



Ministry for the Environment

Proposed Turitea Windfarm Review of construction and decommissioning effects

25 June 2009

Project 7482.1

Environmental Context Ltd
A member of the Environment and Business Group



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List of abbreviations

ARC	Auckland Regional Council
CEMP	Construction and Environmental Management Plan
ESCP	Erosion and sediment control plan
Horizons	Manawatu-Wanganui Regional Council (Horizons Regional Council)
PNCC	Palmerston North City Council
SEMP	Site environmental management plan
WQMP	Water quality monitoring plan

1 Introduction

This report has been prepared in accordance with the agreement for sub-consultant engagement between MWH New Zealand Ltd (MWH) and Environmental Context Ltd dated 12 June 2009 to support resource consent applications for a wind farm at Turitea by Mighty River Power (the applicant).

The scope and nature of the services are set out in paragraphs 1-3 below.

1. Review and assess the following information:
 - information in the resource consent application by Mighty River Power that is applicable to construction effects
 - expert witness evidence (including rebuttal evidence) by Mighty River Power that concerns construction effects
 - evidence from submitters that concerns construction effects
 - if available, any relevant reports arising from expert caucusing (due 19th June)
 - carry out field work if necessary and time permitting.
2. Prepare a report discussing the validity of this information concerning construction effects, and form opinions based on experience, expertise, and field work (if necessary and time permitting), on the conclusions drawn, and any short comings or gaps. Also, provide opinion on likely decommissioning effects, which is an area not covered in the application.
3. Support opinions with findings from any field work and incorporate this information into an independent opinion on the construction and decommissioning effects, with detailed reasons for this opinion. Liaise as required with other independent experts, including with the visual and landscape effects expert, on the vegetative restoration of the large areas of disturbed land and associated issues relating to erosion and sediment control.

2 Report author

This report has been prepared by Nigel Mark-Brown of Environmental Context Ltd. The assessments and opinions in this report are those of the author. This report is written in the first person, where “I” refers to Nigel Mark-Brown.

3 Author experience

I have 34 years experience in a broad range of environmental and civil engineering projects. My qualifications are BE (Civil), MIPENZ and Chartered Professional Engineer (environmental, civil).

My experience includes in-depth expertise in environmental engineering and management, including stormwater flow and quality management, the discharge of

contaminants to soil and water, flood management, erosion and sediment control, contaminated site remediation, wastewater treatment and disposal, water resources and supply, design and construction of earth fill dams, geotechnical investigation and reporting for building development, assessment of environmental effects for new projects or existing situations involving potential or actual adverse effects on the environment.

I have managed and participated in numerous multidisciplinary environmental projects in New Zealand, Australia, Europe and the Pacific.

I have carried out assessments of effects, preparation of erosion and sediment control plans, consent applications and presentation of evidence at resource consent hearings for a number of earthworks operations in the Auckland area, including a sand mine, disposal of sediment removed from a pond in public open space and for earthworks related to large civil works. I stay abreast of latest developments in erosion and sediment control practice including attending Auckland Regional Council seminars, workshops and field days. I have completed a chemical treatment workshop for flocculation of sediment ponds and have also recently carried out bench tests and prepared a flocculation management plan for an earthworks site in the Auckland area.

My civil engineering experience includes site investigation, hydrologic, geotechnical and civil design, contract administration and construction supervision for a number of earth fill detention dams in the Rangitikei area and irrigation water supply dams in the Auckland area. I have also carried out design, contract administration and site observation for roading, wastewater sewer, water and stormwater services for residential and industrial subdivisions.

4 Conflict of interest

I have not previously carried out and am not currently carrying out any work for the applicant (Mighty River Power), Palmerston North City Council (PNCC) or the Manawatu-Wanganui Regional Council (Horizons Regional Council, or Horizons).

I have worked some years ago with Mr Levy and Mr Male to a limited extent on other projects un-related to this one. I do not have any past or current personal or business relationship with any of the other submitters or expert witnesses.

5 Aspects of the project considered within this report

The Turitea wind farm is proposed to be established along a 14 kilometre stretch of the northern Tararua Ranges, approximately 10 km East of the city of Palmerston North.

