IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of a Board of Inquiry appointed under s146 of the Resource Management Act 1991 to consider an application by Mighty River Power Limited for resource consents to construct, operate, and maintain a wind farm at Turitea

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REBUTTAL EVIDENCE OF GRAHAM JOHN LEVY

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1. INTRODUCTION

1.1 My name is Graham John Levy. My qualifications and relevant experience are set out in my evidence in chief. I confirm that I have prepared this rebuttal evidence in accordance with the Environment Court Code of Conduct for Expert Witnesses (July 2006).

1.2 I am providing this rebuttal evidence to comment on and respond to some of the primary evidence presented in respect of these applications that relate to erosion and sediment control and to water quality matters.

1.3 In particular, I will comment on the evidence of John Male, Chris Taylor, and Paul Blaschke, presented on behalf of Palmerston North City Council. Also Michael Joy and Alan Palmer on behalf of Tararua Aokautere Guardians and Friends of Turitea Reserve, and John Flenley appearing on his own behalf.

1.4 Specifically, I address the following matters:

(a) Risk-based approach;

(b) Use of Greater Wellington Regional Council's Erosion and Sediment Control Guidelines (GWRC guidelines);

(c) Quantification of increased sediment and nutrient discharge;

(d) Other water quality and environmental risks;

(e) Consequences of device failure or slip of cut/fill batters;

(f) Hydrological and erosion effects on stream headwaters;

(g) Lack of technical detail, uncertainty of outcomes;

(h) Monitoring plan.

2. RISK-BASED APPROACH

2.1 At paragraph 75(c) of his evidence, Mr Male recommends that a peer reviewed risk matrix be developed. He recommends at paragraph 75(a) that stockpiling of soil or vegetation in the water supply catchment be avoided, which also inherently reflects a risk-related approach, with the judgement made that consequences of the construction activities in water supply catchment are more serious than in other catchments.

2.2 Mr Taylor (paragraph 54) suggests that the applicant's focus has been on source areas and likelihood of an event, and not sufficiently on consequences.

2.3 The Australia and New Zealand Standard *Risk Management* (AS/NZS4360:2004) states that "*risk is measured in terms of a combination of the consequences of an event and their likelihood*".

2.4 In the context of selection of turbine sites and spoil disposal areas, as set out in the evidence in chief of Mr James, the design did not explicitly set out a formal risk matrix, but the process has involved an approach that recognises risk. Our assessment has been that the combination of likelihood and consequence of placing these works in the water supply catchment will still result in a low overall risk, as I will explain in more detail later in this rebuttal evidence through some specific assessments of consequences. That approach has resulted in some potential turbine sites being omitted from the design, and others being removed from the design at a later date as risk factors became more evident.

2.5 Our approach has also recognised that while the Palmerston North City water supply is a critical public asset (Taylor, paragraph 20), the Turitea Wind Farm, if constructed and operated appropriately, does not pose a high risk to the water supply. Both Mr Taylor (paragraph 63) and Mr Male (paragraph 74) agree with this, subject to listed criteria in each case. While I will challenge some of those criteria in my rebuttal evidence, I agree that the effects will be less than minor. In designing the wind farm, a balance has been struck which avoids an excessively protectionist approach to the water supply catchment at the expense of the adjacent catchments, which the ecological evidence has identified as also having high values in places (for example in Blaschke, at the end of paragraph 4.51). The need to avoid adverse effects on these other catchments has been an integral part of the design.

2.6 Nevertheless, in response to the submissions, the applicant has removed any spoil disposal sites from within the water supply catchment. This recognises the principle of avoidance that Mr Male advocates in paragraph 75(a). Similarly, it is proposed that vegetation from site clearance not be stockpiled in the water supply catchment area, except locally where it may be used as mulch cover to avoid erosion and trap sediment. Appropriate alternate disposal areas outside the water supply catchment have been identified, and Mr James will supply a further set of drawings to demonstrate this.

2.7 Mr Male has suggested a peer reviewed risk matrix be prepared with the consensus of all stakeholders (paragraph 75(c)). In my opinion requiring stakeholder consensus would be inappropriate in the context of any condition of consent, potentially leaving the consent-holder unable to implement any works in the event of non-cooperation of a stakeholder. The more appropriate approach, as proposed by the applicant, is that a Site Environmental Management Plan (SEMP) be prepared with full details of micro-siting and environmental management for each site. An officer of the consent authority will participate in the field inspections relating to the preparation of this SEMP, and the completed SEMP will be submitted to the Regional Council. Further to that, for the water supply catchment (which is the one area with critical public infrastructure and a clearly identified stakeholder), the agreement between PNCC and the applicant already specifically requires (at clause 6.2(f)) that MRP and PNCC must agree on erosion and sediment control to avoid discharge of contaminants to the water supply catchment where this may have an adverse effect. The term 'adverse effect' is also defined in that agreement to mean *"an adverse effect on water quality that cannot reasonably be mitigated and which will reduce water quality to below the applicable Ministry of Health guidelines for human consumption".*

2.8 In my opinion these two provisions are sufficient to provide independent review, key stakeholder involvement, and to manage risk.

