them to create offerings which rapidly made them viable.

8.17 An indication of the lack of pressure for adoption of any additional Matahina HEP capacity (and therefore substitution for gas and coal with cost avoiding benefits) is given by PWC's conclusion in a recent analysis that the market is characterised by "soft demand" (so that there is little pressure for additional supply of electricity) coupled with significant recently added capacity and significant planned capacity[6].

8.18 In addition, to the extent that non-gas and thermal offerings are created, the apparent "savings" in carbon emissions accruing to HEP over the thermal and gas alternative do not arise either.

8.19 The conclusion is then that the SRMC advantage over gas and thermal along with the carbon emission avoidance benefits may not, particularly at the levels of output contemplated, necessarily lead to the cost savings claimed.

8.20 The benefits attributed to "costs avoided" are therefore in my view easily over stated.

Benefit from Cost Avoidance Calculation

8.21 I set out below calculations to show the maximum benefit (a hypothetical value) followed by what I believe to be a more realistic estimate of benefits to be gained through cost avoidance:

	Price Per MWh	Displacement Factor	Matahina "Saving" 3 GWh"
Coal	$ 61.60	0.963	$ 163,132
Gas	$ 77.50	0.963	$ 205,239

Present value: $ 3,683,720

8.22 In relation to this table:

(a) As explained in the NZIER report whether gas or coal is used as a substitute when hydro falls short depends on a number of context specific factors and I have proxied this by taking the average saving as the input to the Present Value calculation;

6 PWC "Leading Energy" Auckland, November 2010.

(b) To maintain consistency with the capitalisation rate used in the costs calculation I have again used the 10 year government bond rate of 5%;

(c) The calculation is made (and this is consistent with the figure used in the "benefit to shareholders calculations below) on the basis of the 275 MWh net generation used by the NZIER to reflect transmission costs / losses where closer generators are displaced;

(d) The estimates of greenhouse gases used by the NZIER have been adopted. I agree with the comments on estimation difficulties made in their report and see no advantage to moving from the assumptions used in the report.

8.23 In the following table I have assumed that only 75% of the hypothetically achievable revenue will be derived for the reasons set out above and thus benefits through "avoided cost" will be lower as set out:

	Price Per MWh	Displacement Factor	Matahina "Saving" 3 GWh"
Coal	$ 61.60	0.963	$ 130,506
Gas	$ 77.50	0.963	$ 164,192

Present value = $ 2,946,973

8.24 All other assumptions are identical.

8.25 The conclusion is that under either the hypothetical calculation or what I have termed the "more realistic calculation" immediately above the avoided costs, and therefore benefit claimed from this source for the entire life of the project, is small compared with, for example, TPL's operating revenue of $766m for the single year end March 2011.

Wider Consequences for the Electricity System

8.26 Under this heading, benefits are said to accrue to the diversification produced throughout the HEP component of the generation market through spreading exposure to factors such as climatic effects and storage.

8.27 In terms of logic, this is likely to be the case. The issue is one of materiality and size of the risk reduction achieved. In my view, given that the entire

Matahina HEP Scheme accounts for only 1.9% of installed generation capacity the beneficial effect of a small expansion to this is likely to be small.

8.28 The fact that the effect is likely to be tiny is likely helpful as well given that an expansion, while perhaps creating risk reduction benefits for HEP parts of the total system, also concentrates risk further on HEP for the system as a whole when it already suffers from a high exposure to this form of generation (since HEP already accounts for some 70% of electricity generated).

8.29 I conclude that the net benefits in this area are negligible.

Recreational Opportunities

8.30 The NZIER report explains the benefits of the recreational opportunities arising from the existence of Lake Matahina to the extent that these can be ascertained.

8.31 Their analysis more than adequately describes the difficulties in quantifying such benefits. It is equally the case however that, in spite of these difficulties, it is well established that such attractions are of benefit and there is no reason to believe that is not the case with the Matahina scheme.

8.32 What is a great deal more difficult to establish is that the proposed operations creates any additional benefit. In short the recreational benefits have "already been counted" and there is in my view nothing to suggest that additional benefits will become available.

Expenditure and Employment Impacts

8.33 The NZIER explains the way in which multiplier effects benefit the community through the expenditures made by TPL and how those benefits translate into investment, operating profits and employment. I accept the logic of the argument and the substance of the analysis provided but note that:

(a) The analysis applies to the existing Matahina operation. The benefits are thus "already counted". There would not appear to be any additional expenditure or employment likely to arise through the proposed alterations to the river and HEP management regimes; and,

(b) Further to this, the various reports note that the existing overhead and other management arrangements provide scope within their present capacity to generate additional output without further investment of human or financial resources.

8.34 Consequently, I do not believe that the multiplier effects noted can be counted as additional benefits accruing to the project.

8.35 To the extent that it turns out that additional expenditure is required and that additional employment is generated as a result of the proposed changes, and in respect of the existing multiplier effects more generally[7], I note that there are two important caveats around the size of impacts felt and their contribution to overall net economic gain.

8.36 The first relates to the fact that a significant proportion of "economic impact" attributed to a given project, typically a new project, and identified by multiplier analysis arises through transfer of employment and capital from elsewhere in the economy. Thus:

(a) Matahina HEP's "gain" is someone else's loss with the only net gain being the difference in value added when, if, and to the extent that the transfer of the use from one context to another results in a more efficient use.

(b) It is for this reason that multiplier studies have become notorious for over estimating the beneficial side effects of projects analysed. The impact analysis for the Matahina HEP does not identify the extent of such transfers.[8]

8.37 Secondly, while a project can produce beneficial economic impacts through the use of capital and labour resources it is not necessarily the case that the full impact of the estimated benefits will accrue as being "new" to the communities affected. The reason for this is simply that even if the resources in question were not being used for the project being considered they would be being used in some (likely lesser in value) use.

8.38 Typically some attempt should be made to account for the fact that resource attributed to a project (such as Matahina and any expansion of its operation) would be otherwise employed if not employed in the project. Thus Haveman

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7 I note that this general point would be of considerable significance if for example TPL had to scale down its operation with resultant losses in operating and capital expenditure.

8 Economic Impacts, Value Added, and Benefits in Regional Project Analysis Author(s): Joel R. Hamilton, Norman K. Whittlesey, M. Henry Robison, John Ellis. Source: American Journal of Agricultural Economics, Vol. 73, No. 2 (May, 1991), pp. 334-344.
Published by: Blackwell Publishing on behalf of the Agricultural & Applied Economics Association
Stable URL: http://www.jstor.org/stable/1242718

and Krutilla[9] conclude that net benefit accrues to somewhere between 6% and 31% (versus 100%) of effects modelled.

8.39 To the extent that these effects affect the NZIER estimates then their estimate of $5.5m total impact on the regional economy might in fact be closer to a range of $330,000 to $1.7m before considering transfer effects. There would also likely be positive impacts beyond the region though NZIER do not separately identify these but they too would likely be small.

8.40 Finally it should be stressed that the specifics of the current proposal do not contemplate additional expenditure and thus there should be no additional impacts or multiplier effects.

9. BENEFITS TO SHAREHOLDERS

9.1 The most significant quantum of benefits of the proposals arise in the form of risk adjusted value added for TPL shareholders. The shareholders of TPL are the beneficiaries of the Tauranga Consumer Energy Trust (majority) and Infratil N.Z. Limited.

9.2 Benefits to shareholders through increased value take the form of dividends or gains in capital value. They are particularly important as a measure of value because they represent:

(a) Benefit generated after the effects of risk and cost have been applied to revenues so that they represent genuine addition of value;

(b) Benefits earned and returned to owners through dividends or capital growth become available for welfare enhancing consumption or saving and reinvestment; and,

(c) Through these two processes – earning risk adjusted value and promoting welfare enhancing reinvestment and consumption, contribute to total national economic welfare.

9.3 Accordingly justification of the proposal in the cost benefit equation depends significantly upon the ability of the proposal to generate risk adjusted gains for its owners.

9 Haveman, R.H. and J.V. Krutilla Unemployment, Idle Capacity and the Evaluation of Public Expenditures, National and Regional Analysis, Baltimore, John Hopkins University Press 1968.

9.4 Significantly perhaps (though it makes no difference to the existence of net benefit), 33% of the owners in this case are local and regional residents. I note as well that significant numbers of the investors in the various groups making up the 50.5% shareholder (Infratil) are district, regional and national investors.

9.5 I have used the following procedure to assess the benefits to shareholders.

(a) Revenue has been assumed to be derived at the disclosed transfer price of $82 per MWh;

(b) Maximum volume has been assumed to be the 275 MWh generation (effective generation after transmission costs and in line with NZIER assumptions);

(c) I note that the maximum volume achievable at the price disclosed means that a maximum of $22,550,000 could be generated and this represents some 2.94% of operational revenue of TPL as a whole as at 31 March 2011 and reported by Reuters Thomson;

(d) I have assumed that in year one no additional revenue will be generated by Matahina because of the combined effects of the need to implement changes should the consent be granted and the continued sluggish performance of the economy;

(e) Given two "flat years" and a "normal" growth rate of barely 2% reported by PWC[10] in residential, I have assumed that years two and three (out from the granting of the consent should it be granted) would see half of the maximum revenue earned in each year with the full potential reached in year three;

(f) Reuters Thomson report that TPL achieved an after tax profit margin of 14,67% for the year ended 30th March 2011. This is an abnormally high margin for the industry as noted by PWC[11]. The industry average is reported as 6.4% and it can be expected that as competition and continued efficiencies permeate the sector more thoroughly, over time the TPL margin will move to this level. I have assumed that this process will take some five (5) years;

10 PWC Op. Cit.
11 PWC Op. Cit.

(g) In line with these assumptions an after tax net profit figure has been derived. I have then expressed the total benefit (with full capacity output of 275 MWh from year four (4) to perpetuity) as being proxied by the net after tax profit arising in the various years explained above and in the quanta explained. The calculations are set out in Appendix I to my evidence.

(h) I have used a standard cost of capital calculation in bring net profits to a present value as to account for the risks to TPL in delivering these profits[12].

9.6 Using this procedure I estimate benefits to shareholders to be in the vicinity of $16,868,200, say $16.87m.

10. SUMMARY AND ESTIMATED NET BENEFIT

10.1 This section sets out in summary form the costs and the benefits as discussed in detail above.

10.2 The following table sets out the full summary:

Item	*Conclusion*	*Estimated Value*
Benefit		
Creation of a valuable commodity	Likely to be created through other means if not TPL generated thus net economy wide benefit captured either in avoided cost or not attributable to project directly.	Nil
Avoided cost through not using coal or gas	Taking NZIER analysis but adjusting for more realistic uptake given highly competitive nature of market.	$2.95m
Wider consequences for electricity supply system	Potentially adds to HEP diversification but concentrates exposure to HEP on system wide basis. May cancel one another out. Size of projects likely make impact negligible and not material.	Nil
Creation of recreational opportunities	Already embedded from existing project. No addition.	Nil
Expenditure and employment impacts	Proposal involves no new impacts. Existing is minor.	Nil

12 Data from Bloomberg and Thomson Reuters and consistent with other figures used in my evidence (for example for the riskfree rate). The cost of equity capital used is 7.9%.

Item	*Conclusion*	*Estimated Value*
Risk adjusted value added for shareholders	Positive but no more than "run of business" from addition.	$ 16.87m
Potential gain to consumers in quality of service	Positive but likely to be imperceptible relative to national effects. Proposal impact negligible.	Nil
TOTAL		**$19.82m**
Costs		
Value at risk	Certainty equivalent of additional cost of catastrophic failure imposed.	$25.55m
Mitigation operating costs	Estimate range for increased operating costs	$1.125 - $4.5m
Mitigation capital costs	Present value given spread of capital investment.	$ 5.63m
TOTAL		**$32.3m - $35.7m**
Estimated net benefit	All present values	**-$12.48 to -$15.88**

11. **SENSITIVITIES AND NET BENEFIT**

11.1 I note and wish to stress that neither making estimates of inputs nor drawing conclusions about net benefits in the type of analysis I have undertaken and necessitated by the data available and state(s) of knowledge is a precise exercise. For this reason I have:

(a) Stressed the importance of ranges rather than point estimates;

(b) Expressed my final estimate of net benefit as a range;

(c) Noted the various assumptions underlying the analysis. Those assumptions are not meant to "mirror reality". Their role instead is to provide a useful and consistent framework for understanding the costs and benefits at issue.

11.2 The greatest sensitivity lies in the estimate of the increased risk of stop bank failure. There is no means for estimating this risk with great precision. Failing to make an estimate however induces other still greater risks.

12. CONCLUSION

12.1 I conclude, on this basis, that given the proposal as I understand it and as disclosed in the application that the costs outweigh the benefits of the proposal by a significant margin, with scope for a significant margin of error.

Efficiency and Cost Sharing

12.2 By way of conclusion, I note that the estimates set out above and their impacts (along with those in all other evidence presented in these areas) rest on the underlying assumption that a reasonably efficient means for apportioning costs is available to the parties.

12.3 This is of crucial importance in seeking outcomes which align with the net benefits estimated. The importance does not lie in notions of equity and fairness so much as in the fact that unless costs and benefits are not internalised to the parties which generate them, sub optimal outcomes will result.

12.4 Parties who generate costs and pay for those costs face incentives to manage costs in line with benefits and to adjust their modes of operation to match costs with offsetting benefits.

12.5 Thus internalising costs by paying attention to cost sharing mechanisms rather than relying on, say, administrative compliance is likely to offer the best prospect of costs and benefits falling within the ranges estimated above.

Philip Brent Wheeler
July 2011

Appendix I to the evidence of Philip Brent Wheeler

Growth Path	Year 1	Year 2	Year 3	Year 4	Year 5	Term
	Recessionary					
Growth rate	0%	1.50%	1.50%	0.00%	0.00%	0.00%
Revenue	$ -	$ 11,275,000	$11,275,000	$ 22,550,000	$22,550,000	$22,550,000
Margin	14.67%	12.00%	10.00%	8.00%	6.40%	6.40%
Estimated NPAT	$ -	$ 1,353,000	$ 1,127,500	$ 1,804,000	$ 1,443,200	$ 1,443,200
Cost of capital	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%
PV	$5,291,891					
Perpetual	$ 11,576,326					
	$16,868,217					
All values March 2011						

65750 - 65753
A762479

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of an application by **TRUSTPOWER LTD** to the **BAY OF PLENTY REGIONAL COUNCIL** for water permits associated with the operation of the Matahina Hydroelectric Power Scheme

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STATEMENT OF EVIDENCE OF COLIN DAVID MEADOWCROFT

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1. **INTRODUCTION**

Qualifications and Experience

1.1 My name is Colin David Meadowcroft. My position at Bay of Plenty Regional Council (BOPRC) is Engineering Manager for the Environmental Hazards Group (EHG). I have been in this role since August 2009.

1.2 I am also the lead Flood Manager for the EHG. Our group has the responsibility for providing adequate river flood warnings to the community, in addition to maintaining flood protection to meet approved levels of service.

1.3 I have been a Chartered Member of the Institution of Civil Engineers (MICE) in London for 7 years.

1.4 My qualifications include a Master's Degree in Civil Engineering (with Honours) from Exeter University (UK), graduating in July 1997.

1.5 I have over 14-years of experience in the civil engineering industry, specialising in water and environmental engineering, including two positions with international consultancies leading hydraulic modelling centres of excellence.

Expert Witness Code of Conduct

1.6 While I am not giving my evidence as an expert witness, I have been provided with a copy of the Code of Conduct for Expert Witnesses contained in the Environment Court's Consolidated Practice Notes 2006. I have read and agree to comply with that Code. This evidence is within my area of expertise, except where I state that I am relying upon the specified evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Purpose and Scope of Evidence

1.7 The EHG lodged a submission dated 16 October 2009 to TrustPower's Notified Applications for Resource Consent: Matahina Dam Replacement Resource Consent Applications 65750, 65751, 65752 and 65753.