This report addresses the surface water-related effects of construction and possible future decommissioning of the proposed wind farm. The components of the wind farm for which construction aspects have been addressed in this report are those presented by Mighty River Power to support various resource consent applications to PNCC and

Horizons, including revisions to the layout in January 2009. The revisions comprised removal of nine turbines and related roading and spoil disposal and removal of one proposed stream crossing from the originally proposed wind farm layout:

The components of the wind farm for which there may be surface water-related effects from earthworks and related disturbance:

- platforms for crane set up and for foundations of turbine installations, with a maximum number of 122 turbines
- platforms for crane set up and for foundations of three wind monitoring masts
- new roads of a total length of 33 km
- upgrading 24 km of existing roads
- underground power reticulation
- road culverts at several locations
- Browns Flat and Pine Plantation substations
- concrete batching plants
- foundations of internal transmission lines, up to 20 lattice towers and poles for external transmission lines
- total earthworks volumes (from information dated 23/6/09 provided by the applicant:
 - roads and turbine pads etc.:
 - cut: 1,437,940 m³
 - fill: 485,730 m³
 - topsoil: 236,880 m³
 - for spoil disposal
 - area: 39.5 ha
 - fill: 1,442,800 m³
- sewage generated by the workforce
- use of hazardous substances during construction.

6 Information and evidence reviewed

A summary of the information and evidence reviewed for this report is set out below under the following headings:

- consent application and additional information
- expert and rebuttal evidence
- expert evidence from submitters
- other submission
- caucusing.

6.1 Consent application and additional information

Information in the resource consent application and additional information supplied by the applicant and its consultants that is applicable to construction effects and which I have reviewed comprises:

1. Resource Consent Applications and Assessment of Environmental Effects, August 2008; main report together with the following appendices:
 - Appendix D: Ecology
 - Appendix E: Construction Effects Report July 2008 including example Erosion and Sediment Control plans
 - Appendix F: Water Quality Plan August 2008
 - Appendix J: Water Ecology – Assessment of In-Stream Ecological Effects August 2008
 - Appendix L: Traffic – Transportation Assessment, August 2008.
2. Turitea Wind Farm Preliminary Geotechnical Report, Revision B, July 2006.
3. Section 92 Requests for Further Information – Consolidated Responses January 2009; main report and the following attachments:
 - Attachment 3 Vegetation and Land disturbance within 10 m of a water body – dwg 0848 RK 223 23/9/08
 - Attachment 4 Figure 4b (Wildlands) detailed vegetation map
 - Attachment 5 Soil disposal sites – 4 x drawings Site Layout sheets 1 to 4, drawing 0848 RK 202 to 205 Rev E 4/7/08
 - Attachment 6: Cleanfill sites areas and volumes
 - Attachment 7 Substation Drainage Plans- Browns Flat and Pine Plantation Revision A
 - Attachment 8, which appears to be the same as Attachment 3 above.
4. Revised layout and associated information:
 - Ecology (Wildlands) comment – letter from Wildlands dated 16 January 2009
 - Explanation of modifications to Turitea Project subsequent to lodgment of resource consent application in 2008
 - Revised layout- drawing 0848- RK 200 Rev F 6/1/09
 - Updated figure 4.1 – Summary of the key components of the Turitea Wind Farm.
5. Construction and Environmental Management Plan, draft June 2009.
6. Memorandum from Chris James to P. Laurenson dated 22 June 2009, providing responses to various information requests by MWH on my behalf. Attachments to the memorandum include:
 - Layout plans: 1: 2000 drawings showing road layout and spoil sites
 - Tables of preliminary earthworks volumes

- Long sections of all named roads (42 long section drawings)
- Typical cross sections through cut and fills for each named road (6 drawings).

6.2 Expert and rebuttal evidence

Expert witness evidence on behalf of the applicant that concerns construction effects was presented by:

- C. James
- G. Levy
- B. Coffey
- G. Williamson
- R. Galloway
- W. Shaw.

Expert witness rebuttal evidence on behalf of the applicant was presented by:

- A. Parsons
- C. Shaw
- G. Alexander
- W. Shaw
- A. Watson
- B. Coffey
- D. Black
- G. Levy
- S. Vaughan.

6.3 Expert evidence from submitters

Expert evidence from submitters that concerns construction effects was presented by the following parties:

For Palmerston North City Council (PNCC):

- P. Blaschke
- C. Taylor
- J. Male
- J. Baker.

For Horizons Regional Council (Horizons):

- P. Hindrup.

For Tanenuiarangi Manawatu Inc:

- Paul Horton.

For Tararua Aokautere Guardians (Inc.) and Friends of Turitea Reserve (Inc.) (joint presentation):

- Statement of evidence from A. Cookson, L. Tremaine
- Section E: Ecological Impacts
- Expert evidence of
 - D. Lucas
 - I. Gabites
 - M. Joy
 - A. Palmer.

6.4 Other submissions

The following members of the public also made submissions:

- J. Flenley
- G. Rapson
- Barbara Jackson.

6.5 Caucusing

Report of caucusing between John Male, Chris Taylor (GHD for PNCC) and Andrew Watson and Graham Levy (Beca for Mighty River Power) on 12 June 2009.

7 Site visit

I carried out a site visit on 12 June 2009 with Mike Omer of Mighty River Power, Julie Meade Rose of Social Environmental Ltd, Jeremy Trevathan of Acoustic Engineering Services Ltd and Julia Williams of Drakeford Williams.