2.9 I note that in the context of water supply, some parties reference the Turitea Reserve (Blaschke, paragraph 3.6), and others reference the water supply catchment (Male, paragraph 14). In terms of water quality risk to the Palmerston North City water supply, it is important to recognise that it is the catchment that is of relevance to any assessment, management and controls, as that is the source of water to the City. The Turitea Reserve, which is the subject of rules in the Water Supply Bylaw 2008, includes land outside the water supply catchment, and in addition there is land that is within the catchment that is not within the Reserve. In particular, it omits much of the rural land in the north west of the catchment that drains directly to the lower reservoir. Therefore, any conditions of consent that address protection of the City water supply must reference the "water supply catchment", not the "Turitea Reserve".

3. USE OF GWRC GUIDELINES

3.1 Dr Blaschke expresses the opinion in paragraph 6.6 of his evidence that the GRWC Guidelines "*are nearing the end of their useful life*". As evidence, he states that additional conditions of consent have been applied in recent hearings, and indentifies three such conditions.

3.2 In my opinion, Dr Blaschke has failed to recognise the purpose of guidelines in the context of a project such as the Turitea Wind Farm. Guidelines such as these are constantly evolving, to keep up with improved knowledge and with available technology. While a review will incorporate recent advances, the principles of erosion and sediment control outlined in the guidelines remain valid, as do most of the suite of devices and methods for which details are provided. They provide a wealth of information to guide the implementation of the project environmental measures, which are equally relevant today as they were when the guidelines were written.

3.3 The additional conditions included in consents do sometimes reflect a ramping up of environmental performance criteria, although more often they relate to site specific requirements (e.g. whether flocculation is needed or appropriate, which I address later in this evidence).

3.4 In my opinion successful erosion and sediment control outcomes are relatively insensitive to the selection of guidelines, with the dominant factor being robustness in the design and more particularly the day-to-day management of the works. My advice to the applicant has been focussed on setting out a robust management approach to the works, with responsibilities clearly identified, and including a high-level Construction Environmental Management Plan (CEMP) which will be reviewed by the consent authority (proposed regional consent condition 7), and site specific SEMPs on which the Council will provide on-site input (proposed condition 9), as described in my evidence in chief. This approach, with appropriate review and approval processes lying with the consent authority, will be most likely to achieve the sediment avoidance outcomes sought by submitters, irrespective of the guidelines selected.

4. QUANTIFICATION OF INCREASED SEDIMENT AND NUTRIENT DISCHARGE

4.1 Mr Taylor expresses concern at increased sediment (paragraph 30) and nutrient (paragraph 32) loads reaching the water supply reservoir, and affecting treatment plant operation. He refers to Mr Male's evidence on this matter in terms of quantification. I will principally respond to Mr Male's quantification of sediment and nutrient loads, while Mr Watson will apply my results in the context of effects on the treatment plant in response to Mr Taylor's evidence.

Sediment

4.2 At paragraph 30, Mr Male estimates that current sediment loads to the reservoir are of the order of 2200t/yr, using a GIS-based calculation tool developed by NIWA. He then (paragraph 47) estimates that sediment loads will increase by 500 to 1500t/yr during construction. I have no dispute with the Mr Male's approach for the existing situation, and consider the figure of 2200t/yr is reasonable. However, he does not describe the method used to derive the construction phase figures (which as far as I am aware cannot be determined using the NIWA tool), and in my opinion those figures are significantly in error. Part of this error may now also be because of the applicant's decision to avoid spoil disposal within the water supply catchment, as I have already mentioned.

4.3 I have carried out my own analysis for the water supply catchment, using the Universal Soil Loss Equation (USLE) method, as this allows consistent comparisons to be made between existing conditions and construction and operation phase activities. By this method, my best estimate of "existing" sediment load to the reservoir is about 1030t/yr (not accounting for the significant effects that may have resulted from the clearing of 70ha of pine trees in the last few years by PNCC). However, taking uncertainties into account, this estimate could be as high as 1700t/yr. In my view, these results are not inconsistent with Mr Male's results for the existing situation, given that the calculation methods are quite different and both have a high level of uncertainty associated with them.

4.4 I have estimated the construction phase load to the water supply catchment, using the same USLE method as for the existing case. I have conservatively assumed that road earthworks would be open for 2 months before pavement aggregates were placed, that platforms would be open for 4 months before surfacing, the Browns Flat substation takes 6 months to construct and surface (after which the drainage would be directed outside the catchment) and that cut and fill batters take 6 months for grass to fully establish. I would expect all these activities would occur much more quickly than assumed in my calculation.