1.8 The purpose of my evidence is to outline the importance of robust flood management and flood forecasting for Matahina Dam. The EHG addressed these matters in section 2.1 of its Submission.

1.9 Within my evidence, I will specifically:

(a) Provide a brief overview of the existing flood management regime at Matahina in order to provide some context for my remaining evidence (Section 2).

(b) Comment on TrustPower's proposal and the EHG's concerns in this regard (Section 3).

(c) Outline key principles relevant to flood management (Section 4).

(d) Address the outcomes sought by the EHG and the rationale for those outcomes (Section 5).

1.10 I am authorised to give this evidence on behalf of the EHG.

2. BACKGROUND AND CONTEXT – FLOOD MANAGEMENT AT MATAHINA

2.1 This section of my evidence provides a brief overview of the current flood management protocols at Matahina and addresses how TrustPower and the EHG currently manage flood events.

Current Flood Management Conditions

2.2 Matahina Dam is owned and operated by TrustPower Ltd and comprises an earth dam; a concrete spillway structure; and a hydro-electric power station. Discharges from the dam spillway gates and power station penstocks are currently controlled through Condition 3 of the existing Resource Consent conditions, which are as follows:-

Minimum reservoir level (flood pending)	71.6m
Minimum normal operational level	73.15m
Maximum normal operational level	76.2m
Design flood level	76.8m

2.3 Condition 6 of TrustPower's existing consent require TrustPower to provide storage in the dam at the request of the EHG when a flood of 'about 500' cubic metres per second (cumecs) or greater is expected. Provision of storage at the time of a flood is limited by the existing minimum reservoir level (flood pending).

2.4 Storage is to be provided in accordance with the Design Engineer's report attached to the current Resource Consent. The Design Engineer's report sets out the flood operation procedure, the aim of which is to lower the lake to the minimum level before the flood peak reaches the dam.

2.5 In summary, the existing flood management procedures are as follows:

(a) For 'Minor Floods' BOPRC would not request 'any operating procedure' unless flood discharges of over 450 cumecs (at Te Teko) are expected.

(b) For 'Major Floods' over 'about 500 cumecs', at the BOPRC's request, storage should be provided and the dam outflow would be increased to appreciably more than the inflow (to a minimum lake level of 71.6m RL).

2.6 For 'Minor Floods' defined as less than 500 cumecs, the existing conditions require TrustPower to provide BOPRC with relevant level and flow data, and to advise the BOPRC if they propose exceeding the maximum operating level of 76.2m, and is subject to meeting the specified maximum outflow rates, drawdown and lake filling conditions.

EHG Concerns with Current Flood Management at Matahina Dam

2.7 The EHG has a good working relationship with TrustPower and under the current flood management conditions, the EHG Flood Manager may request TrustPower to draw-down lake levels when certain flood conditions are anticipated. However, the 2004 floods demonstrated that improved clarity of roles and responsibilities is necessary in order to maximise the flood attenuation opportunities within the dam, and to minimise the potentially significant downstream environmental impacts.

2.8 The EHG is concerned that the current conditions are not sufficiently clear as to the roles of BOPRC and TrustPower, and in particular, when a flood is "expected" and who determines that.

2.9 In that regard, TrustPower is required under the Building Act 2004 to maintain flood early warning systems. As set out in 5.6 of Peter Lilley's evidence, TrustPower's 'flood forecasting' methodology is based on measuring inflows into Lake Matahina. EHG has concerns with the timeliness and reliability of this approach, which I will further address later in my evidence.

2.10 There is also significant community concern that the Matahina Dam could be better managed in times of flood. Since 2004, BOPRC has been engaged with TrustPower to review the flood management operation at Matahina which prior to this had not been reviewed since 1989. Factors that have been raised so far include:

(a) Provision and use of flood forecasting computer models;

(b) The definition of a flood;

(c) The role of each organisation during a flood;

(d) The appropriateness of the flood pending minimum lake level;

(e) The appropriateness of the maximum lake draw-down rate.

2.11 It is important to the EHG that these issues, discussed further below, are finally clarified with appropriate consent conditions during this process.

3. **TRUSTPOWER PROPOSAL AND EHG CONCERNS**

3.1 This section will briefly address TrustPower's current proposal and EHG's concerns with their proposed approach.

TrustPower Proposal

3.2 The application documents (sections 2.3 and 3.1) state that no changes are sought to the conditions related to flood management of the dam, however TrustPower proposes that the consent refers to a Flood Management Plan (FMP) to confirm flood management procedures.

3.3 The conditions proposed by TrustPower provide for the Matahina Dam to be operated in accordance with a Flood Management Plan when "flood conditions" are predicted or experienced by either the BOPRC or TrustPower.

3.4 The key aspects of the Flood Management Plan are that:

(a) For "minor floods", TrustPower is required to:

(i) Make information available to BOPRC about inflows, lake levels and spillway discharges; and

(ii) Reduce lake levels towards an absolute minimum of 71.6m RL within a defined time period.

(b) For "major floods", TrustPower must provide storage in Matahina Dam by reducing lake levels towards an agreed absolute minimum of 70.0m RL within a defined time period.

3.5 These provisions are similar to those contained in the Design Engineer's Report referred to above, but BOPRC holds some concerns in relation to the proposed Flood Management Plan, which are addressed below.

EHG Concerns

3.6 The operation of the Matahina Dam and reservoir during river flood events has the potential to alter the nature of the flood experienced downstream of the dam, specifically:

(a) The peak flood magnitude in the Rangitaiki River;

(b) The duration of the river flood, and;

(c) The rate of flood increase or decrease experienced downstream.

3.7 Therefore, EHG's position is that the consent should contain sufficient and clear conditions which ensure that floods will be managed appropriately through the dam to minimise flooding and other negative environmental effects, and enhance the performance of the flood protection system.

3.8 EHG's concerns with the TrustPower proposal are:

(a) A "minor flood" is defined as >300m^3/s. BOPRC must have some control over the lowering of the lake levels in minor floods.

(b) The minimum reservoir level (flood pending) in the proposed consent conditions is 71.6 RL, which limits capacity of the dam to attenuate a flood in "large floods" of greater than 500 cumecs.

(c) The Flood Management Plan does not acknowledge the need for good flood forecasting.

(d) The Flood Management Plan contains clauses which may enable TrustPower to operate the dam in a manner differently to that required. EHG's concern is that there is a lack of certainty that the dam will be managed appropriately, or even in accordance with the FMP, in times of flood, or potential flood.

(e) The proposed consent conditions suggest that the Flood Management Plan can be altered at any time by TrustPower and BOPRC must approve those changes if they accord with obligations under the Building Act and Dam Safety Regulations. Of particular importance in this regard is that what constitutes "minor floods" and "major floods", and the operating protocol for those situations, is not currently defined by the consent but by the FMP.

3.9 EHG supports the proposed consent condition which provides that a flood can be predicted by either the BOPRC or the consent holder.

4. FLOOD MANAGEMENT – NATIONAL GUIDANCE AND FLOOD FORECASTING

4.1 This section of my evidence sets out key principles of flood management best practice, relevant to the flood management of the Matahina Dam when a flood is expected, in order to provide context for the outcomes sought.

National Guidance

4.2 The New Zealand Standard for Flood Risk Management (NZS 9401_2008) provides a risk based approach for the comprehensive management of flood risk. This standard defines stakeholder responsibility indicating that floods are of local, regional and national importance. It calls for collaboration and partnership between all stakeholders, including local and central government, and their communities and individuals.

4.3 Communities are required to accept responsibility for managing risks associated with their collective decisions, including balancing benefit, risk, and the cost of supporting flood risk management. Dr Wheeler will present evidence on the benefit and cost of flood risk.

Flood Forecasting

4.4 One of the most important aspects of flood management is the ability to forecast a flood with good reliability and in sufficient time to respond appropriately.

4.5 In the context of Matahina Dam, good flood management includes flood forecasting to estimate flood magnitude, at least 48 hours in advance of the flood peak, whilst also maximising dam safety.

4.6 Appropriate, predictive and diligent management of the dam during floods has the potential to enhance the performance of the flood protection system downstream, potentially alleviating flooding and lessening any risks to landowners and their property and inherent liabilities that may result.

4.7 Following the floods in July 2004, TrustPower and BOPRC embarked upon a joint contract with NIWA to improve flood forecasting at Matahina dam with the development of EcoConnect flood forecasting TopNet model. BOPRC has used this model with reasonable success in recent flood events. The model has been refined and improved considerably since its initial implementation in 2007.

4.8 To further enhance the flood prediction capability for the Rangitāiki River, BOPRC has more recently requested URS NZ Ltd, consulting engineers, to

develop a full catchment hydrologic model to improve understanding of the river response to the catchment's complex hydrology. This model, when fully implemented, will provide a robust tool for better flood forecasting and to maximise flood warnings, whilst also being able to provide increased confidence to TrustPower that the dam will be refilled at the end of the flood (on the storm recession). While the model has yet to be fully tested and peer reviewed, it can already be used to provide an indication of improved flood mitigation opportunities.

4.9 BOPRC is also proactively working with the MetService to best utilise rainfall radar data from the recently constructed and commissioned weather station located near Rotorua.

5. KEY ISSUES AND OUTCOMES SOUGHT BY EHG

5.1 This section of my evidence sets out the outcomes sought by the EHG and the rationale for these outcomes. Mr Dawson will propose conditions in his evidence which will achieve these outcomes and EHG support the imposition of such conditions.

Flood Management Plan

5.2 TrustPower has proposed a flood management plan for the operation of the dam when a flood is anticipated. Provision is made for the flood management plan to be amended and approved by BOPRC by reference to the Dam Safety Regulations and Building Act.

5.3 EHG's key concerns with the flood management plan are outlined above, but briefly:

(a) It includes a number of sections that may cause ambiguity which is likely to create debate during flood situations (e.g. definitions of flood size and circumstances where TrustPower may not accept the request to lower levels).

(b) It contains the definitions of "major" and "minor" floods and the protocols for operation in those situations, but those provisions can be changed by TrustPower.

5.4 Peter Lilley's evidence (Section 5.1) states that "Floods are managed by TrustPower's operations centre with assistance from in-house hydrologists, external technical experts and Peter Lilley". It is important that the consent

conditions clarify the BOPRC Flood Management role and provide for BOPRC to instruct TrustPower to reduce lake levels at specified maximum drawdown rates depending on the size of the anticipated flood. It is also crucial that the FMP is mutually agreed upon in order that it can clearly define the operating procedures.

Flood Forecasting

5.5 Matahina Dam has the capability of reducing the flood peaks providing storage is made available well before the peak of the flood passes the dam. It is widely acknowledged that at least 48-hours warning is desirable to reduce the flood risk. Early estimation of the size of the flood is therefore vital to maximise the use of the dam in a flood event.

5.6 Paragraph 197 of Mr Levy's evidence noted that Matahina Lake level was not drawn down prior to the 2004 event, because rainfall warnings did not indicated as extreme an event as eventually occurred. This signals the need for good flood forecasting to optimise the use of Matahina Dam for flood mitigation.

5.7 TrustPower consider their flow and lake level monitoring as flood forecasting, however EHG's view is that this is simply flow measurement and provides insufficient response time to provide attenuation storage in the dam and provide flood mitigation to avoid severe downstream environmental impacts of flooding.

5.8 Under the Building Act 2004, TrustPower is required to maintain adequate flood warning systems for Matahina Dam.

5.9 Therefore, EHG seeks to ensure that any consent issued for the operation of Mtahina Dam requires the operator (TrustPower) to lower the dam to an appropriate level on prediction of a flood at least two days in advance of the forecast flood. In that regard, I note that:

(a) Table 16 of the May 2009 BECA River Hydrology report states that 23% attenuation can be achieved for a 100-year flood with a 71.6m minimum reservoir level, and section 5.6 suggests 2 days flood warning is necessary.

(b) The June 2011 Review of AEE NIWA report confirms that without reliable flood forecasting up to 2 days in advance, it is difficult for

reservoir management to have any significant impact on downstream flows.

Definition of a Major Flood

5.10 Apart from best practice flood forecasting, of great relevance and concern to the EHG is the definition of "Major" and "Minor" floods and the level of control which BOPRC has in those conditions.

5.11 The existing consent conditions and the proposed Flood Management Plan define a "Major Flood" as one exceeding inflows of >500m3/s and it was only with respect to Major Floods that BOPRC could require TrustPower to reduce lake levels in anticipation of pending floods.

5.12 A "Major Flood" is difficult to accurately determine (particularly under the extreme pressure immediately prior to a flood) without absolute clarity as to who and how this is determined, especially when TrustPower's flood forecasting models are not considered by EHG to be sufficient. It is therefore important that the BOPRC Flood Manager, using the best flood prediction models available, should determine the expected flood magnitude in order to ensure that this is not debated at a critical time.

5.13 Section 5.11 of Peter Lilley's Evidence noted that only 4 "Large Floods" have occurred in the last 60-years, and that only 21 300 cumec floods have occurred during the same period. I consider that, given the flood forecasting tools which the EHG has, the probability of false alarms is small and that on-going flood risk to the downstream community is a good reason for requiring the dam to be drawn down when such a flood is predicted.

Minimum Reservoir Level

5.14 An Extreme Minimum Reservoir Level of 71.6m is specified in the existing consent conditions. This provides for a maximum of approx. 11Mm3 of the total 55Mm3 storage available within the dam.

5.15 It has been suggested that the storage in the dam is negligible as compared to total flood volume, and that the 100-year flood would have filled the dam 15 times. However, significant flood attenuation can be achieved with good flood forecasting at least two days in advance, which is backed up by Table 16 of BECA's May 2009 River Hydrology report.

5.16 EHG requests on behalf of its River Scheme ratepayers and for the local community that the available storage in the dam should be utilised for optimal flood mitigation. TrustPower state that cavitation issues cause generation to cease below the proposed extreme minimum lake level of 71.6m, however, EHG's view is that the benefits of attenuating occasional floods outweighs the cost and/or risk to TrustPower.

5.17 From my discussions TrustPower, I understand that they would accept lowering the dam level to 70.0m when a 300 cumec flood is being experienced and a 500 cumec flood is predicted within the next 24 hours. This is acceptable to EHG which therefore requests that the Extreme Minimum Reservoir level be 70.0m.

Dam Safety

5.18 The Draft Flood Management Plan included in the Appendix of Peter Lilley's Evidence includes several clauses with respect to dam safety. It appears that dam safety issues are most prevalent with respect to higher dam levels rather than the lowering of lake levels for flood mitigation. EHG accepts TrustPower's proposed maximum lake levels and minimum / maximum draw-down rates for flood management which are considered to have the greatest impact on geotechnical / safety matters.

Monitoring

5.19 Robust flood forecasting systems rely heavily upon data assimilation, where the flood prediction must be updated regularly with actual flows before and during the flood. A good knowledge of actual flow predictions is crucial to accurately determine a pending flood.

5.20 EHG seeks that TrustPower is required to improve its monitoring of inflows to Matahina Dam by installing an inflow recorder at the inlet to Lake Matahina in order to quantify lake inflows for both flood prediction and low flow monitoring. The flow data should be provided live via telemetry to EHG.

Colin David Meadowcroft
July 2011

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IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of an application by **TRUSTPOWER LTD** to the **BAY OF PLENTY REGIONAL COUNCIL** for water permits associated with the operation of the Matahina Hydroelectric Power Scheme

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STATEMENT OF EVIDENCE OF CHRISTOPHER JOHN DAWSON

INTRODUCTION

1. My name is Christopher John Dawson. I hold the qualifications of a Diploma in Parks and Recreation Management with Distinction from Lincoln University (1989), a Bachelor of Social Science with Honours majoring in Geography and Resources and Environmental Planning (1996), and a Post Graduate Diploma in Resources and Environmental Planning from Waikato University (1997). I am currently employed as a Senior Planner at Bloxam Burnett & Olliver, a firm of consulting engineers, planners and surveyors based in Hamilton and have held this position for ten years. I have a total of fifteen years experience in resource management planning in New Zealand and am a full member of the New Zealand Planning Institute and the Resource Management Law Association. I am also an accredited decision maker under the Ministry for the Environment's Making Good Decisions Programme.