4.5 My calculation is that the sediment load will increase by approximately 25t/yr, or about 2.5%, as a result of the construction activities. While this seems small, and is much lower that Mr Male predicts, there are some clear reasons why this should be the case:

(a) The work area is a very small proportion of the catchment (less than 2%).

(b) The dominant soil through most of the catchment is predominantly silty sandy, with only about 15% in the silt and clay fractions. This means it is less likely to erode, and is easier to settle in sediment control devices than finer soils.

(c) Much of the earthworks material will be broken rock, as the topsoil layer is relatively thin.

(d) The existing roads have no surfacing, and poor stormwater control, while the future roads will have both, plus elimination of the steepest existing grades.

(e) The earthworks platforms for turbines, cranes and the substation will be effectively flat when finished, and even during construction the earthwork areas will be flatter than existing, reducing the risk of sediment mobilisation.

4.6 The above calculations are based on the USLE method, which uses a 2 year average recurrence interval storm as an “index” value to reflect the generalised rainfall characteristics of the area (i.e. the range of storm events that will occur during the construction period), and calculates expected surface erosion rates. I have separately considered what might happen in a major storm event that caused slips to occur, which potentially mobilise larger quantities of sediment over a short period during one storm. This is addressed later in my evidence under the heading of “Consequences of device failure or slip of cut/fill batters”.

4.7 I have also calculated the sediment yield from the operational wind farm. This is predicted to be lower than for the existing situation, principally due to the works resulting in flatter ground and better stormwater management than for the existing, and the roads having a properly constructed gravel surface. However, the difference is small, and it would be more appropriate to conclude that in the long term the sediment loading change will be insignificant.

4.8 I will address the matters of failure of structures or batters later in this evidence.

4.9 I note that Dr Blaschke, at paragraph 4.44 and subsequently, asserts that sediment trapping will be less than 75% even in full-size ponds. Further (paragraph 6.7), he suggests that grit traps have been shown to perform poorly in some situations. I disagree with the basis of his concern, although I do acknowledge that in some situations (i.e. with finer-grained soils and with larger catchments) grit traps have poor performance.

4.10 The “soil” being used for road and platform construction will predominantly be broken rock, and based on particle size analysis in the geotechnical report I have concluded that the topsoil and upper weathered soil layers over most of the site will have a low fines content. Further, the roads and platforms will be surfaced with basecourse after construction, significantly reducing the fines content on the surface material, and also reducing the susceptibility of the surface to erosion.

4.11 I have undertaken analysis as part of studies into sediment device performance (e.g. for preparation of ARC guidelines), and my findings are that sand-sized and larger sediment can be settled out effectively in relatively small devices. It is only where finer slit and clay material is present that ponds of the size recommended in the guidelines are needed. I am therefore confident that for most of the site, sediment removal rates will be at least 75% for most of the time, even with the use of grit traps for road and platform runoff.

4.12 There will be areas where deeper, finer-grained soils are present, particularly along the western side of the project (mostly outside the water supply catchment). For roads and turbine platforms, the extent of open earthworks will still be small at any given time, resulting in a low risk of sediment discharge even with grit traps for sediment control. The low flow rate and distributed discharge from these traps will pass through vegetation which will further reduce sediment loads.

4.13 The one aspect of the works where there is a higher risk of sediment runoff will be for the spoil disposal areas, where full sized ponds will be used. Given that the embankment batters may be steep, a conservative use of “3%” ponds is proposed for these sites.

4.14 Other submitters also address sediment in a more general manner. Dr Flenley (paragraph 3) comments on the steepness of the site, and the risk of landslipping. He then comments that erosion increases by orders of magnitude as land use changes from bush to scrub to pasture to bare earth, and concludes that this means there will be a massive increase of erosion, affecting the reservoir. Dr Palmer (paragraph 21) also comments on the relative increases in erosion as land use changes, and on the expectation of large quantities of sediment being generated due to the steepness of the site (paragraphs 16, 18).

4.15 The generic statements made by Dr Flenley and Dr Palmer are overstated, although there is certainly a significant increase in potential for erosion when comparing bare soil to farmland, and farmland to undisturbed native bush. What they do not account for is that the exposed areas are relatively small, and the nature of the soils over much of the site is such that erosion potential is low. Further, there will be flatter surface gradients on the works than naturally, and significant measures to address sediment runoff. Therefore, the generic statements are not relevant in the context of a development such as this. I have addressed these matters in more detail both in my evidence in chief, and earlier in this rebuttal evidence.

Nutrient

4.16 Mr Male (paragraph 29) calculates that existing nutrient loads to the reservoir are 11,500kg/yr for nitrogen, and 550kg/yr for phosphorus. He estimates (paragraph 46) that nutrient loads will increase by 400kg/yr for total nitrogen, and 35kg/yr for total phosphorus. He does not state the method used to calculate the change in loads.

4.17 I have undertaken analysis of existing loads and expected future nutrient loads as a result of the works. I have based this on data in the *Lake Managers Handbook, Land-Water Interaction*, MfE 2002, which provides generalised loadings for different types of land use.

4.18 Based on that data, I predict that the current total nitrogen loading would be approximately 9,400kg/yr, which (taking into account uncertainty) is in agreement with Mr Male's estimate. I have also calculated existing phosphorus loads at 1,550kg/yr, which is somewhat higher than Mr Male's estimate.

4.19 For the future (operational) situation, I estimate that the loadings will increase by 309kg/yr for nitrogen (4.2%), and 30kg/yr for phosphorus (1.9%). While these changes differ from those of Mr Male (3.5% and 6.4% respectively), they are of the same order.

4.20 During construction, there will be 250t/yr of nitrogen associated with earthworks, and 25kg/yr of phosphorus. In addition, in the event of a slip in the works within the catchment, there could be a further one-off load of the order of 20% to 40% of these amounts. Mr

Watson will address the implications of these numbers for the water supply reservoir and treatment plant.

4.21 Associated with nutrients is the matter of colour, which Mr Taylor raises at paragraph 31. I have assumed that some of the cleared vegetation may be used as mulch on batters. This may lead to a reduction in turbidity (and apparent 'colour') in the water supply reservoir due to reduced sediment load.

4.22 The natural decomposition of biological matter contributes to the organic content and 'true colour'. Dissolved organic acids like tannins and lignins give water a brown/yellowish tea-like color. Therefore, the use of mulch in the catchment may increase the 'true' colour of the water body. However, the quantity of vegetation cleared and retained as mulch relative to the size of the catchment and the current land (forest) would have little effect on the colour of water in the reservoir. Mr Watson will address the implications of this for the water supply reservoir and treatment plant.

5. OTHER WATER QUALITY AND ENVIRONMENTAL RISKS

5.1 Dr Joy, in paragraph 4.1 of his evidence, expresses concern at the downstream effects from discharge of sediment. In paragraphs 4.3 and 6.7(b) he then assumes that flocculants will be used to reduce sediment discharges, potentially resulting in toxic discharges to streams.

5.2 I have addressed the estimates of sediment discharges elsewhere in this evidence. In terms of the need for flocculation, my assessment, based on particular size analysis from samples obtained during geotechnical investigations, and on my own observation of materials on site, is that there is a relatively small silt and clay fraction in most of the soils that will be encountered. Flocculation is most suitable where there are significant proportions of fine-grained soils (e.g. dispersive clays) that are difficult to settle in their natural state. Given the nature of the soils on this site, I do not envisage that flocculation will be needed on this project.

5.3 As an aside I do note that while there are potential risks to receiving environments associated with discharge of some flocculants, flocculation is widely used and advocated by regional councils for earthworks sites in areas where sediment is difficult to settle in ponds.

5.4 Mr Taylor (paragraph 54) systematically addresses a number of water quality matters covered in my evidence in chief. I will respond to most of the matters raised, and Mr Watson will respond on other matters.

5.5 Part (a) relates to hydrocarbons. In (a)(i) Mr Taylor is concerned that locating contamination could be problematic in such a large water body. Contamination is unlikely to be a problem if only minor amounts are present. I have observed floating hydrocarbons on the stilling basin below the upper dam (at the outlet from the existing hydropower plant). This discharges to the lower reservoir, and the contamination does not appear to be a problem for the water supply. Only if there was a large spill would clean-up be necessary, and in that situation it would be relatively easy to locate and address the contamination. Similarly, potential spill sources will be directly related to the works areas, and will be easy to locate.

5.6 In (a)(ii) Mr Taylor states that a refuelling distance of 50m from a waterway may not always be practical. I disagree. Most of the work sites are on the top of ridges, and any permanent watercourses are at some distance. I do not consider this will be difficult to achieve, although it may require that earthworks plant be moved to a suitable location for refuelling. The one location where there is a potential constraint is at the Browns Flat substation, and the drainage will be arranged at that location so that any spill has a significant overland flow path distance before reaching a stream. The Browns Flat drainage will be discharged away from the water supply catchment once built, and during construction the refuelling could be undertaken remote from streams.

5.7 In (a)(iv) Mr Taylor states that my evidence on spill kits is somewhat generic. This may be the case in the evidence, but this matter is addressed in more detail in the draft CEMP. Hydrocarbon spill avoidance and management are matters that are commonly addressed on construction sites, and in my view do not need greater elaboration in evidence. The approach taken will reflect best practice and the risk to the water supply and to streams will be low.

5.8 Part (b) addresses sediment contamination and nutrients. I have already addressed item (i) on nutrient loadings in this rebuttal evidence. Item (ii) questions the level of treatment in the sediment ponds, and I have also addressed this matter in my rebuttal evidence.