2. My work experience over the past fifteen years has involved preparing, processing and reporting on subdivision and landuse applications for projects throughout the Waikato, Bay of Plenty, King Country and South Auckland. More recently I have been involved with structure planning in Cambridge and Te Kauwhata along with wind energy projects in the western Waikato. I was also the planner for Winstone Aggregates when they recently consented an expansion to their quarrying activity at Camerons Quarry in Otamarakau, Eastern Bay of Plenty.

3. I am familiar with the area subject to this application and have visited the site subject to this application.

Expert witness code of conduct

4. I have read and am familiar with the Code of Conduct for Expert Witnesses in the current (2006) Environment Court Practice Note. I agree to comply with this code of Conduct in giving evidence to this hearing and have done so in preparing this written brief. The evidence I am giving is within my area of expertise, except where I state I am relying on the opinion or evidence of other witnesses. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed. I understand it is my

duty to assist the Commissioner impartially on relevant matters within my area of expertise and that I am not an advocate for the party which has engaged me.

Scope of Evidence

5. I will begin my evidence by confirming my opinion as to the planning status of the application under the Operative Bay of Plenty Regional Water and Land Plan.

6. I will then consider the proposal in terms of section 104 of the Act and specifically discuss those effects of concern to the Environmental Hazards Group (EHG) of the Bay of Plenty Regional Council with reference to the evidence of other witnesses for the EHG. In doing so I have relied on the evidence of Mr Crabbe, Mr Williams, Dr Wheeler, Dr O'Halloran, Mr Burchett and Mr Meadowcroft.

7. I will then undertake an assessment against the relevant statutory planning documents that apply to the application, including the Proposed National Policy Statement on Renewable Electricity Generation, the provisions of the Operative Bay of Plenty Regional Policy Statement and Rule 47C of the Operative Bay of Plenty Regional Water and Land Plan.

8. I will then undertake an assessment against Part II of the Act and provide an overall conclusion as to whether I consider that the proposal will constitute the sustainable management of natural and physical resources. I will then recommend a set of conditions that would assist in mitigating the effects of concern to the EHG.

Site Description and Existing Environment

9. I do not propose to repeat the site description and proposal which has been covered extensively in the evidence of other witnesses, specifically those witnesses for the applicant and the Section 42A report prepared by the BOPRC.

10. The Rangitaiki River is part of the Rangitaiki-Tarawera Rivers Scheme (RTRS), a flood protection scheme administered by the Environmental Hazards Group (EHG) of the Bay of Plenty Regional Council (Regional Council). The RTRS was constructed between 1971 and the early 1980's to provide flood protection for the settlements and adjacent

rural areas traversed by the Rangitaiki River. The river runs through the small settlements of Te Teko, Edgecumbe and Thornton before entering the open ocean.

11. The Rangitaiki River is part of the Rangitaiki River Scheme Maintenance Area 1 in Schedule 5 of the RWLP and as the Rangitaiki Floodway in Schedule 6 of the RWLP along with Reids Canal, a man made drainage channel east of the river which provides additional volume for river flows in the event of a flood.

12. There is no question that the presence of the Matahina HEPS has had irreversible effects on the environment. The physical structure of the dam is part of the existing environment as is the removal of the sediment load due to impounding it behind the dam.

13. The existing river environment is covered extensively in the evidence of Mr Williams and Dr O'Halloran for EHG. I consider the key facts to glean from their evidence is that the Rangitaiki River is a highly sensitive environment and the impacts of the Matahina HEPS must be viewed in this context. Mr Williams states that: "*The volcanic deposits on the plains include highly permeable layers, and there is a high level of interchange between river and ground waters. There are, thus, severe stability problems of ground heave and piping development during flood events, as well as bank erosion and channel migration.*"[1]

14. Mr Williams also states that: "*The lower Rangitaiki River is an especially difficult river to manage, given the proximity of the stopbanks on the natural levee beside the main river channel, the highly erodible soils of its alluvial plains and the very high permeability of soil layers in the ground beside the river channel*".[2]

15. As discussed by Mr Williams, river management is a continuous process that aims to maintain favourable pre-conditions along the river before a flood event to ensure that the eventual flood will be contained within the constructed defences.[3] Therefore the work undertaken by the EHG is about continuously preparing the Rangitaiki-Tarawera River Scheme (RTRS) to be as ready as possible for a future flood event through a combination of flood prediction and flood management as set out in the evidence of Mr Meadowcroft and riverbank protection works as set out in the evidence of Mr Crabbe.

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[1] Evidence of Mr Williams – paragraph 18
[2] Evidence of Mr Williams – paragraph 25
[3] Evidence of Mr Williams – Paragraph 22

16. The evidence of Dr O'Halloran is that the history of the Rangitaiki Plains is that they are geologically very young and unconsolidated and that the soils can be readily disturbed by changes in water levels, load or earthquakes.[4] The history of the plain formation process has lead to "a wide and uppredictable variety of soil types and grain sizes within small horizontal and vertical distances."[5]

17. Therefore the environment within which the Rangitaiki River runs and Trustpower seeks to renew their existing consents and implement an alternative operating regime for the Matahina HEPS is one that is inherently fragile and hard to manage. The river environment would therefore be difficult one within which to manage a flood protection scheme, even without the presence of the dam. The operation of the dam makes that inherent fragility and susceptibility to change even more difficult.

18. It is against this background of the existing environment that the application by Trustpower must be considered.

Activity Status

19. The site lies within the jurisdiction of the Bay of Plenty Regional Council who administer the Bay of Plenty Regional Water and Land Plan (RWLP). This plan superseded the Bay of Plenty Regional Land Management Plan and the Transitional Regional Plan and was declared operative by the Regional Council on 1 December 2008.

20. The activity status of the renewal application falls to be considered under Rule 47C as a Controlled Activity (Lawfully Established Hydroelectric Power Schemes in Schedule 11) of the RWLP. The matters over which the Regional Council has reserved its control which are relevant to the concerns raised by the EHG are those matters set out under Rule 47C items (a) to (v) of the RWLP as set out below.

"Environment Bay of Plenty reserves its control over the following matters:

a) Measures to provide for the passage of fish, both upstream and downstream.
b) Upstream and downstream water levels, residual flows and water quality.

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[4] Evidence of Dr O'Halloran – paragraph 3.2
[55] Evidence of Dr O'Halloran – paragraph 3.4

c) *Screening of intake and diversions structures.*
d) *Intake velocities.*
e) *Measures to manage erosion effects (including destabilisation of beds and banks or river).*
f) *Measures to identify and manage the risk of dam failure.*
g) *Stability of the land bordering the dam.*
h) *Measures to manage discharges to water from the use or alteration of the dam structure.*
i) *Measures to avoid, remedy or mitigate any adverse effect on aquatic ecosystems, areas of significant indigenous vegetation, significant habitats of indigenous fauna.*
j) *The quantity and flow rate, outstanding natural features and natural character.*
k) *Measures to avoid, remedy or mitigate any adverse effect on aquatic ecosystems, areas of significant indigenous vegetation, significant habitats of indigenous fauna.*
l) *Volume and rate of any take or diversion.*
m) *Techniques for ensuring the safe passage of flood water.*
n) *Effects on the relationship of tangata whenua and their culture and traditions with the site and any waahi tapu or other taonga affected by the activity.*
o) *Effects on the ability of tangata whenua to exercise their kaitiaki role in respect of any waahi tapu or other taonga affected by the activity.*
p) *Measures to avoid, remedy or mitigate adverse effects of the operation on downstream infrastructure.*
q) *Measures to avoid, remedy or mitigate adverse effects on lawfully established downstream infrastructure.*
r) *The range, or rate of change of levels or flows of water.*
s) *The structural integrity and maintenance of the structure.*
t) *Measures to avoid, remedy or mitigate adverse effects on amenity values (including recreation), and existing public access to and along the margins of rivers and lakes.*
u) *Information and monitoring requirements.*
v) *Administration charges under section 36 of the Act.*[6]

21. There is no reference in the matters of control to the provision of Financial Contributions under *Section 10 – Financial Contributions* of the RWLP. I also refer to Table 46 – Circumstances and Purposes of Financial Contributions and note that item 5 – Protection, Restoration or Enhancement of River and Lake Beds does not make reference to Rule 47C.

[6] Bay of Plenty Regional Water and Land Plan – Matters of Control under Rule 47C

Section 104 of the RMA

22. Section 104 of the Act sets out those matters that a consent authority must have regard to, (subject to Part 2), in considering an application.

"(a) any actual and potential effects on the environment of allowing the activity; and

(b) any relevant provisions of -

...

(v) a Regional Policy Statement or proposed regional policy statement:

(vi) a plan or proposed plan; and"

Section 104 (1) (a) any actual and potential effects on the environment of allowing the activity

23. Given that the application for a renewal of the Matahina HEPS is a Controlled Activity under Rule 47C of the RWLP, the Regional Council has limited the matters over which it reserves control to the content of this rule. I will therefore assess the effects of the application by reference to the matters in respect of which the consent authority has jurisdiction to impose conditions in terms of the matters of control in Rule 47C, which are broad ranging. On those issues that are outside my areas of expertise, I rely on the evidence of the other witnesses for the EHG for my opinion.

24. Key aspects of the application relevant to EHG are:

a) Reduction in the Rangitaiki Minimum Flow so that it is not less than 20 cumecs (10 MW) except when lake inflows are less than this in which case outflows from the Matahina HEPS shall match inflows.
b) No limit to the number of operating peaks but peaks must be conducted within the maximum and minimum discharge limits set by the Constraints Envelope. No peaks when inflows are less than 20 cumecs.
c) Increased upward ramping rate from the current 70 cumecs per hour to 97 cumecs per hour.
d) Increased downward ramping rate from the current stepped rates over the first, second and subsequent hours to a constant downward ramping rate of 30 cumecs per hour.

e) No change to the operating regime in Minor Floods (up to 500 cumecs) or Major Floods (in excess of 500 cumecs).[7]

25. The potential adverse effects arising from the proposed activities proposed by the applicant are set out below in relation to the relevant matters of control in Rule 47C. I set out my opinion in relation to each of these matters of control with respect to the evidence of the witnesses who have appeared before me on behalf of the EHG. I have grouped the matters of control based on the type of effect being considered.

Rule 47C (b) Upstream and downstream water levels, residual flows and water quality
Rule 47C (h) Measures to manage discharges to water from the use or alteration of the dam structure.

Rule 47C (k) The quantity and flow rate, outstanding natural features and natural character.
Rule 47C (l) Volume and rate of any take or diversion.

Rule 47C (r) The range, or rate of change of levels or flows of water.

26. Dr O'Halloran notes in her evidence that rapidly dropping river levels can leave high water pressures within the stopbank face. This in turn can result in slope stability failures and subsequent exposure of the stopbank to river erosion.[8] Dr O'Halloran states that particularly fine grained soils such as the silt and silty fine sands are most susceptible to loss of particles due to fluctuating water levels. This erosion of the fine grained layers can then lead to overhangs of over lying soils with subsequent collapse and regression of the river bank[9]. Dr O'Halloran concludes that: "*fine grained soil particles can be lost from the river bank on a daily basis if there is a fluctuating river level. Particles can be lost if the river level is lowered due to natural fluctuations. It is however, considered that the daily fluctuations are more frequent, and possibly faster, that those due to natural flows and are therefore causing more rapid erosion of the river bank than natural flows.*"[10]

27. Mr Williams notes in his evidence that the constant water level fluctuation of the hydro-power operation prevents the establishment of vegetation on the bank within this range of

[7] Assessment of Environmental Effects – Trustpower Ltd (page 41-42)
[8] Evidence of Dr O'Halloran paragraph 4.5
[9] Evidence of Dr O'Halloran paragraph 7.3
[1010] Evidence of Dr O'Halloran paragraph 7.15

levels[11]. He also comments that "*the deposition of the suspended load as siltation on the banks and berms of the river channel is important in terms of a fine material cover, which supports vegetation colonisation and growth. The vegetation then increases the deposition on flow recessions. The hydro fluctuations, with the continual flow acceleration and deceleration they generate, affect this deposition and vegetative growth, reducing both vegetation and the sealing up of fine deposits.*"[12]

28. It is my opinion based on the evidence of Dr O'Halloran and Mr Williams that while the nature of the Rangitaiki River is it is susceptible to erosion due to naturally changing river levels, the increased ramping rates and multiple peaking regime proposed by Trustpower will exacerbate the erosive effects of the river on both the riverbanks and stopbanks. In my opinion there is sufficient evidence to require appropriate mitigation by limiting the operating regime so as to limit these erosive effects.

Rule 47C (e) Measures to manage erosion effects (including destabilisation of beds and banks or river).

Rule 47C (q) Measures to avoid, remedy or mitigate adverse effects of the operation on lawfully established downstream infrastructure.

29. The evidence of Mr Williams and Dr O'Halloran is that the proposed operating regime will have adverse effects on the Rangitaiki – Tarawera Rivers Scheme (RTRS) in terms of greater erosion impacts both on the riverbanks and stopbanks. The options available to the applicant to manage erosion effects are either to provide sufficient financial contribution to fairly mitigate the percentage of the annual erosion that can be attributed to the operation of the Matahina HEPS or to operate the scheme in such a manner as to minimise the erosion effects arising.

30. The evidence of Mr Williams is that the present financial contribution by the applicant to the RTRS is very minor[13] and that the dynamic nature of river and flood processes means that a qualitative approach must be taken to the assessment of the contribution as opposed to a quantitative approach[14].

[11] Evidence of Mr Williams – paragraph 1.50
[12] Evidence of Mr Williams – paragraph 1.51
[13] Evidence of Mr Williams – paragraph 1.80
[14] Evidence of Mr Williams – paragraph 1.92

31. Mr Williams then outlines a series of principles that should be utilised in assessing any such contribution. One method of calculating such a contribution is described in the evidence of Mr Burchet as a "live" financial model. While the committee may not be able to impose a financial contribution it is useful to have some means of quantifying the financial extent of the impacts of the Matahina HEPS on the RTRS on an annual basis.

32. In reliance on the evidence of Mr Williams who considers that the offer of financial compensation made by the applicant via condition 26 is inadequate, the only alternative means of managing the effects of the Matahina HEPS is to operate the scheme so as to minimise those effects. Mr William's recommendation is that a run or river operation would avoid adverse effects on the river scheme but, in the alternative, the operation could be restricted to a single peak operation in order to more closely resemble the offer of compensation made by Trustpower. I have addressed this further below.

Rule 47C (m) Techniques for ensuring the safe passage of flood water

33. The provision for utilising the Matahina HEPS for flood management is set out in the evidence of Mr Meadowcroft. He summarises the position of the EHG as: "*Appropriate, predictive and diligent management of the dam during floods has the potential to enhance the performance of the flood protection system downstream, potentially alleviating flooding and lessening any risks to landowners and their property and inherent liabilities that may result.*"[15]

34. The key concerns of the EHG are that the current proposal by the applicant does not provide sufficient certainty nor does it maximise the use of the Matahina HEPS for flood management purposes. The key areas that EHG seeks to clarify with respect to improved flood management from the Matahina HEPS are;

   a) improved flood management with the respective roles of the consent holder and the Bay of Plenty Regional Council clearly defined;
   b) Earlier and more accurate flood forecasting including up to two days warning of an impending flood event to enable the maximum use of the lake capacity;

[15] Evidence of Mr Meadowcroft – paragraph 4.6

c) Clear definitions for a "major" and "minor" flood so all parties can proceed with certainty;
d) Setting an extreme Minimum Reservoir Level of 70 m Moturiki Datum.