5.9 Part (c)(i) notes that septic tanks may be subject to flooding due to surface water, and cause contamination. There are two points to note in this regard. Firstly, septic tanks are commonly used for sewage treatment on remote sites, and (apart from the water supply catchment) there will be many such systems in the catchments to which the two substation sites discharge. Secondly, the discharge will not be to the water supply catchment. Proper design will mean that the potential adverse effects are less than minor.

5.10 Part (e)(i) addresses detergents from equipment washing. I concur with Mr Taylor's conclusion that the effects will be less than minor.

5.11 In part (e)(iii) Mr Taylor refers to Mr Male's evidence (at paragraph 21), where he disputes my statement that there are "*generally long flow paths*". I suggest my comments have been taken out of context. Mr Male comments that some water supply catchment flow paths are quite short (as little as 15 minutes), and I agree with him in the context of the water supply catchment, although there are also some longer flow paths. However, my comment on long flow paths was explicitly in the context of equipment washing, which will be undertaken at a limited number of selected sites. I remain of the opinion that these can be located and managed such that there is a very low risk of detergents from washing reaching watercourses, which is the point I was making in my evidence in chief.

5.12 At (f)(i) Mr Taylor states that Mr Male will address potential nutrients arising from debris and rubbish. I did not find any such explicit reference in Mr Male's evidence, but the matter of nutrients was raised, and I have responded in this rebuttal evidence.

6. CONSEQUENCES OF DEVICE FAILURE OR SLIP OF CUT/FILL BATTERS

6.1 Mr Male (paragraph 75(b)) recommends raising standards where the consequence of failure is high. This is, in principle, a sound approach, although Mr Male is not specific about what the trigger level might be, or what standards he considers should be adopted. He also states that the likelihood and consequences of a sediment device failure should be considered (paragraphs 34(b), 37) and the potential for a wave downstream, affecting the integrity of the reservoir (paragraphs 41, 42). He even makes an assessment of the consequences if all the spoil disposal volume reached the reservoir (paragraph 43). Clearly this could not occur, since even in the application most of the spoil disposal was to be outside the water supply catchment, and now the applicant has agreed to not place any spoil disposal areas within the water supply catchment.

6.2 In response to Mr Male's evidence, I have sought to assess consequences, and have considered the potential failure modes and quantities, in discussion with Mr Alexander, and then assessed the fate of the sediment that would be released.

6.3 The applicant already proposes that the works be designed to a high standard. Mr Alexander addresses the geotechnical risk and design standards in his rebuttal evidence.

6.4 Fill for platforms and roads will be engineered structures built of appropriate material properly compacted in accordance with a geotechnical design. The risk of these failing is very low. The suggestion of Dr Blaschke, at paragraph 4.47, that fill batters might "blow out" is not realistic, although the possibility he raises of collapse of a road cutting in heavy rain is a possibility that is addressed later in this rebuttal evidence.

6.5 The most likely source of slips will be localised slips in cut batters and these are most likely to occur during and soon after construction, while the sediment control works are still in place. Apart from generally shallow topsoil layers, the slips will largely comprise broken weathered rock.

6.6 The principal deposition area will be on the roads or turbine platforms, from where it can be removed to a spoil disposal area. Slips are more likely to occur during rainfall events, and therefore some sediment will be carried to the stormwater system and treatment devices, with a small proportion being discharged to the receiving environment, in the same way as sediment from surface runoff. The quantity reaching the reservoir from such a site in the main (upper) reservoir catchment would be minor.

6.7 Spoil disposal areas will only be placed outside the water supply catchment. As for fills, these will be fully engineered as retaining structures, and the placement of spoil will be strictly controlled to avoid instability. Therefore the likelihood of failure is very low.

6.8 Sediment ponds associated with the spoil disposal areas will be water retaining structures, again with proper engineering design. The GWRC guidelines require pond spillways to be able to pass the 1% AEP[1] event without eroding. This is the same standard as is commonly adopted for flood risk management in urban areas, and is more than adequate to manage the risk associated with these structures, which will not contain large volumes of water.

[1] AEP – Annual Exceedance Probability – the probability that an event of a given size will be equalled or exceeded in any year.

6.9 It should be noted at this point, in response to a number of submitters who suggest that rainfall in this area is particularly intense, that as for any engineering project, the works will be designed taking into account the rainfall characteristics of the area in which they are to be built.

6.10 In the event that there was a slip failure at some point within the water supply catchment, the dilution in the upper reservoir would be significant and the concentrations reaching the water treatment plant would be low, as I will outline below.

6.11 A "worst case" scenario would be a slip occurring within the Waters property – the farmland at the north-western corner of the proposed wind farm that discharges directly to the lower reservoir. This would only occur after an extended period of severe weather, worse that a 2 year ARI storm, and with a lower probability of occurrence since it would not occur in every such storm. In the event that such a slip occurred away from the road or a turbine platform, it would release about 130t (tonnes) of sediment. Taking a very conservative view of particle size distribution, based on test pits on the Love property, there could be a content of up to 40% clay and 20% silt. It is important to recognise that this is not representative of most of the water supply catchment, but may apply in some western areas. Through most of the proposed wind farm area the silt and clay fraction combined will be less than 15%.

6.12 Of the above slip, about 76t would be in the clay and silt fraction, and of this about 47t would reach the reservoir within the storm period. Most of the remaining silt would settle out in the reservoir, but much of the finer clay would remain in suspension for an extended period of time. I estimate that this could result, for the lower reservoir and assuming full mixing, in concentrations in the order of $160g/m^3$ persisting for some days, and gradually reducing to background concentrations over about two weeks. Mr Watson will address the implications of this for the water treatment plant operation.

6.13 A more realistic scenario would be a smaller slip, with a much lower clay content and a lower proportion reaching the reservoir. This would lead to a peak sediment concentration of less than $80g/m^3$ in the lower reservoir, and considerably lower than this in the upper reservoir.

6.14 In terms of risk of sedimentation of the lower reservoir, it should be noted that a $100m^3$ slip, fully depositing in the lower reservoir, would reduce the reservoir depth on average by less than 5mm, and less than 0.05% of its storage capacity. In the upper reservoir a slip would have much less effect. In both cases the risk to reservoir capacity would be less than minor.

6.15 I have not been able to identify any source of sediment or water associated with the proposed works that is large enough or located in such a position that a failure could result in a wave that in any way threatened the integrity of the water supply dam, or resulted in sufficient deposition that it would compromise the integrity of the reservoir storage.

6.16 In summary, I consider that the design standards that will be adopted will mean that risk of a major earthworks structure failure will be very low. The consequences of a slip in the water supply catchment are also low. I therefore conclude that Mr Male's suggestion that standards be raised in particular circumstances where consequences are high is not applicable to the proposed works.

7. HYDROLOGICAL AND EROSION EFFECTS ON STREAM HEADWATERS

7.1 Mr Male states (paragraph 39) that stormwater should be released in a hydrologically neutral manner. He also identifies a potential risk of erosion to streams due to increased runoff in the headwaters (paragraph 40).

7.2 While I agree with Mr Male that hydrological neutrality is an ideal to strive for in terms of project environmental effects, from my experience it is not achievable in reality. Any development project will alter hydrological regimes in some way. Therefore the objective should be to minimise the change in hydrological regime, such that potential adverse effects can be managed.

7.3 The current water catchment access roads have nearly impervious surfaces, and from my observation discharge to the adjacent land without causing any adverse effect. It is proposed that a similar approach be adopted for the road upgrades, with discharge distributed to small, frequent outlets (no more than 50m apart), as outlined in my evidence in chief at paragraph 77. The flow will then be attenuated as it passes through the undergrowth, before reaching the streams.

7.4 As outlined in paragraph 79 of my evidence in chief, where it has been necessary to concentrate flows, these must be conveyed to a stream channel capable of conveying the flow without erosion. In many of these locations along ridgelines, there would be greater risk of adverse effects from constructing a flow attenuation pond on a steep hillside than would result from a discharge such as I have outlined.

7.5 While these points are outlined in my evidence in chief under the heading of erosion and sediment control, the nature of the project will be that for the roads the drainage works from the construction phase will remain in place as the permanent stormwater works.

7.6 The same comments will apply to the turbine platforms.

7.7 Because the impervious areas are small, and are distributed throughout the upper catchment areas, the effects on any one headwater stream will be minor.

8. LACK OF TECHNICAL DETAIL, UNCERTAINTY OF OUTCOMES

8.1 Mr Male states (paragraphs 52, 53) that there is not enough detail on the locations and methods for sediment management. Dr Blaschke also raises this matter at 6.1 and 6.4 of his evidence. Dr Palmer (paragraphs 19, 20) comments that there is uncertainty of outcome, and far less detail than he has seen in "*recent building consents for house alterations*".

8.2 Mr Male also comments that there is some vagueness in the use of terms such as "*if practical*", and that the approach is "*largely applicant and contractor driven*" (paragraph 38).

8.3 I disagree with these statements in regard to the appropriateness of the detail provided. The level of detail needs to be considered in the context of the overall approach, and in doing so it is clear that the approach is robust.

8.4 At this stage, micro-siting of wind turbines has not occurred, as that will be determined by the selection of the type of machine to be installed. The detailed design of the platforms will follow the micro-siting of the turbines. The sediment control design is dependent on the design of the platforms, and therefore cannot be undertaken until the platforms are designed. Some management and programming aspects cannot be finalised until the earthworks contractor has been engaged, and has determined how the works will be programmed.