35. I discuss conditions which would address the concerns of the EHG below.

National Policy Statement for Renewable Electricity Generation 2011

36. The National Policy Statement for Renewable Electricity Generation 2011 (NPS 2011) was gazetted on 14 April 2011 and takes effect 28 days after the notice in the New Zealand Gazette. This means that decision makers must take its provisions into account after 13 May 2011. However it is acknowledged that it will take some time to include provisions into Regional Policy Statements, Regional Plans and District Plans to take account of the NPS 2011.

37. The objective of the NPS 2011 is *"to recognise the national significance of renewable electricity generation activities by providing for the development, operation, maintenance and upgrading of new and existing renewable electricity generation activities"*[16] to enable New Zealand to meet or exceed its national target for renewable electricity generation.

38. Policy A requires decision makers to recognize the benefits of renewable generation activities while Policy B requires decision makers to acknowledge the practical implications of achieving this. Practical constraints include having regard to what is required to maintain the generation output of existing activities and avoiding reductions in the overall output plus investing heavily in new renewable generation.

39. Policy C1 requires decision makers to acknowledge the practical constraints of renewable electricity generation such as the need to be in a location specific to the resource and recognising the existing infrastructure. Specific mention is made in Policy C of the importance of designing measures which allow operational requirements to complement and provide for mitigation opportunities and to consider adaptive management measures as well. Policy C2 requires decision makers to look at measures such as environmental

[16] National Policy Statement for Renewable Electricity Generation 2011 – Objective page 4

offsets or environmental compensation when considering residual environmental effects that cannot be avoided, remedied or mitigated.

40. In the context of the Matahina HEPS proposal I consider that the NPS 2011 gives some overarching policy direction in terms of both flood management and offsets for adverse effects. The concerns of the EHG in terms of flood management have been set out in the evidence of Mr Colin Meadowcroft and include a concern with both adequate flood forecasting and an ability to utilise Lake Matahina for flood attenuation. This is a critical issue for the EHG and the landowners and ratepayers they represent, who make up the community within the catchment of the Rangitaiki River.

41. As set out in the evidence of Mr Williams and Ms O'Halloran, the Rangitaiki River is located in a very sensitive geological environment which is vulnerable to erosion under the existing twin peaking regime and that the proposed operating regime of the Matahina HEPS will make the preconditions for those effects to occur, even greater.

42. In my opinion, the national benefits of the proposed operating regime are relatively minor when compared to the existing output of the Matahina HEPS. As stated in the evidence of Mr Burchett, "*peaking does not increase the output of a hydro station (in fact it may slightly reduce it) but it does significantly increase the value of that output.*"[17] Mr Burchett also states that: "*The NZIER Report promotes the benefits of Matahina in a national context however these benefits are existing and the effects of a multiple peaking operation can only be assessed against incremental benefit. The only stated incremental national benefit is increased output due to the lake being kept higher which is estimated at 3GWh/yr or an increase in output of 1% which is insignificant.*"[18]

43. In my opinion the contribution of an amended operating regime towards meeting the targets in the NPS 2011 will be very small and this must be weighed against the likely adverse effects that both the existing regime and the proposed regime are predicted to cause. This is discussed later in my evidence under the assessment against the relevant provisions of the RWLP and my assessment against Part II of the Act. I also note the evidence of Mr Burchett who comments that the generation capacity of the Matahina

[17] Evidence of Mr Roger Burchett – paragraph 6.1 pg 9
[18] Evidence of Mr Roger Burchett – paragraph 6.2 pg 9

HEPS will not be compromised by the proposed operating regime recommended by the EHG, therefore not reducing its capacity to reduce greenhouse gases[19].

44. The NPS 2011 also clearly signals that offsetting measures or compensation which benefits the local environment and community affected should be considered. The evidence of Mr Williams is that the $50,000 offered by the applicant to offset their share of the adverse effects caused by the amended operation is inadequate and also does not take account of changing circumstances each year. The "live" compensation model as discussed in the evidence of Mr Burchett[20] provides a reasonable approach to the question of compensation, however given that there is no provision within Rule 47C to access the provisions of Section 10 – Financial Contributions of the RWLP, any compensation needs to be offered up by the applicant. This is discussed later in my evidence.

<u>Section 104 (1) (b) any relevant provisions of a Regional Policy Statement or proposed regional policy statement</u>

Operative Bay of Plenty Regional Policy Statement

45. The Operative Bay of Plenty Regional Policy Statement (RPS) was made operative on 1 December 1999 and provides the overall principles for the promotion of sustainable management in the Bay of Plenty Region. I discuss below those Objectives and Policies that I consider to be relevant in the consideration of these applications.

Section 8.3.2 – Water Allocation

Objective 8.3.2 (a) The efficient management of water-body levels and flows which enables people and communities to provide for their well-being, preserves the natural character of wetlands, lakes and rivers and their margins, and protects outstanding natural features, aquatic life and significant values.

Policy 8.3.2 (b) (ii) To ensure that the effects of activities on social, economic and cultural values, and community well-being, are taken into account in water allocation decisions.

[19] Evidence of Mr Burchett – Paragraph 6.15 (a)
[20] Evidence of Mr Burchett – Paragraphs 7.2 – 7.8

Section 11 Natural Hazards

11.1 Background – "A natural hazard is simply a natural event. It is only the presence of people that turns a natural event into a natural hazard. In parts, the Bay of Plenty Region is thinly populated and the impact of a natural event, such as an earthquake, may be minimal. Other parts of the region are densely populated and the occurrence of such an event would have a large impact on the community. [21]

Objective 11.3.1 (a) – The vulnerability to natural hazards of the region's people and communities, and its natural and physical resources, is avoided or mitigated.

Policy 11.3.1 (b) (v) – To recognise and protect the integrity of natural ecosystems that are natural defences against flooding, inundation or erosion, particularly where new subdivision, use and development is proposed.

Policy 11.3.1 (b) (xii) – To maintain the integrity of existing flood protection works to the greatest extent practicable.

Section 13 Physical Resources / Built Environment

13.1 "Background – Physical resources refers to a variety of aspects of the built environment, including matters such as .... dams and flood control structures."[22]

The built environment meets basic human needs such as shelter and warmth,......contributes to the community's quality of life and protects its assets. For these reasons, it is essential that the built environment is managed in a sustainable way for current and future generations. [23]

Policy 13.3.1 (b) (iii) – To provide for the long term security of existing physical resources and built environments.

Section 14 Energy

Objective 14.3.3 (a) The adverse effects on the environment associated with the development of energy resources and the production, distribution and use of energy are avoided, remedied or mitigated.

Policy 14.3.3 (b) (i) To ensure that the adverse effects on the environment and people of the region from the generation and distribution of energy are avoided, remedied or mitigated.

46. The RPS provides a strong policy direction that recognises the risks posed by natural hazards on physical resources and the community while acknowledging that energy resources are available for use, provided the adverse effects of their use and development are properly addressed. Policy 11.3.1 (a) indicates that vulnerability to natural hazards is

[21] Bay of Plenty Regional Policy Statement – Natural Hazards – Background statement page 141
[22] Bay of Plenty Regional Policy Statement – Section 13 Physical Resources / Built Environment Background – page 165
[23] Bay of Plenty Regional Policy Statement – Section 13 Physical Resources / Built Environment Background – page 166

avoided or mitigated. Given the inherent fragility of the Rangitaiki River as set out in the evidence of Mr Williams and Dr O'Halloran and in particular the comments from Mr Williams with respect to the importance of maintaining flood pre-conditions[24], I consider that this Policy sets an important direction. The Rangitaiki River is susceptible to riverbank erosion and the operation of the Matahina HEPS has the potential to increase the sensitivity of the river to flood damage.

47. I consider that the proposed HEPS operating regime will increase the risks to the flood scheme therefore increasing the risks to the surrounding communities who rely on the scheme for protection without sufficient avoidance or mitigation being offered by the applicant. The proposed operating regime for the Matahina HEPS will introduce greater variation in Rangitaiki River levels through unlimited peaking, increased upwards and downward ramping rates and a reduced minimum low flow rate within the Rangitaiki River.

48. The evidence of Dr O'Halloran states that the Rangitaiki Plains are "*geologically very young and unconsolidated. This means that soils can be readily disturbed by changes in water levels, load or earthquakes.*"[25] Dr O'Halloran later in her evidence concludes that: "*The simple model that I have analysed shows that fine grained soil particles can be lost from the river bank on a daily basis if there is a fluctuating river level. This can also occur if the river level is reduced due to natural fluctuations. It is however, considered that the daily fluctuations are more frequent, and possibly faster, than those due to natural flows and are therefore causing more rapid erosion of the river banks.*[26]

49. The importance of protecting flood mitigation structures for the long term benefit of the adjacent communities comes through in these policies. This increased potential for erosion of the riverbank and subsequent effects on the stopbanks must then be put in context with the evidence of Dr Bruce Wheeler who sets out the economic considerations required for the communities surrounding the Rangitaiki River and which are protected by the RTRS. Mr Wheeler concludes in his evidence that the Estimated Net Benefit of the proposal, taking into account the costs and expected benefits arising from the scheme is a

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[24] Evidence of Mr Williams – paragraph 3.15
[25] Evidence of Marianne O'Halloran – paragraph 3.2
[26] Evidence of Marianne O'Halloran – paragraph 7.12

net loss of $12.4 to $15.8 million[27]. This substantial disbenefit must be weighed against the estimated benefits of the proposed new regime which result in only a small increase in the overall Gigawatt hours produced. [28]

50. The evidence of these witnesses for the EHG is that the operation of the Matahina HEPS will result in adverse effects on the Rangitaiki – Tarawera Rivers Scheme in respect of which the offer of compensation made by the applicant is insufficient. A failure to adequately mitigate the effects of the operating regime leads me to conclude that avoidance is the only other option given that a Controlled Activity application cannot be declined. In this context I have considered a "run of river" operation as one that would avoid effects, while a single peaking operation as one that would minimise effects. I have recommended a number of conditions that would address the concerns of the EHG as **Attachment 1** to my evidence.

51. In reliance on the evidence of Mr Williams, Dr O'Halloran and Dr Wheeler above, it is my opinion that the proposed operating regime is inconsistent with the relevant Objectives and Policies of the Operative Regional Policy Statement as set out.

Proposed Bay of Plenty Regional Policy Statement

52. The Proposed Bay of Plenty Regional Policy Statement (RPS) was released on 9 November 2010 for public submission and for which the submission period closed on 8 February 2011. The further submission period has now closed (19 May 2011) and hearings are scheduled to be held in September and October 2011. On this basis, I consider that little weight can be placed on the provisions of the Proposed RPS as the statutory process has some way to go before it is completed and the final form of the Proposed RPS becomes clear.

[27] Evidence of Dr Wheeler – paragraph 11.2
[28] NZIER report p 24

Bay of Plenty Regional Water and Land Plan

53. The Bay of Plenty Regional Water and Land Plan (RWLP) was made operative on 1 December 2008 and sets in place a regime of objectives, policies, rules and methods for the management of land, beds of water bodies, water and geothermal natural and physical resources across the Bay of Plenty Region. The RWLP contains a number of objectives and policies that are relevant to the consideration of this application.

Section 3 - The Integrated Management of Land and Water

Objective 17 'Riparian margins are appropriately managed to protect and enhance their soil conservation, water quality and heritage values.'

Objective 22 - Recognition of the beneficial effects of the use and development of water, land and geothermal resources on the social, cultural and economic wellbeing of people and communities.

Policy 32 – To allow resource use and development where there are beneficial effects on the social, cultural and economic wellbeing of people and communities and adverse effects on the environment are avoided, remedied or mitigated.

54. These objectives and policies highlight the importance of riparian vegetation in stabilising the margins of water bodies and filtering runoff. The appropriate management of the margins impacts on soil conservation and river management as the "*riparian vegetation stabilises stream banks and reduces bank erosion, especially during flood events*"[29]. The management of the river system also has an effect on the riparian margins as set out in the evidence of Mr Williams.

Section 4 – Discharges to Water and Land

Objective 27 – *Discharges of water to water avoid, remedy or mitigate adverse effects on the environment as appropriate to the values, uses and existing environmental quality of the activity site.*

[29] Bay of Plenty RWLP Issue 13, Para 2 (2) page 31

Policy 47 – *To avoid, remedy or mitigate the adverse effects of discharges of water to water on:*

(a) *Flooding*

(b) ..

(c) *Stability of the beds and banks of the receiving water body.*

Comment

55. The relevant objectives and policies of this section highlight the importance of considering the values and uses of the activity site when assessing the effects of discharging water to water. The importance of the Rangitaiki River and the surrounding Rangitaiki Plains is highlighted in the evidence of Dr Wheeler. I note in particular the comments of Dr Wheeler who states that: "*Annual agricultural revenue from the Rangitaiki Plains was estimated at over $200 million.*"[30]

56. Dr Wheeler has undertaken an economic analysis of the impacts of the amended operating proposal in terms of a cost benefit framework. Dr Wheeler concludes that: "*the costs outweigh the benefits of the proposal by a significant margin, with scope for a significant margin of error*"[31]. My interpretation of this economic conclusion from an environmental perspective is that Dr Wheeler considers that not all of the adverse effects arising from the change in operation regime for the Matahina HEPS can be appropriately avoided, remedied or mitigated and that some of those effects will have a higher probability of being realised through an increased risk of the failure of flood protection works.

Section 5 - Water Quantity and Allocation

Objective 40 – *Allocation of water resources in the Bay of Plenty recognises hydroelectric generation as a renewable energy source.*

Objective 41- *Water flows in streams and rivers are maintained to:*

(a) .....

(b) .....

(d) ......

(e) Avoid or mitigate adverse effects on downstream environments and existing uses of the water resource.

[30] Evidence of Dr Wheeler – paragraph 8.4

[31] Evidence of Dr Wheeler – paragraph 13

Objective 47 – *Damming and diversion activities avoid, remedy or mitigate adverse effects on the environment as appropriate to the values, users and existing environmental quality of the water body and downstream of the activity.*

Policy 65 – *To allow for flow variation in streams and rivers when allocating water and controlling the effects of damming and diversion activities.*

Policy 81 – All new damming and diversion activities, or changes to existing damming and diversion activities, are required to comply with the following environmental standards:

Table 18 – Environmental Standards for Damming and Diversion Activities

	Aspect	**Environmental Standard**
(a)	Water Flow	.....
(b)	Water Quality	.....
(c)	*Stability of Banks and Beds of Water Bodies*	*Avoid, remedy or mitigate adverse effects on the stability of banks and beds of surface water bodies, including scour, erosion and slumping which can be directly attributed to the existence and operation of the dam. Any erosion events that can be directly attributed to the existence and operation of the dam are to be remedied or mitigated as soon as practicable.*
(d)	Landscape values, natural character, recreational use, public access	.....
(e)	Wetlands	.....

57. These Objectives and Policies point to the importance of balancing the use of rivers for purposes such as the generation of electricity with the need to avoid, remedy or mitigate adverse effects *as appropriate to the values, users and existing environmental quality of the waterbody and downstream of the activity.*[32] The context of the Rangitaiki River as set out in the EHG witnesses is that the river is fragile and very susceptible to erosion, even without the existence of the Matahina HEPS. In addition the Rangitaiki Plains provide a home and production base for approximately 9,000 people with a well developed social and economic infrastructure[33].