8.5 Given the above realities, it is not practical to expect to provide detailed drawings of the sediment control works at this consenting stage of the process. Rather, it is essential that there be a robust process to manage the environmental decisions and outcomes through the project, with flexibility to adapt to situations as they evolve. This is addressed in the following hierarchy for Turitea Wind Farm:

(a) The application identifies appropriate erosion and sediment control guidelines to be used (GWRC), and identifies which type of device or method will be used for each part of the works. Typical details of proposed devices are set out in the guidelines.

(b) Draft conditions of consent define appropriate processes and environmental outcomes. These have provisions for review of key management documents.

(c) A project-wide CEMP identifies project policies, practices and responsibilities. The final CEMP is to be submitted to the consent authority so that it can be reviewed for compliance with the conditions of consent.

(d) The Contractor will be required to develop their own Environmental Management Plan: Delivery (EMP:D) which will reflect their approach to environmental management under the umbrella of the CEMP.

(e) Subsidiary Site Environmental Management Plans (SEMPs) are to be prepared, specific to each site and reflecting detailed design. The consent authority is to be involved in the site inspections, at which construction-related environmental issues are identified and resolved. The final SEMP is to be submitted to the consent authority.

(f) Specific Erosion and Sediment Control Plans (ESCPs) are to be prepared for the earthworks by the contractor, approved by the consent holder, and incorporated into the SEMP (and hence also submitted to the consent authority).

(g) There will be a rigorous programme of inspection and audit, set out in the CEMP, to avoid the risk of device failures and monitor and remedy any non-compliances.

8.6 In accordance with 8.5(c) above, a draft CEMP is attached to this rebuttal evidence. The technical details of this draft have been prepared under my supervision, the document then adapted by MRP to reflect their environmental management procedures, and authorised by the applicant (as acknowledged by Mr Williamson). The following points should be noted:

(a) It is supplied to the Board as a draft for information, to provide an indication of the CEMP form and general content as envisaged by the applicant;

(b) There are some elements that are incomplete, and are awaiting specialist input and the outcomes of the Board of Inquiry;

(c) The draft will only be completed once the consents are granted and the consent holder has approved the project to proceed and under what contractual form;

(d) The final CEMP, and any subsequent revisions, will be subject to review by the consent authority.

8.7 With the process outlined above, I conclude in response to Mr Male's evidence, that:

(a) The level of detail is appropriate to the stage of the project, and the process outlined above allows sufficient flexibility to adapt to final design, while also providing assurance of appropriate environmental outcomes;

(b) The flexibility implied with use of the term "if practical" is appropriate, in the context of the procedures outlined above;

(c) The process must inevitably be applicant and contractor driven as they have the responsibility to deliver the environmental outcomes, but there is provision in the process for appropriate levels of involvement from the consent authority; and

(d) In response to his suggestion that spoil disposal areas be removed from the water supply catchment, this has been done.

9. MONITORING PLAN

9.1 There are a number of submitter comments on the proposed monitoring, including on the applicant's Water Quality Monitoring Plan (WQMP). Mr Male (paragraph 66, 71) suggests a need for 5 years of baseline monitoring. However, I note that the *Turitea Water Quality Impact Assessment* prepared by GHD for PNCC (and reviewed by Mr Male), which is attached to the evidence of Mr Taylor as Appendix 2, contains what appears to be a recommended baseline monitoring plan (Appendix C). This states that monitoring should commence "*at least 6 months prior to construction but include sampling during summer months*". In my opinion, an extended period of baseline monitoring (e.g. 5 years) is not essential but I consider 6 months pre construction is too short, as it does not cover a full range of seasons. I remain of the opinion that 1 full year of baseline monitoring will be adequate, and that any suggestion that there should be 5 years is excessive in this context. I further note that PNCC already has more than 5 years of data on its raw water intake, which is the key point where water quality is critical, and which should provide an adequate baseline of quantitative data.

9.2 Mr Taylor (paragraph 62(a)) states that monitoring should continue for 3 years after completion of construction. In my opinion this is a reasonable approach, but this matter is already addressed by the WQMP. Most risk associated with the project construction (especially sediment) will have occurred during the construction phase. The project construction will last for approximately 3 years, but most components of the earthworks will have been completed in the earlier part of that programme, so any continuing effects should have largely disappeared. The WQMP already recommends operational phase monitoring that includes continuing the construction phase monitoring, but progressively reducing the frequency in response to observations from the monitoring that there are no ongoing effects. I consider this is the appropriate approach, rather than an arbitrary 3 year continuation of the full programme.