58. In my opinion, the proposal is contrary to the above objectives and policies.

[32] Regional Water and Land Plan – Objective 47
[33] Evidence of Dr Wheeler – paragraph 3.1

Resource Management Act 1991

Part II of the Act

59. Section 104 is subject to Part II of the Act, which sets out its purpose and principles. The overall purpose is to promote sustainable management which is defined in section 5(2) as:

> *"managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic and cultural well being and for their health and safety while:*
>
> *a) sustaining the potential of natural and physical resources to meet the needs of future generations,*
> *b) safeguarding the life supporting capacity of air, water, soil and ecosystems; and*
> *c) avoiding, remedying or mitigating the adverse effects of activities on the environment.*

The proposal by Trustpower seeks to increase the flexibility of the operating regime for the Matahina HEPS in order to generate more electricity at times when that power is worth more. It is important to consider the need to utilise the physical resource of the Rangitaiki River to generate power but then to balance the benefits of that power generation with the adverse effects on the environment. Section 5 (1) talks about enabling people and communities to provide for their social, economic and cultural wellbeing, however that overarching directive is tempered by the provisions of s 5 (1) (a), (b) and (c).

60. The evidence of the EHG witnesses demonstrates the inherent fragility of the environment within which both Trustpower operates and the local community lives. I acknowledge that the RMA is not a "no net adverse effects" statute, however in my opinion Trustpower has underestimated the extent (and consequent cost) of the adverse effects on the Rangitaiki – Tarawera Rivers Scheme.

61. The evidence of the EHG witnesses is that the mitigation offered by Trustpower through the offer of compensation is inadequate to offset the adverse effects. Therefore in my opinion the proposal does not promote the overall purposes of the Act.

62. On this basis, a "run of river consent" which avoids adverse effects of the proposal is warranted, however if the committee does not consider this an appropriate course, a single

peaking regime could be implemented which alongside conditions which provide for a robust monitoring and reporting regime and a peer review panel mechanism for reviewing the results of that monitoring and making recommendations to the BOPRC would more strongly promote the overall purpose of the Act. Trustpower would be able to continue to generate electricity from a renewable resource, while at the same time ensuring that the significant uncertainty over the risk of adverse effects, does not result in the realisation of that risk being visited upon the Rangitaiki – Tarawera Rivers Scheme without appropriate mitigation in place.

63. Section 6 requires all persons exercising powers under the RMA to "recognise and provide for various matters of national importance." In my opinion only section 6 (a) is relevant to the consideration of this application:

Section 6

"a) The preservation of the natural character of the coastal environment (including the coastal marine area), wetlands, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use, and development; and
b) .....
c) ....
d) ......

64. Section 6 (a) of the Act requires consideration as to whether the proposed use of the Rangitaiki River constitutes an "inappropriate use". In my opinion the existence of the Matahina HEPS and the irreversible effects associated with it are part of the existing environment and in that sense form part of the "baseline". However the operating regime which constitutes a "use" of the river, is up for consideration through these proceedings. The evidence of Mr Williams and Dr O'Halloran is that not only is the Rangitaiki River inherently fragile and susceptible to erosion from river fluctuations due to natural processes but that the proposed operating regime will exacerbate this erosion and increase the risk of scheme failure. Without either an appropriate offer of financial mitigation or an operating regime that limits the adverse effects arising from the operation I do not consider the proposal will adequately provide for the provisions of sec 6 (a).

65. Section 7 of the Act requires particular regard to be had to (amongst other things) the following:

Section 7

"(a).....
(b).....
......
(j) the benefits to be derived from the use and development of renewable energy."

66. I do not consider that the majority of the provisions of section 7 have relevance to concerns of the EHG, however I am of the opinion that there are only modest benefits to be had in terms of the increase in the amount of electricity generated under the modified operating regime. The evidence of Mr Burchett is that the increased output is limited to 3GWh/year or an increase in output of 1% which is insignificant[34]. The extent to which the committee is to place weight on the provisions of section 7 (j) must be tempered by the evidence of the EHG witnesses that the modest amount of additional electricity will be generated at the expense of increased erosion risk and risks to the Rangitaiki –Tarawera Rivers Scheme which at present have not been appropriately mitigated.

67. I do not discuss the provisions of Section 8 as I consider these to be outside the interests of the EHG.

Part II

68. As required by the RMA, the consideration of this proposal requires a broad overall judgement as to whether the proposal will constitute the sustainable management of natural and physical resources. In my opinion, the proposal as it current stands does not constitute sustainable management in that while it seeks a flexible operating regime that targets the higher prices in the electricity market, it does so at the expense of the Rangitaiki – Tarawera Rivers Scheme by exacerbating an already fragile and susceptible river system even more.

Recommended Conditions

[34] Evidence of Mr Burchett – paragraph 5.3

69. In light of the analysis undertaken above and having regard to the matters over which the Regional Council has reserved control, I recommend amendments to conditions in respect of the following three key areas.

a) Because of the damage to the river system, limit the operating regime in order to minimise further adverse effects of the operation of the Matahina dam. In that regard recommendations which require that:

i. When inflows are equal to or less than 40 cumecs, outflows should equal inflow.

ii. When inflows are more than 40 cumecs, outflows should be equal to or more than 40 cumecs.

iii. TrustPower are only permitted a single peak per day, with the amplitude of that peak limited to twice the average inflow of the previous day.

iv. There is no change to the ramp up and ramp down rates permitted beyond those authorised by the existing consent.

b) Optimise the opportunity to utilise the dam to mitigate flood damage. In that regard I recommend conditions which require:

i. Provision for the BOPRC to require TrustPower to lower the level of the dam to 71.6m when the BOPRC predicts a flood of 300 cumecs or more (as opposed to 500 cumecs as sought by TrustPower) at a rate specified by BOPRC.

ii. Provision for the BOPRC to require TrustPower to lower the level of the dam to 70.0m (as opposed to 71.6m as proposed by TrustPower) when the BOPRC predicts a flood of 500 cumecs or more at a rate specified by BOPRC.

iii. Inclusion of these trigger points as conditions of consent, rather than provisions in the Flood Management Plan which may be amended without a variation to the conditions of consent.

iv. Amendments to the conditions to enable the BOPRC to approve amendments to a flood protocol.

c) If long term consent is going to be granted, recommend an adaptive management regime which would comprise:

i. A requirement for TrustPower to develop, for BOPRC approval, a monitoring plan which is specifically designed to identify and, to the extent feasible, quantify the effects of TrustPower's operations. The cross sections should require recording of the specific matters recommended by Mr Williams in his evidence.

ii. The establishment of an independent peer review panel comprising experts in river and geotechnical processes who receive the information generated from the monitoring undertaken, interpret that information and report on a periodic basis to BOPRC. The peer review panel should have powers of recommendation to the BOPRC on amendments to the monitoring plan or to other consent conditions.

iii. The Peer Review Panel should have powers of recommendation to BOPRC in relation to fine tuning the monitoring plan in light of the monitoring information received, reporting to BOPRC as to the mechanisms and causes of damage to the river scheme, and recommendations as to amendments to the flow regime, potential remedial action or appropriate compensation.

iv. Review conditions should be included which are tailored specifically to respond to the Panel's recommendations – including amendments to the flow regime or the undertaking by TrustPower of specific work in the event that the monitoring indicates that such a response is necessary

or appropriate – and to provide for a financial contribution condition in the event that the regional plan is amended.

70. In my opinion, if no adaptive management regime is imposed via conditions of this consent, a short term consent of ten years is appropriate given the uncertainties that exist around the extent of the impacts of the Matahina HEPS on the Rangitaiki – Tarawera Rivers Scheme. This would enable the effects to be reassessed at the time of the next consent renewal process.

71. The three key areas set out above are reflected in the **attached** conditions of consent, however these are a work in progress.

Chris Dawson
6 July 2011

Matahina HEPS Reconsenting Project
Proposed Conditions of Consent

General

1. The dam, penstock intake, tailrace, spillway and dewatering tunnel and points of discharge associated with the Matahina Hydroelectric Power Scheme are to be sited as shown in the plans attached to this resource consent as **Appendix One**.

2. The maximum height of the Matahina Dam shall not exceed 80 metres as measured from the bed of the Rangitaiki River to the dam crest.

3. The individual Matahina Spillway Gate widths shall not exceed 8.53 metres.

4. [This condition is intentionally left blank].

Civil Safety

5. The consent holder shall, within seven days of receiving a request from the Bay of Plenty Regional Council, provide a copy of all information it holds regarding the dam safety management systems employed at the Matahina Hydroelectric Power Scheme to the Chief Executive of the Bay of Plenty Regional Council.

6. The consent holder shall maintain the Matahina Dam and all its appurtenant components and ancillary/appurtenant structures to the standards recommended in the operative version of the NZSOLD Dam Safety Guidelines.

Lake Levels

7. The consent holder shall operate the Matahina Hydroelectric Power Scheme so as to comply with the following maximum or minimum operating levels for Lake Matahina (all levels are stated in 'metres above Moturiki Datum').

Extreme Minimum Reservoir Level (flood pending)	70.00 ~~71.60~~ metres
Minimum Operational Reservoir Level	73.15 metres
Maximum Operational Reservoir Level	76.20 metres
Maximum Reservoir Level during floods of less than 200 cubic metres per second	76.40 metres
Design Flood Level	76.80 metres
Spillway Gate Crest Level	76.40 metres

8. The rate of change in the level of Lake Matahina shall not exceed 0.3~~25~~ metres per hour except under 'emergency Conditions' when 0.5 metres per hour may be required.

9. For the purpose of Condition 8 'emergency Conditions' occur when:

   a. Plant within the Matahina Hydroelectric Power Scheme has failed;

b. The electrical network or transmission system has become constrained or unavailable;

c. A natural event, such as a flood, restricts the ability to operate all or any aspect of the Matahina Hydroelectric Power Scheme safely; or

d. Storage needs to be provided in anticipation of a flood event which is forecast in terms of condition 63B.

Intake Screens

10. The intake to the Matahina Hydroelectric Power Scheme penstocks shall be fitted with a screen. The gap between bars of the screen shall be no greater than 90 millimetres.

11. Within 12 months of this consent commencing the consent holder shall have prepared and submitted a comprehensive report to the Chief Executive of the Bay of Plenty Regional Council that:

    a. Describes the feasibility of installing further deterrent measures at the intake structure of the Matahina Dam to avoid or minimise the entrapment of adult eels;

    b. Describes the alternative deterrent measures considered and assesses the strengths and weaknesses of each measure; and

    c. Recommends a deterrent measure for deflecting adult eels from the intake structure of the Matahina Dam towards the spillway gates or an alternative downstream migration pathway.

12. When preparing the report required by Condition 11, the consent holder shall consult with the Department of Conservation, Fish and Game New Zealand, Kokopu Trust, Ngati Awa, Ngati Haka Patuheuheu, Ngati Manawa, Ngati Whare, Ngati Tuwharetoa, Ngati Umutahi and any additional parties deemed relevant by the Chief Executive of the Bay of Plenty Regional Council. This shall include submitting a draft of the report to those parties for comment and allowing one month for a response. The consent holder shall provide a copy of any comments received to the Chief Executive of the Bay of Plenty Regional Council.

13. Within 12 months of receiving certification from the Chief Executive of the Bay of Plenty Regional Council that the report addresses the matters set out in Condition 11, the consent holder shall implement the deterrent measure recommended in the report.

14. The consent holder shall provide final copies of the report required by Condition 11 to the Kokopu Trust, Department of Conservation, Fish and Game New Zealand, the Royal Forest and Bird Protection Society, Ngati Awa, Ngati Haka Patuheuheu, Ngati Manawa, Ngati Whare, Ngati Tuwharetoa, Ngati Umutahi and any additional parties deemed relevant by the Chief Executive of the Bay of Plenty Regional Council.

Boat ramps

15. The consent holder shall install and maintain a water level indicator at the main launching boat ramp located at map reference NZTM 1934917, 5774496. This water level indicator shall be installed within six months of the commencement of this consent.

16. The consent holder may temporarily restrict public access to the boat ramps (and associated pontoon structures) located at map references NZTM 1934917, 5774496 and NZTM 1934987, 5774200 due to reasonable health, safety and security requirements. Access may only be restricted to one boat ramp and any associated pontoon structure at a time. Where access is restricted by the consent holder, it shall notify the Chief Executives of both the Bay of Plenty Regional Council and the Whakatane District Council in writing. The written notification shall (i) explain the need for the restriction, and (ii) estimate the duration that the restriction will apply for.

Lakeshore Processes and Sedimentation

17. The consent holder shall, within one year of this consent commencing, and then every five years thereafter, undertake inspections of the Lake Matahina shoreline. The inspection shall (i) use the methodology and visit the sites identified by Dr Martin Single in his report entitled "*Matahina Hydroelectric Power Scheme Re-consenting: Assessment of Environmental Effects – Lakeshore Erosion (October 2008)*" and (ii) consider the entire lake, but shall note the changes at the sites of erosion scarps highlighted on the map attached within **Appendix Two.**

18. The inspection required by Condition 17 shall identify potential erosion and sedimentation hazards for lake users.

19. In addition to the inspections undertaken in accordance with Condition 17, inspections shall be undertaken by the consent holder following every 'flood event'. These inspections shall also identify potential erosion and sedimentation hazards for lake users.

20. For the purpose of Condition 19, the term 'flood event' shall mean a flood of greater than 500 cubic metres per second into Lake Matahina.

21. The consent holder shall report the findings of the Lake Matahina shoreline inspections required under Conditions 17 and 19 to the Chief Executive of the Bay of Plenty Regional Council within two months of the completion of each inspection. The report must:

    a. Identify any works that are needed to avoid, remedy or mitigate significant erosion and sedimentation hazards attributable to Lake level fluctuations and the reasons for any conclusions reached; and

    b. If works are recommended, describe the nature of the works, the timeframe for carrying out the works, and the reasons for undertaking those works; and

    c. Include an assessment of whether any additional monitoring is required and the reasons for any conclusions reached.

22. Within three months of receiving certification from the Chief Executive of the Bay of Plenty Regional Council that the report required in Condition 21 addresses the shoreline erosion and sedimentation hazards caused by the lake level fluctuations associated with the operation of the Matahina Hydroelectric Power Scheme, the consent holder shall implement any mitigation measures recommended in the report.

General Monitoring

23. The consent holder shall monitor and keep records of the Matahina Hydroelectric Power Scheme reservoir level, the megawatt set point data, the flow of water discharged from the Matahina Power Station and/or via the Matahina Spillway, the flow taken for cooling water purposes and the flow of water in the Rangitaiki River (as measured at the Te Teko river flow recording site) and any other upstream monitoring data. The time interval between data readings shall be recorded at no greater than 30-minutes and the data gathered under this condition (excluding the megawatt set point data and flows taken for cooling water purposes) shall be available to the Bay of Plenty Regional Council via telemetry at all times

24. Reservoir levels shall be measured to an accuracy of +/-0.1 metres. Flow of the water in the Rangitaiki River, over the Matahina spillway, abstracted into the Matahina penstocks and abstracted into the cooling system associated with the Matahina Power Station shall be measured to an accuracy of +/- 10 percent and the data gathered under this condition shall be made available to the Bay of Plenty Regional Council via telemetry at all times.

25. All records and monitoring results required by Conditions 23 and 24 shall be kept for a minimum period of 18 months from the date of each entry and shall be provided to the Chief Executive of the Bay of Plenty Regional Council:

    a. Annually (on the anniversary of this consent commencing); and

    b. Within seven days of the consent holder receiving a request from the Chief Executive for the record and monitoring results.

25A Within three months of the commencement of this consent, the consent holder shall install additional lake inflow recorders to accurately measure inflows into Matahina Dam to the satisfaction of BOPRC. The data shall be available via telemetry to Bay of Plenty Regional Council at all times.

Contribution to River Bank Protection Programme

26. The consent holder shall within 3 months of this consent commencing, and annually thereafter, contribute $51,520.00 + GST to the Rangitaiki Tarawera River Scheme implemented by the Bay of Plenty Regional Council. This contribution will be 'PPI' adjusted annually.

Periods of Normal Operation ~~– Prior to the Implementation of the Modified Operating Regime~~

27. Except as provided for by Condition 63, the consent holder shall operate the Matahina Hydroelectric Power Scheme in accordance with Conditions 28 to 34, which shall apply until Conditions 47 and 51 have been fully satisfied.

28. ~~The minimum load generated by the Matahina Power Station shall not be less than 22 megawatts40 cubic metres per second, except when the inflows into Lake Matahina are less than 40 cubic metres per second.~~

29. When inflows into Lake Matahina are less than 40 cubic metres per second, the consent holder shall operate the Matahina Hydroelectric Power Scheme to ensure that the flow in the Rangitaiki River, immediately downstream of the Matahina Hydroelectric Power Scheme, equals, ~~when measured over a 24-hour period~~, the inflows into Lake Matahina.

29A When inflows into Lake Matahina are greater than 40 cubic metres per second, the consent holder shall operate the Matahina Hydroelectric Power Scheme to ensure that the flow into the Rangitaiki River, immediately downstream of the Matahina Hydroelectric Power Scheme, shall not fall below 40 cubic metres per second.

30. There shall be no more than one ~~two~~ operating peak~~s~~ per 24-hour period provided that the amplitude of the peak shall be limited to twice the average inflow as measured over the preceding 24 hour period.

31. For the purpose of Conditions 29 and 30, the term '24-hour period' shall be from 12-midnight to 11.59pm.

32. For the purpose of Condition 30, the term 'operating peak' is defined as an increase in the load generated by the Matahina Power Station to a maximum and/or constant generation load followed by a subsequent decline in the load generated.

33. The maximum ramp up rate ~~increase in the load generated by the Matahina Power Station~~ shall not exceed ~~37 megawatts per hour~~ 70 cubic metres per second except during an under-frequency event and/or flood event.

34. The maximum ramp down rate ~~decrease in the load generated from the Matahina Power Station~~ shall not exceed:

   i. ~~16 megawatts per hour in the first hour~~ (30 cubic metres per second per hour for the first hour);
   ii. ~~12 megawatts per hour in the second hour~~ (22 cubic metres per second per hour for the second hour);
   iii. ~~8 megawatts per hour~~ (14 cubic metres per second per hour) for every hour thereafter

except during an under-frequency event and/or flood event.

Periods of Normal Operation – Following the Implementation of the Modified Operating Regime [These conditions no longer necessary if EHG relief granted]

35. The consent holder may operate the Matahina Hydroelectric Power Scheme in accordance with Conditions 36 to 40 when Conditions 47 and 51 have been fully satisfied.

36. The consent holder shall ensure that a flow of not less than 20 cubic metres per second is maintained in the Rangitaiki River, immediately downstream of the Matahina Hydroelectric Power Scheme, at all times.

37. Except as provided for by Condition 63, the maximum and minimum set-points for the load generated by the Matahina Power Station shall be determined from the rolling average of the load generated from the power station over the previous 72 hours of operation.

38. Except as provided for by Condition 63 and in addition to the duty established by Condition 37, the maximum and minimum set-points for the load generated by the Matahina Power Station shall be determined from the following table.

Rolling 72 hour average generation ('P') (MW)[1]	**Minimum Generation Set-point (megawatts)**	**Maximum Generation Set-point (megawatts)**
Less than 10	P	P
10 - 16.7	10	(2.5 * P) - 4
16.7 - 33.6	(0.3 * P) + 5	(2.5 * P) - 4
33.6 - 50	(0.3 * P) + 5	80
50 - 80	P - 30	80
Greater than 80	50	Spillway may operate

39. The maximum increase in load generated from the Matahina Power Station shall not exceed 52 megawatts per hour except during an under-frequency event and/or a flood event.

40. The maximum decrease in load generated from the Matahina Power Station shall not exceed 16 megawatts per hour except during an under-frequency event and / or flood event.

Notification

41. Should the maximum rates of increase and decrease set out within Conditions 33 and, 34, 39 and 40 be exceeded as a consequence of an under-frequency event and/or flood event, the consent holder shall notify the Chief Executive of the Bay of Plenty Regional Council within 72 hours of the under frequency event and/or flood event occurring.

Definitions

42. For the purpose of Conditions 33 and, 34, 39 and 40 the term 'under frequency event' shall mean either;

a. An interruption or reduction of electricity injected into the national grid, or

b. An interruption or reduction of electricity injected from the HVDC link into the South Island HVDC injection point or the North Island HVDC injection point

where there is, within any 60-second period, an aggregate loss of electricity in excess of 60 megawatts.

43. For the purpose of Conditions 33, 34, 39, 40 and 63, the terms 'flood event' and 'flood Conditions' shall mean when (i) flows into Lake Matahina exceed

[1] Refer to Advice Note 1 for the indication of the flow (as seen and measured at the Te Teko flow gauge - NIWA reference number 15412) associated with the MW set points cited in Condition 37.

160 m^3/s cubic metres per second, and/or (ii) the water level in Lake Matahina is equal to, or exceeds 76.20 metres above Moturiki Datum.

Modified Operating Regime Notification **[These conditions are longer necessary if EHG relief granted.]**

44. Prior to the commencement of the modified operating regime set out within Conditions 36 to 40 the consent holder shall notify the public of the new operating regime and the manner in which it will alter the flows in the Rangitaiki River. Notification shall be made via:

a. Letters to the New Zealand Jet Boating Association, the local branch of the Fish and Game Council, Horticulture New Zealand and the Bay of Plenty Province of Federated Farmers; and

b. A media release to boating and angling / fishing magazines including New Zealand Fishing News, New Zealand Fishing World, Fishing Magazine (on-line magazine), Boating New Zealand, Propeller Magazine and Trade-a-Boat New Zealand; and the regional newspapers including the Whakatane Beacon, Bay of Plenty Times, Rotorua Daily Post and Eastern Bay of Plenty News; the local radio stations including 1XX in Whakatane; and

c. The website of TrustPower Limited; and

d. Installing signage at public boat ramps on the Rangitaiki River below the Matahina Dam (Map reference NZTM 1934359, 57747759), at the Thornton Motor Camp (Map reference NZTM 1940840, 5796847) and on the Bridge Supports at Edgecumbe and Te Teko.

Intake Modifications **[These conditions are no longer necessary if EHG relief granted.]**

45. The consent holder shall, prior to the commencement of the modified operating regime, offer to implement the intake modifications summarised in the table attached to this resource consent as **Appendix Three** with reference to the relevant intake owner. In this regard:

a. The consent holder shall write to the intake owner informing them of their entitlement to the intake modifications. That correspondence shall inform the intake owner of their right to have the modifications carried out either prior to, or after the implementation of the modified operating regime, and shall expressly state that the offer shall remain valid for 12 months following implementation of the modified operating regime.

b. The consent holder shall wait at least three months for the intake owner to respond to the written offer required by Condition 45(a) of this resource consent.

c. Where any intake owner(s) do not respond to, or accept the written offer required by Condition 45(a) of this resource consent, the consent holder shall not be obliged to carry out the modifications prior to implementation of the modified operating regime, but shall, within two months of implementing the modified operating regime, repeat the written offer required by Condition 45(a) of this resource consent and reconfirm that it

remains valid for 12 months following implementation of the modified operating regime.

d. Where any intake owner(s) accept the written offer required by Condition 45(a) of this resource consent, the consent holder shall carry out the modifications at a practicable time agreed between the consent holder and the intake owner(s) provided that if a practicable time cannot be arranged within three months of any such acceptance the consent holder may proceed to implement the modified operating regime.

45A. In the event that:

a. Any of the modifications undertaken in accordance with Condition 45 require a variation to an existing resource consent, or a new resource consent; and/or

b. An existing take of water that is permitted under Rule 41 of the Bay of Plenty Regional Water and Land Plan requires a resource consent, as a consequence of the modified operating regime

the variation or new consent shall be obtained by the consent holder prior to the implementation of the modified operating regime.

46. The consent holder shall prepare a report that documents:

a. The offers and/or the modifications made to the intakes under Condition 45 of this resource consent; and

b. The resource consents/variations to existing resource consents that are required under Condition 45A and which have been secured.

The report shall be submitted to the Chief Executive of the Bay of Plenty Regional Council for certification. The Chief Executive of the Bay of Plenty Regional Council shall only issue the certificate if he/she is satisfied that the offers have been made and/or the intakes have been modified in accordance with Condition 45 and the necessary resource consents/variations to existing resource consents required under Condition 45A have been secured.

47. The modified operating regime shall not commence until the Chief Executive of the Bay of Plenty Regional Council has issued his/her certificate under Condition 46 of this resource consent.

Downstream Abstractors Management Plan **[These conditions no longer necessary if EHG relief granted.]**

48. The consent holder shall, prior to the commencement of the modified operating regime, prepare a Downstream Abstractors Management Plan ('**DAMP**') in respect of the modifications that have been carried out pursuant to Condition 45 of this resource consent. The DAMP shall be developed by a suitably qualified and experienced expert (or experts).

49. The DAMP shall:

a. Describe the measures that have been installed, and/or modifications that have been made by the consent holder, in accordance with

Condition 45 of this resource consent, to maintain the ongoing performance of the existing intakes following the implementation of the modified operating regime.

b. Establish a complaints and investigation process that is available for the owners of the existing intakes should they become concerned that the modified operating regime is adversely affecting the effective and efficient operation of their intake.

c. Identifying a person (or persons) that can be contacted, at any time, by the owners of the existing intakes to discuss a concern associated with the operation of their intakes.

d. Identify a toolbox of measures that can be implemented to rectify a problem with each intake that has been modified in accordance with Condition 45.

e. Identify a toolbox of measures that can be implemented to address the impact of a water supply being interrupted while Condition 49(d) is being implemented (such as the temporary supply of water from an alternative source).

f. Set out mediation and arbitration procedures for dealing with issues or disputes that arise in relation to the implementation adequacy and effectiveness of the additional measures specified in the Condition 45 and/or the DAMP.

50. When preparing the DAMP required by Condition 48 of this resource consent, the consent holder shall consult with the owners of every intake that has been modified in accordance with Condition 45 of this resource consent. This shall include submitting a draft of the plan to those parties for comment and allowing one month for a response. The consent holder shall provide a copy of any comments received to the Chief Executive of the Bay of Plenty Regional Council.

51. The modified operating regime shall not commence until the Chief Executive of the Bay of Plenty Regional Council has certified that the DAMP addresses the matters set out in Conditions 49 and 50.

52. The consent holder shall, twelve months after the commencement of the modified operating regime, prepare an updated DAMP in respect of the modifications that have been carried out after commencement of the modified operating regime pursuant to Condition 45 of this resource consent. The requirements of Conditions 49 and 50 of this resource consent shall apply in respect of the updated DAMP in respect of all intake owners who were not encompassed in the DAMP first prepared in accordance with Condition 48.

Intakes Exemption

[These conditions no longer necessary if EHG relief granted.]

53. Conditions 45 to 52 of this resource consent shall not apply in respect of any existing intake(s) if alternative arrangements are agreed by contractual obligation between the consent holder and the intake owner.

Erosion Monitoring Plan

54 The consent holder shall appoint an appropriately qualified independent expert (or experts) to monitor the Rangitaiki River from the Matahina Dam to its mouth.

54A The consent holder shall prepare a plan to be entitled the Erosion Monitoring Plan (EMP) to identify and to the extent possible quantify the adverse effects of the Matahina HEPS on the pattern and rate of erosion in the Rangitaiki River downstream of the dam. The EMP ~~monitoring programs and the methodology to be employed in the monitoring are~~ shall be submitted for the approval of the BOPRC. As a minimum the EMP shall include those matters set out in (a) to (e) below.

a. Monitoring shall be conducted to determine changes to the riverbed below the Matahina Dam. This monitoring program shall ~~see~~ require the consent holder monitoring 15 cross-sections at the sites identified on the Plan attached as **Appendix Four**. The first cross-section survey shall be completed within 12 months of the modified operating regime commencing. Each cross section survey shall as a minimum record the following information:

(i) A consistently structured set of river cross sections based on the character and meander pattern of the river so as to enable hydraulic modelling of the river and indicate channel changes;

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(ii) An inventory of the erosion hazard along the river which categorises channel form, channel curvature (or sinuosity), bed materials, bank height, slope and materials, bank and berm cover (vegetation), protection measures in place and the type and proximity of assets alongside the river channel. Each position shall be defined with reference to cross section position and river profile distance.

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(iii) A photographic record of selected sites and eroded banks located by position including a log of bank height, slope and materials with repeat photographs over time of the same bank locations. Photographs shall be taken at low flow periods (approximately 40 m3/s at Te Teko flow recorder).

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(iv) A series of groundwater monitoring wells at selected sites along the river with continuous recording of water levels in the wells over periods that cover very low and flood periods. Records to be correlated with measurements of water levels in the river adjacent to the monitoring wells. Each well shall be located and have a drilling log of materials and soil strength (penetrometers readings) recorded with it.

~~a.~~b. The EMP shall include provision for subsequent surveys to occur every five years thereafter, and within two months of any of any flood event exceeding 320 cubic metres per second at Te Teko. If erosion protection works have been undertaken at any of the 15 cross sections

such that they are no longer a valid sampling site, a replacement site that is representative of that part of the river shall be selected.

b. c. The EMP shall include provision for the results of the cross-section surveys conducted in accordance with Condition 54A(a) shall to be compared with the results of the previous surveys, as reported in the report entitled '*Matahina HEPS – Biennial Rangitaiki River Monitoring*' (Beca Infrastructure Limited - 2010).

c. d. The EMP shall include provision for monitoring to shall be conducted to determine if there has been a change to the pattern or rate of erosion in the Rangitaiki River below the Matahina Dam. This monitoring programme shall involve:

i. An annual inspection of the Rangitaiki River between the Matahina Dam and Edgecumbe by jet boat, for the first three years after the commencement of the consent modified operating regime, and

ii. An inspection of the Rangitaiki River between the Matahina Dam and Edgecumbe by jet boat within two months of any of any flood event exceeding 320 cubic metres per second at Te Teko.

d. The EMP shall include provision for the monitoring program in Condition 54(c) is to continue after the completion of the first three years of monitoring, but may occur at a reduced frequency. As a minimum, the monitoring is to be conducted every two years from the third anniversary of the commencement of the consent modified operating regime, and within two months of any flood event exceeding 320 cubic metres per second at Te Teko.

e. The EMP shall include provision for the results of the inspections conducted in accordance with Condition 54(c) shall be compared to the outcomes reported in the document entitled '*The Matahina HEPS Rangitaiki River Monitoring Report*' (2010, Beca Infrastructure Limited).

54B General Monitoring Plan

The consent holder shall develop a General Monitoring Plan (GMP) to monitor the adverse effects of the Matahina HEPS on the matters set out in condition 54A(a) below. The GMP shall be submitted for the approval of the BOPRC. As a minimum the GMP shall include provision to address those matters set out in (a) to (c) below:

a). The provision to monitor the effects of the modified operating regime on aquatic flora and fauna. is to be monitored. This monitoring programme shall include weed bed and riparian vegetation health and coverage assessments, an assessment of macro-invertebrate abundance and diversity of the Rangitaiki River between the Matahina Dam and Edgecumbe, and the measurement of temperature and dissolved oxygen levels (concentration and percent saturation concentration).

b). The weed bed and riparian vegetation health/coverage and macro-invertebrate abundance/diversity monitoring required under Condition

54A(a) shall be undertaken at six monthly intervals over a period of 36 months from the commencement of the modified operating regime.

c). The temperature and dissolved oxygen level monitoring required under Condition 54A(a) shall be undertaken:

i. Immediately downstream of the Matahina Hydroelectric Power Scheme's tailrace; and

ii. At the Te Teko river flow recording site; and

iii. Every 15 minutes over a period of 24 months from the commencement of the modified operating regime.