9.3 Mr Male states (paragraph 57) that visual inspections have some potential downfalls, on the grounds that erosion may take place at locations other than the reference points (paragraph 58), and that identifying the significance of a plume can be very subjective (paragraph 58). He proposes an approach that includes quantification of risks to the water supply, and data to provide an understanding of reservoir dynamics (paragraph 75(d)). More specifically (paragraph 60), he proposes flow monitoring, nutrient and organics sampling, sampling in streams as well as reservoirs, and sampling at different levels within the reservoirs.

9.4 I note, in regard to his concerns at the potential downfalls of visual monitoring, that quantitative monitoring is equally susceptible to the same downfalls. Since sediment discharges are episodic, scheduled quantitative sampling of water quality is equally likely to miss the times when there are elevated discharges, and therefore will give a misleading result.

9.5 Much of the monitoring that Mr Male suggests has potential to assist in understanding the behaviour of the reservoirs, which will assist PNCC in managing them. However, in my opinion, given the relatively minor effects of the Turitea Wind Farm in terms of contaminant discharges, Mr Male's proposed scope is excessive as a means of identifying project effects. I therefore remain of the opinion that the applicant's WQMP provides a robust basis for effects monitoring.

9.6 Mr Taylor (paragraph 56) recognises that "*the Applicant's WQMP and estimation of effects is prudent however not substantiated on a scientific basis in terms of baseline water quality*". I have, in this evidence, provided further detail on our assessment of likely contaminant discharges, which are expected to be minor. Therefore, I am of the opinion that the monitoring needs to be simple and practical, and provide a basis for quick identification of effects and causes so that remedial and avoidance work can be undertaken.

9.7 The WQMP was not intended as a rigorous quantitative analysis of the characteristics of the reservoir, such as might be needed for operation of the treatment plant. It assumes that the treatment plant already monitors those contaminants that are important to its operation, and therefore has a good baseline set of quantitative data and an ongoing monitoring programme for these parameters.

9.8 Dr Joy recommends continuous monitoring of suspended sediment (paragraph 4.4(1)) and of sediment accumulation (paragraph 4.4(2)). He is correct that the only reliable means of accurately quantifying sediment discharge is through continuous monitoring of both concentration (usually through measuring turbidity and correlating this with sediment concentration) and flow rate. In my experience this is an expensive and labour intensive process in the context of a field site, and even then it is difficult to obtain reliable results over an extended period of time. This approach would only be warranted if there was a high risk associated with the activity.

9.9 Adopting a risk-based approach, my assessment is that the likelihood of a significant sediment event in the upper reservoir is very low, and the consequences are also low in terms of effects on the water treatment plant because the reservoir size will settle out most of the sediment. I address this matter in more detail under the "failures" heading of my evidence. In most areas the risk is so low as to not warrant more than the visual monitoring proposed.

9.10 The only site where more comprehensive monitoring might possibly be warranted is on the tributary at the north west corner of the site, draining the Waters' farm land, and discharging directly to the lower reservoir. At this site, the likelihood of a sediment discharge event is low and is similar to other parts of the water supply catchment (noting that there will be no spoil disposal areas), but the consequences are potentially higher because the lower reservoir is relatively small and it feeds directly to the raw water intake.

9.11 Despite this, my assessment is that even on this site, continuous monitoring would not assist in managing or avoiding effects. Mr Watson provides comment on the extent to which it could provide an early warning to the operation of the Turitea water treatment plant.

9.12 Dr Joy also recommends sediment deposition monitoring (paragraph 4.4(2)). The method he suggests is a suitable approach to sediment accumulation monitoring. However, this approach faces the same potential downfalls that Mr Male has pointed out. There are a large number of streams feeding to the reservoir, and a sediment event could potentially occur in any one of them. Further, the larger ones have variable morphology – pools, riffles, and naturally changing bed form with time. Intensive monitoring of all streams at a number of representative locations in each would be needed to be sure of capturing the relevant event, and there would still be a problem separating out what was natural sediment accumulation from what was project generated. In my view this approach would not provide any more robust monitoring, in terms of identifying and responding to events, than would visual monitoring.

9.13 Therefore I conclude that, while there are more robust quantitative means of measuring effects, the risk assisted with the Turitea Wind farm construction and operation does not justify adopting them.

10. CONCLUSIONS

10.1 I have considered the evidence presented by submitters where it relates to my work on sediment management and water quality. While some important matters have been raised, I note there are also suggestions that fail to recognise the realities of implementing a project of these type, and which seek safeguards or monitoring that are not justified by the level of risk the project poses.

10.2 I have attempted to clarify and expand on the project detail and effects assessment where that assists in addressing the matters raised by the submitters.

10.3 The applicant has identified one matter of particular concern, and as additional risk mitigation has opted to not place any spoil disposal areas within the water supply catchment.

10.4 With that provision in place, I conclude that the measures proposed for management of sediment and water quality, as set out the application and in my evidence in chief, remain appropriate to the project and to the receiving environment.

Graham John Levy

5 June 2009