Reporting

55. The consent holder shall provide reports detailing the results of the monitoring required under Condition 54 and 54A to the Chief Executive of the Bay of Plenty Regional Council no later than 39 months of the ~~modified operating regime~~ consent commencing. Copies of the reports shall also be forwarded to the Panel established pursuant to condition 83A hereto, the relevant branches of the Department of Conservation, the Royal Forest and Bird Protection Society, Horticulture New Zealand, the Bay of Plenty Province of Federated Farmers, Fish and Game New Zealand, the Kokopu Trust, Ngati Awa, Ngati Haka Patuheuheu, Ngati Manawa, Ngati Whare, Ngati Tuwharetoa, Ngati Umutahi, the Environmental Hazards Group of the Bay of Plenty Regional Council and any additional parties deemed relevant by the Chief Executive of the Bay of Plenty Regional Council.

56. In addition to the reporting requirements set out in Condition 54A, the consent holder shall notify the Chief Executive of the Bay of Plenty Regional Council if the dissolved oxygen concentration at the Te Teko river flow recording site is less than 80 percent. The notification shall be in writing and shall record the dissolved oxygen levels measured, and the duration that the dissolved oxygen concentration was less than 80 percent. The notification shall be made within 48 hours of the consent holder becoming aware of the dissolved oxygen concentrations being less than 80 percent.

57. ~~In the event th~~at T~~t~~he monitoring completed under Condition 54 of this resource consent shall be submitted ~~identifies that the modified operating regime is:~~

~~Adversely affecting the pattern or rate of river erosion~~.

to the Peer Review Panel established pursuant to condition 83A of this resource consent for consideration and advice to the BOPRC as to the implications of the monitoring results and the adequacy of the mitigation proposed.

57A In the event that the monitoring completed under Condition 54A of this resource consent identifies that the ~~modified~~ operating regime is:

a) Adversely affecting the aquatic flora and fauna; or

b) Adversely affecting water quality

the consent holder shall appoint a suitably qualified independent expert (or experts) to prepare and submit a further report (or reports).

Those reports prepared under the GMP shall be submitted to the Chief Executive of the Bay of Plenty Regional Council that recommend mitigation measures to address the adverse effects that are apparent and any associated on-going programme of monitoring. The reports shall be prepared and submitted to the Chief Executive of the Bay of Plenty Regional Council for certification no later than 3 months after the report (or reports) required in accordance with Condition 54A of this resource consent have been submitted. The Chief Executive of the Bay of Plenty Regional Council shall only issue the certificate if:

d. The proposed mitigation measure(s) will appropriately address the adverse effect(s); and

e. The proposed monitoring programme will enable the effectiveness of the mitigation measure(s) to be adequately assessed.

58. The consent holder shall, within 3 months of receiving certification from the Chief Executive of the Bay of Plenty Regional Council in accordance with Condition 57 of this resource consent, implement the mitigation measures recommended in the report.

59. In the event that monitoring conducted in accordance with Conditions 17 to 21, 54(a) and/or 54(b) of this resource consent identifies that a cultural and/or archaeological site (or sites) is damaged, modified or destroyed by events that are attributable to the ~~modified~~ operating regime the consent holder shall advise the Chief Executive of the Bay of Plenty Regional Council within 48 hours of the consent holder being aware of the damage, modification or destruction. In such an event the following actions and subsequent mitigation shall be undertaken:

a. Within 48 hours of the consent holder being aware of the damage, modification or destruction, the consent holder shall advise Ngati Awa, Ngati Tuwharetoa and the New Zealand Historic Places Trust.

b. Within 7 days of the consent holder being aware of the damage, modification or destruction, the consent holder shall commission a suitably qualified archaeologist to provide a report on the site, including advice from the appropriate Pukenga of Ngati Awa and Ngati Tuwharetoa, and any recommended actions or mitigation measures.

c. Within 7 days of the report required in accordance with Condition 59(b) being completed, the consent holder shall provide a copy of the report to Ngati Awa, Ngati Umutahi and Ngati Tuwharetoa for comment, allowing one month for a response. Upon receipt of any comments the consent holder shall submit the report, and any comments received from Ngati Awa or Ngati Tuwharetoa to the Chief Executive of the Bay of Plenty Regional Council for review and certification.

d. Within 7 days of the report required in accordance with Condition 59(b) being completed, the consent holder shall also provide a copy of the

report to the New Zealand Historic Places Trust if it has been established that an archaeological site has been damaged.

60. Within 6 months of receiving certification from the Chief Executive of the Bay of Plenty Regional Council that the report required in Condition 59(b) adequately addresses environmental effects associated with the damage, destruction or modification, the consent holder shall implement any recommended actions or mitigation measures set out in the report.

~~**Modified Operating Regime Consent Review Opportunity**~~

~~61. The Chief Executive of the Bay of Plenty Regional Council may, in accordance with section 128 of the Resource Management Act 1991, not less than 43 months after the commencement of the modified operating regime, serve notice of its intention to review, amend, delete or add to the Conditions of this resource consent to deal with any unanticipated adverse effects on the environment which result from the modified operating regime.~~

~~62. All reasonable costs incurred by the Bay of Plenty Regional Council in undertaking a review of the consent under section 128 of the Resource Management Act 1991, as specified in Condition 61, shall be borne by the consent holder.~~

Flood Operating Conditions

63. ~~The Matahina Hydroelectric Power Scheme shall be operated in accordance with the Flood Management Plan attached as **Appendix Five** to this resource consent when 'flood Conditions' into Lake Matahina are predicted (by either Bay of Plenty Regional Council or the consent holder) or experienced.[EHG prefer achieving flood management via the following conditions~~[EHG prefer achieving flood management via the following conditions.]

63A When BOPRC predicts a flood of 300 cumecs or more up to forty eight hours in advance, the consent holder shall reduce the lake level at a rate specified by the BOPRC but not more than 0.3 metres per hour so as to bring the lake level to 71.6 m Moturiki Datum.

63B When BOPRC predicts a flood of 500 cumecs or more up to forty eight hours in advance, the consent holder shall reduce the lake level at a rate specified by the BOPORC but not more than 0.5 metres per hour so as to bring the lake level to 70 m Moturiki Datum.

63C Within three months of the commencement of the consent, the consent holder shall, following consultation with the Environmental Hazards Group of the Bay of Plenty Regional Council, develop for approval by the Bay of Plenty Regional Council, protocols in relation flood management strategies and communication with the Environmental Hazards Group of the Bay of Plenty Regional Council to give effect to Conditions 63A and 63B hereof. Once approved, flood management shall be undertaken in accordance with those protocols.

~~*Flood Management Plan*~~[EHG prefer achieving flood management via the preceding conditions.]

64. ~~The contents of the Flood Management Plan attached as **Appendix Five** to this resource consent shall be reviewed within 12 months of the commencement of this consent and every 24 months thereafter by the consent holder. Any amendments to the Flood Management Plan shall take into account the recommendations of the Environmental Hazards Group of the Bay of Plenty Regional Council and shall not have effect under Condition 63 until the Chief Executive of the Bay of Plenty Regional Council certifies that they accord with the relevant obligations of this Resource Consent, the Building Act 2004 and the Building (Dam Safety) Regulations 2008, or any subsequent revisions to the Act .~~

Fish Passage

65. The consent holder shall facilitate the upstream passage of native fish species that currently arrive at the Matahina Dam face (targeting longfin eel, shortfin eel, koaro, banded kokopu, shortjaw kokopu and giant kokopu species (the 'target species')) and downstream passage of adult eels past the Matahina Dam, the objective of which is to ensure that the Matahina Dam does not prevent the establishment and maintenance of diadromous native fish populations in the Rangitaiki River catchment upstream of the Matahina Dam.

66. Within 6 months of this consent commencing the consent holder shall have submitted a report, prepared by a suitably qualified independent expert, to the Chief Executive of the Bay of Plenty Regional Council that describes:

a. The up and downstream fish passage systems that the consent holder will adopt to comply with Condition 65; and

b. The programme of monitoring that will be undertaken to record the live fish (by number and species):

i. Transferred upstream of the Matahina Dam, and

ii. Observed achieving passage downstream of the Matahina Dam

to demonstrate whether the fish passage systems are assisting in the achievement of the objective set out in Condition 65.

67. When preparing the report required by Condition 66, the consent holder shall consult with the Department of Conservation, Fish and Game New Zealand, the Kokopu Trust, Ngati Awa, Ngati Haka Patuheuheu, Ngati Manawa, Ngati Whare, Ngati Tuwharetoa, and Ngati Umutahi (and any additional parties deemed relevant by the Chief Executive of the Bay of Plenty Regional Council). This shall include submitting a draft of the report to those parties for comment and allowing one month for a response. The consent holder shall provide a copy of any comments received to the Chief Executive of the Bay of Plenty Regional Council.

68. The report required by Condition 66 shall be submitted to the Chief Executive of the Bay of Plenty Regional Council and must, as a minimum:

a. For upstream passage:

i. Set an objective for the effectiveness of the fish trap and transfer system and detail how the achievement of the objective will be monitored; and

ii. Specify the period over which the fish trap and transfer system will be operated (this period will align with the peak migration period(s)) for the species listed in Condition 65. The Consent Holder is to adopt a precautionary period of operation for the fish trap and transfer system until the Chief Executive of the Bay of Plenty Regional Council certifies that he/she is satisfied that the peak migration period is adequately defined; and

iii. Specify the programme of monitoring that is to be undertaken to refine the peak migration period(s); and

iv. Detail the design and location of the fish trap, the methodology to be used in the transfer of the live fish (including a requirement for the target species to be transferred to areas upstream of the Aniwhenua Hydroelectric Power Scheme at least once per week) and specify the locations where the live fish will be transferred to and the reasons for the locations; and

v. Specify the measures to be undertaken to enhance fish survival during the transfer and post release periods.

b. For downstream passage:

i. Set an objective for the effectiveness of the downstream adult eel passage system and detail how the achievement of the objective will be monitored; and

ii. Describe the proposed downstream adult eel passage system, and detail the alternative options considered/assessed, the costs and benefits of each alternative and set out the reasons for recommending the proposed adult eel passage system.

69. Within 12 months of receiving certification from the Chief Executive of the Bay of Plenty Regional Council that the report required in Condition 66 addresses the matters set out in Conditions 66, 67 and 68 the consent holder shall implement the fish and adult eel passage systems and monitoring programmes recommended in the report.

70. The consent holder shall annually report (on the anniversary of the commencement of this consent), to the Chief Executive of the Bay of Plenty Regional Council, on the work undertaken to comply with Condition 69 and the monitoring undertaken including:

a. An estimate of the number of each species transferred upstream of the Matahina Dam and the location of their release; and

b. An estimate of the number of adult eels that have passed downstream of the Matahina Dam; and

c. Results of the monitoring conducted to assess the health and viability of

the fish populations upstream of the Matahina Dam.

71. Within 3 years of this consent commencing the consent holder shall appoint a suitably qualified independent expert (or experts) to prepare and submit to the Chief Executive of the Bay of Plenty Regional Council a report that:

a. Details the work that has been undertaken to comply with Conditions 65 to 70;

b. Reports the contribution made by the upstream and downstream fish passage systems to the achievement of the objective set out in Condition 65;

c. Assesses the effects of the Matahina Dam and Lake Matahina on fish populations and describes the benefits of the work that has been undertaken to maintain and enhance these populations; and

d. Makes recommendations about mitigating the effects of the Matahina Dam and Lake Matahina on upstream fish populations, including:

i. The value of continuing the facilitation of fish passage;

ii. The species that should be targeted for any ongoing facilitation of passage;

iii. Any changes to the programme that would help achieve the objective set out in Condition 65; and

iv. Describing alternative measures and/or programmes for avoiding, remedying or mitigating the effects of impeding fish passage, in the event that the focus on facilitation of passage is shown to be unsuccessful in maintaining viable populations of the target species upstream of Lake Matahina.

72. When preparing the report required by Condition 71, the consent holder shall consult with the Department of Conservation, Fish and Game New Zealand, Kokopu Trust, Ngati Awa, Ngati Haka Patuheuheu, Ngati Manawa, Ngati Whare, Ngati Tuwharetoa, and Ngati Umutahi (and any additional parties deemed relevant by the Chief Executive of the Bay of Plenty Regional Council). This shall include submitting a draft of the report to those parties for comment and allowing one month for a response. The consent holder shall provide a copy of any comments received to the Chief Executive of the Bay of Plenty Regional Council.

73. Within 6 months of receiving certification from the Chief Executive of the Bay of Plenty Regional Council that the report addresses the matters set out in Condition 71, the consent holder shall implement the mitigation measures recommended in the report.

74. The consent holder shall provide final copies of all reports required by Conditions 66 to 71 to the Department of Conservation, Fish and Game New Zealand, the Royal Forest and Bird Protection Society, the Kokopu Trust, Ngati Awa, Ngati Haka Patuheuheu, Ngati Manawa, Ngati Whare, Ngati Tuwharetoa, Ngati Umutahi (and any additional parties deemed relevant by the Chief Executive of the Bay of Plenty Regional Council).

Cooling Water Discharge

75. The maximum rate of discharge of water used for cooling purposes at the Matahina Dam Powerhouse to the Rangitaiki River shall not exceed 140 litres per second.

Maintenance Activities

76. The consent holder shall notify the Chief Executive of the Bay of Plenty Regional Council of its intention to carry out maintenance activities at the Matahina Hydroelectric Power Scheme that will disturb the bed of Lake Matahina and/or the Rangitaiki River at least 48 hours prior to the commencement of the activities. The notification shall be in writing and set out the nature of the proposed activities, their purpose and anticipated duration.

77. No contaminants (other than sediment) shall be released to the area of Rangitaiki River or Matahina Lakebed, beyond the area that is being worked, from equipment being used for the activity, and no refuelling of equipment shall take place on any area of the Rangitaiki River or Matahina Lakebed. All equipment used in the maintenance activities undertaken by, or at the request of the consent holder shall be cleaned to the MAF Biosecurity didymo cleaning standards prior to, and following the work undertaken within the bed of Lake Matahina or the Rangitaiki River to minimise the prospect of aquatic weeds being transferred into or from the Rangitaiki River catchment.

78. All material removed from a structure or from within the immediate vicinity of a structure, and all excess construction materials shall be removed from the river and/or lakebed within 7 days following the completion of the work. The consent holder shall ensure that any stockpiles of materials are located so that the materials cannot enter a water body and/or a watercourse.

79. Dewatering of any work site shall be for the minimum time necessary to undertake the work. If dewatering for more than 48 hours is expected to be necessary the consent holder shall notify the Chief Executive of the Bay of Plenty Regional Council before the work begins. The notification shall be in writing and shall describe the activity, its purpose and expected duration.

80. Maintenance activities undertaken in accordance with this consent shall not cause the flow of the Rangitaiki River to be less than 20 cubic metres per second immediately below the Matahina Hydroelectric Power Scheme.

Relationship with Tangata Whenua

81. The consent holder shall, at least once per calendar year, convene a meeting with representatives of the Bay of Plenty Regional Council, Ngati Awa, Ngati Haka Patuheuheu, Ngati Manawa, Ngati Whare, Ngati Tuwharetoa and Ngati Umutahi, to discuss any matter relating to the exercise and monitoring of this consent.

82. The meeting required by Condition 81 need not occur if either (i) the tangata whenua parties listed in the Condition advise the Bay of Plenty Regional

Council that the meeting is not required, or (ii) there is no response from all of the Tangata Whenua groups to an invitation from the consent holder to meet.

83. The consent holder shall keep minutes of the meetings held in accordance with Condition 81 and shall forward them to all attendees and to the Bay of Plenty Regional Council.

Peer Review Panel

83A Not less than two months prior to the exercise of this consent, the consent holder shall engage at its cost an Independent Peer Review Panel (the Panel) whose membership shall be subject to the written approval of the Chief Executive of the Bay of Plenty Regional Council or delegate.

The Panel shall consist of three independent experts suitably qualified or experienced in river processes, flood management, geotechnical issues and related environmental effects, whose role will be to assist the Bay of Plenty Regional Council to manage, supervise and monitor the exercise of this consent.

The Panel shall meet at a frequency of not less than once per 24 month period for the duration of the consent and shall engage professional service providers from time to time to assist the Panel to undertake the tasks assigned to them under the conditions of this consent. The Panel shall also meet with the Bay of Plenty Regional Council staff, the consent holder and/or tangata whenua representatives as listed in condition 81 on request.

83B The role of the Panel shall be to assist the Bay of Plenty Regional Council in the supervision and monitoring of the exercise of these consents. Without limiting the generality of this role, the general functions of the Panel, in addition to those specified elsewhere in this consent, shall include but not be limited to:

(i) Reviewing the monitoring plan set out in condition 54 that shall be applied to the Rangitaiki River from the Matahina Dam to its mouth to determine if there has been a change to the pattern or rate of change of erosion including the need to establish a baseline of river monitoring data and the length of time to establish such a baseline.

(ii) Reviewing the information to be logged at each monitoring site and the frequency of monitoring over the duration of the consent as set out in condition 54(a) and making recommendations as to suggested changes to monitoring requirements.

(iii) Reviewing the monitoring results reported under condition 54 and reporting to the Chief Executive of the Bay of Plenty Regional Council on the adequacy of the mitigation proposed by the consent holder through the report prepared under condition 57 and making

recommendations to the Regional Council with respect to the same where appropriate..

(iv) Consider the relative causes of the erosion recorded through the monitoring reported under condition 54 and consider what portion is derived from natural river operation and what portion is derived from the operation of the Matahina HEPS and what the relative contribution should be of the consent holder to the costs of the Bay of Plenty Regional Council in undertaking their river control work for the previous year.

(v) Recommending to the Bay of Plenty Regional Council that the consent holder undertake surveys or other investigations for the purposes of enquiring into any adverse effects arising from the exercise of the consents.

(vi) Making recommendations to the Bay of Plenty Regional Council that a review of conditions under section 128 of the Resource Management Act 1991 be undertaken if necessary or appropriate, including:

- Further avoiding , remedying or mitigating adverse effects on the Rangitaiki River Scheme as a result of the activities authorised by this consent;
- Amending the monitoring requirements;
- Any other matters it considers appropriate

(vii) Recommend to the consent holder that it amend the financial contribution offered under condition 26 in terms of its adequacy in mitigating the adverse environmental effects of the operating regime of the Matahina HEPS.

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(viii) Recommend that the Council initiate a review of the consent under condition 84 in the event that it is able to require a financial contribution.

General Review

84. In accordance with sections 129 of the Resource Management Act 1991, the Chief Executive of the Bay of Plenty Regional Council may serve notice of its intention to review, amend, delete or add to the Conditions of this resource consent under section 128 of the Resource Management Act 1991 by giving a notice of review during the month of March 2013 and/or March 2018 and/or March 2023 and/or March 2028 and/or March 2033 and/or March 2038, for the purpose of:

(i) ensuring that the Conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent

which were not foreseen at the time the application was considered or which it is appropriate to deal with at a later stage;,

(ii) to review the effectiveness of the conditions in avoiding, remedying or mitigating adverse effects on the environment form the consent holder's activities and, if considered appropriate by the Regional Council, to deal with such effects by way of further or amended conditions;

(iii) addressing any adverse effects on river and stopbank erosion arising from the activities authorised by this consent;

(iv) to review the effectiveness and efficiency of the conditions in ensuring sustainable management of the Rangitaiki River Scheme;

(v) to review such conditions as may be recommended by the Panel;

(vi) to amend the financial contribution provided for by condition 26 in the event that the Regional Plan provides for financial contributions to compensate for environmental damage caused by the activities of the consent holder.

.85. In accordance with section 128(1)(b) of the Resource Management Act 1991, the Chief Executive of the Bay of Plenty Regional Council may serve notice of its intention to review, amend, delete or add to the Conditions of this resource consent for the purpose of ensuring that the Conditions reflect any instream minimum flow regime that is made operative in an applicable planning instrument.,

86. The Chief Executive of the Bay of Plenty Regional Council may, within six months of the completion of any environmental investigation or compliance report carried out by the Regional Council, or on the receipt of monitoring results that show there is an adverse effect on the environment, serve notice on the consent holder under section 129 of the Resource Management Act 1991 of its intention to review the Conditions of this consent under section 128 of the Resource Management Act 1991.

87. All reasonable costs incurred by the Bay of Plenty Regional Council in undertaking a review of the consent under section 128 of the Resource Management Act 1991, as specified in Conditions 84 to 86 shall be borne by the consent holder.

ADVICE NOTES:

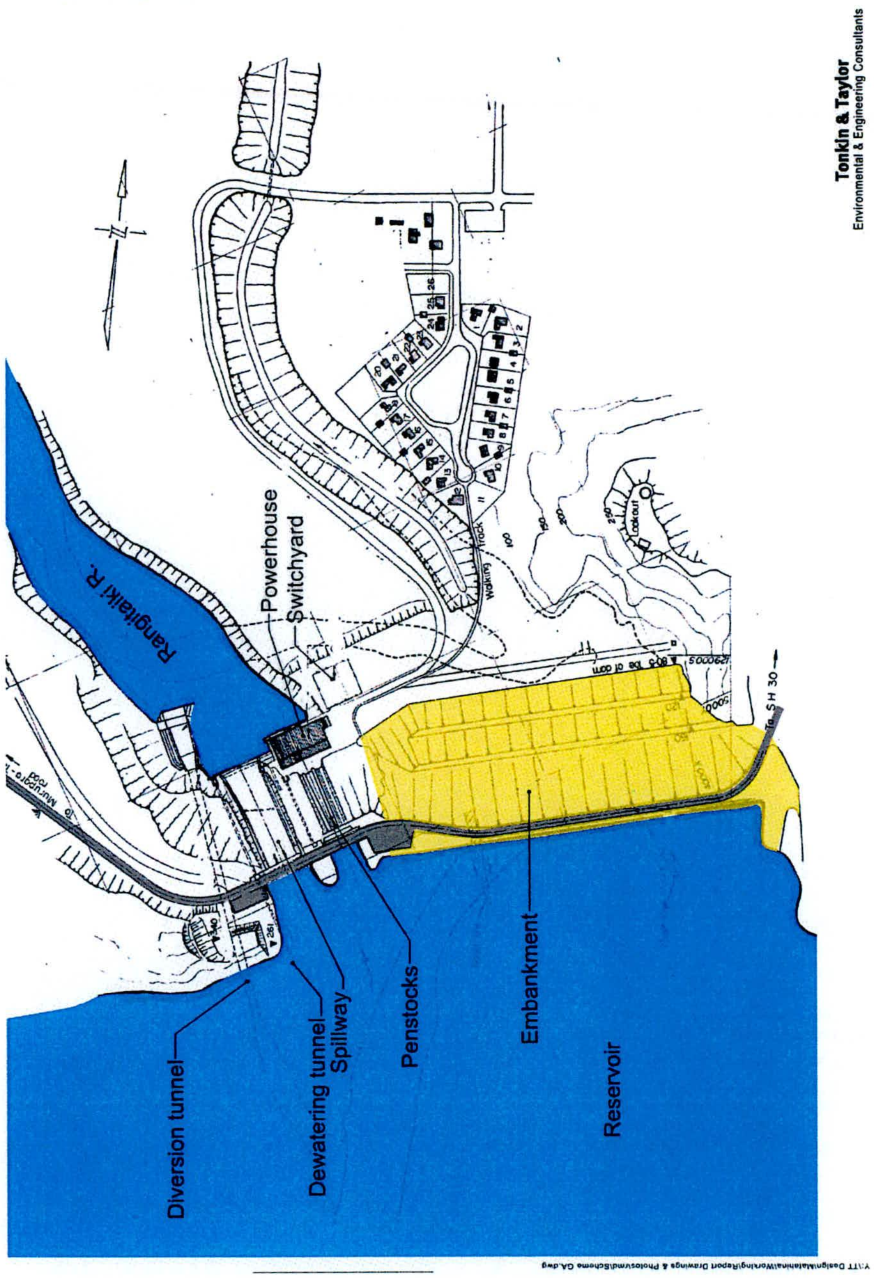
1. The following table records the modelled relationship between the 'MW generation set points' cited in Condition 38 and the flow (set as a range) seen in the Rangitaiki River below the Matahina Hydroelectric Power Scheme. The flow ranges cited is what is expected at the Te Teko water-monitoring gauge[2] site, which is below the Hydroelectric Power Scheme.

[2] NIWA reference number 15412.

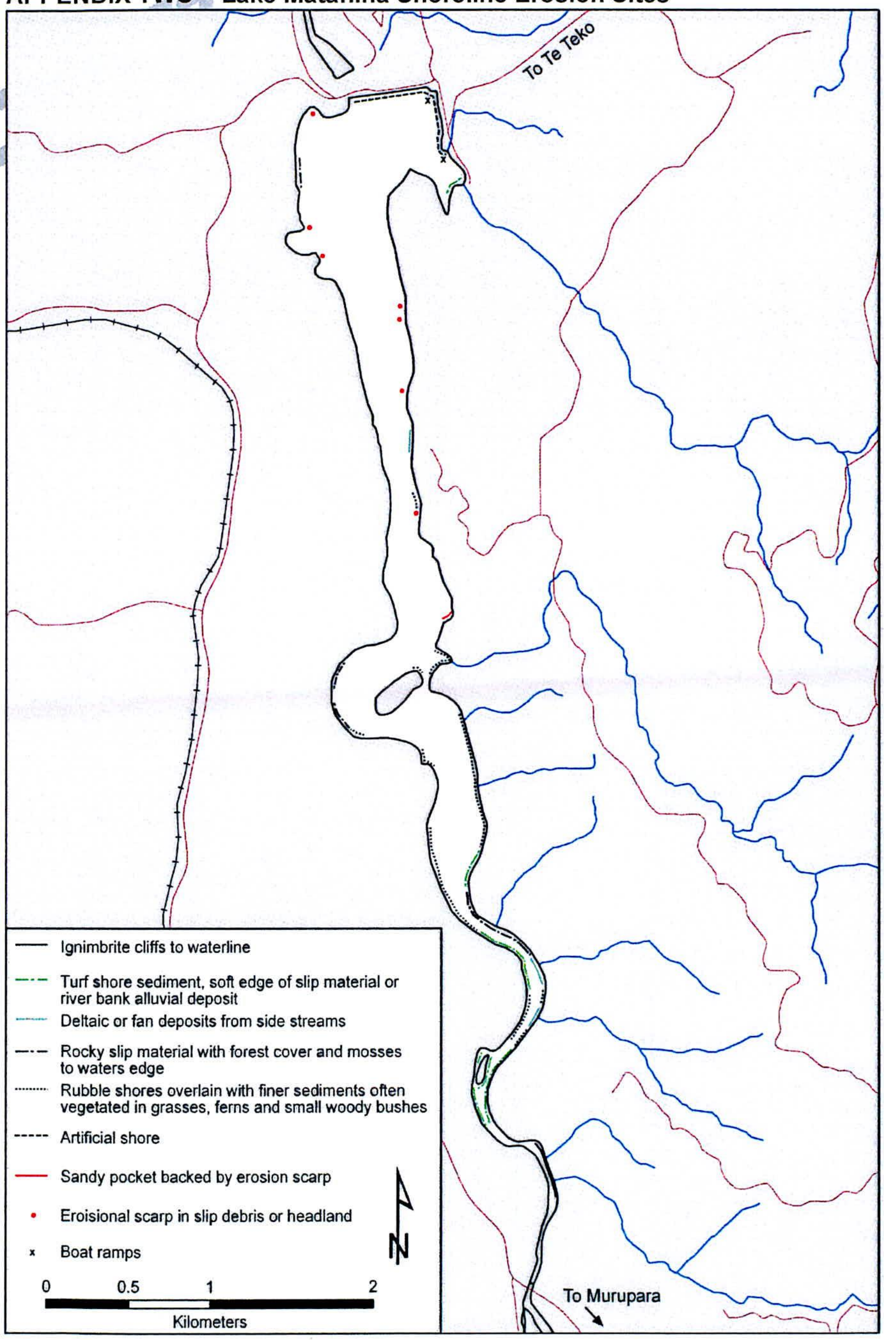
Rolling 72 hour average generation ('P') (MW)	Minimum Generation Set-point (MW)	Maximum Generation Set-point (MW)	Te Teko Flow Range (m^3/s)
Less than 10	P	P	-
10	10	21	25 – 51
16.7	10	37.75	25 – 85
33.6	15.08	80	34 – 170
50	20	80	40 – 170
80	50	80	90 – 170
Greater than 80		Spillway may operate	-

Typically during periods when inflow and generation is high there is a flow gain in the reach of the River between the Power Station to Te Teko of about 2 to 5m^3/s, although this may be greater during sustained wet periods, when generation is also more continuous at Power Station capacity.

APPENDIX ONE – Matahina Hydroelectric Power Scheme Plans



APPENDIX TWO – Lake Matahina Shoreline Erosion Sites



APPENDIX THREE – Schedule of Intake Modifications

River distance from dam, km	Abstractor (Owner)	Mitigation Requirement
36.6 River Mouth		
34.5 R	Craig Hammond	Install duplicate conductivity sensor/transmitters to control pump; install additional 30,000 L tank; install intake screen.
34.5 R	Michael Noord	Install additional pump and 20,000 L storage tank; install duplicate conductivity sensor/transmitters to control pump; install intake screen.
34.5 Thornton Bridge		
34.5 L	Vincentius Vierboom	Install additional pump and 20,000 L storage tank; install duplicate conductivity sensor/transmitters to control pump; install intake screen.
33.5 L	Unknown	Upgrade to floating intake; install intake screen.
30.6 L	Gow Family Trust	Extend intake structure by 3 m; provide a lifting gantry.
29.8 L	Ian and Julie Kinvig	Extend pipe by 5 m for first intake.
		Extend second intake into deeper water; install intake screen
29.8 L	Phillip and Margaret Leaming	Extend intake into deeper water, install intake screen.
29.6 R	Murray Langdon (Oriini Farms Limited)	New intake using concrete rings, 2 m out from existing intake; install intake screen.
27.2 R	Unknown	Extend intake into deeper water; install intake screen.
25.5R	Fonterra Co-operative Group Limited	Modifications to water intake and fire pump barges to move further from riverbank.
25.3 Edgecumbe Bridge		
24.2 L	Alexander and Robyn Harvey and Jurgen Herbke	Replace existing pump with more powerful model; increase suction pipe diameter; install intake screen.
23.5 R	Unknown	Provide floating pontoon extending intake into deeper water; install intake screen.
23.3 L	Unknown	Extend intake into deeper water; install intake screen.
22.3 L	Malcolm Campbell	Extend intake deeper into river. Install screen.

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River distance from dam, km	Abstractor (Owner)	Mitigation Requirement
19.5 Earthquake fault / upstream limit of tidal influence		
18.0 R	Ngati Awa Farms (Rangitaiki) Limited	Lower intake and extend to deeper water
16.8 R	Crighton Robert Martin	Extend intake and upgrade to floating structure
15.7 R	Paul Manson (Omatoroa 7AC1A and 7AC1C2 Trust)	Replace existing pump with more powerful model; increase pipe diameters; extend intake pipe to lower level.
12.5 Te Teko Bridge		
12.1 L	Richard and Helen Hudson	Lower both intakes.
12.0 L	Unknown	Extend intake into deeper water

Chris Dawson evidence - Proposed Consent Conditions – EHG - 6 July 2011 (2.00 pm)

APPENDIX FOUR – Erosion Monitoring Cross-section Locations

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APPENDIX FIVE - Lake Matahina Flood Management Plan