The route of the visit within the wind farm included entering from the Pahiatua-Aokautere Road and traversing the eastern and southern extent of the proposed wind farm along the water catchment road to Browns Flat, stopping at a number of locations along the road to look at the surrounding land, inspect exposed road cuttings and take photographs.

We then went down the existing farm track further south to proposed turbine No. 0115 and looked at the location of proposed culvert crossing C4-C. We then looked at the site of the proposed Browns Flat substation and then exited the site via Greens Road. Mike Omer and I then went up Turitea Road and inspected the Turitea Stream, the upper and lower Turitea water supply reservoirs and the locations of proposed culvert crossings C2-A and C9-A with the land owner.

8 Review and evaluation of information on the nature of surficial soils

As erosion of earthworks is an important aspect of this review, a review of information provided by the applicant on the nature of surficial soils at the site of the proposed earthworks has been carried out. This is summarised below.

The Turitea Wind Farm Preliminary Geotechnical Report, Revision B, July 2006 describes the two main geological units shown on published geological maps of the proposed wind farm site. These are:

- **Esk Head Belt**, which forms the basement rock type of the site, which comprises predominantly sandstone and siltstone sequences within a sheared argillite matrix
- **Quaternary (Alluvial) deposits**. These occur within the Browns Flat area and include alluvial gravels, pumiceous silts and clayey silts with sparse tephra and organic layers. Quaternary deposits also cap hills elsewhere across the site and have been noted as up to 2.5m thick. These sediments include pockets of loess, homogeneous silt and alluvial deposits such as gravels, sandy silt and clayey silt deposits.

The information presented in the Geotechnical Report with respect to the logging and particle size investigations of the upper soils (that is, to depths of approximately 1 metre) is summarised as follows:

Topsoil, comprising silt, thickness varied, being nil at TP6, TP7 and BH, being typically 0.15m thick and maximum of 0.5m BH1.

Subsoils comprising significant proportions of **gravel, sand or rock** were encountered as follows:

- TP2, TP3, TP11: **GRAVELLY SILT**, BH5: **GREYWACKE**
- TP8: **SANDY GRAVEL**; for a sample at a depth 0.4m, particle size distribution results: silt approximately 10%, balance sand and gravel clay

SILT, with minor fractions of clay, sand and gravel, were encountered at the following locations:

- TP1, TP4, TP7, TP9, TP4, TP 10 (silt 0.2 to 0.8m), BH2, BH 3, BH6

I note that for TP7 the particle size distribution results were:

- for a sample from depth: 0-0.3m: clay 39%, silt 37%, sand 17%, gravel 7 %
- for a sample from depth: 0.8m: clay 10%, silt 40%, sand 33%, gravel 17%.

There is an apparent discrepancy between the test pit log description for depth 0-0.3m of “SILT, trace clay...” and the particle size distribution with respect to clay content: – 39% clay. In my opinion, this is a significant proportion, not a “trace” as recorded in the test pit log.

I also note that for TP9 for depth 0.15 to 0.6m, particle size distribution results were: clay 25%, silt 40%, sand 28%, gravel 7%, whereas the test pit log description is “SILT, minor clay, minor gravel, trace fine sand...”. I consider that a clay content of 25% is more than minor.

SILTY CLAY was encountered at the following locations, at the depths noted:

- TP5: depth 0.3 to 0.9m and 1.1 to 2.4m
- TP6: depth 0.1 to 1.3m, 1.8 to 2.4m
- TP10: depth 0.8 to 2.6m.

CLAYEY SILT was encountered at the following locations, at the depths noted:

- BH1: depth 0.25 to 0.5m, 1 to 1.3m.

The above summary of the available geotechnical information shows that significant proportions of subsoils up to 1 metre deep at most of the soil investigation locations over the extent of the proposed construction works have significant clay content. Also of note is that the field log descriptions of clay content at two locations appear to underestimate the actual clay content which was later determined by sieve analysis. This is substantiated by my limited site investigations, which included scraping a sample of shallow subsoil, typically 0.3 m depth below adjacent undisturbed ground level, at a number of locations on the existing water catchment access road between proposed turbines Nos 0001 and 0046. Visual and tactile inspection of these scrapings indicated clayey silt or silty clay material.

9 Summary of potential surface water-related construction effects

From review of the previously listed resource consent information and evidence, submissions, my site visit and experience with other projects, the *potential* effects from proposed construction activities associated with the wind farm are, in summary:

- increase in stormwater runoff flow rates and volumes from roads and platforms with resulting adverse effects on watercourses and streams by erosion and/or deposition
- erosion of road, platform, spoil dumps, other earthworks and exposed surface soils adjacent to earthworks resulting in sediment discharges which may:
 - cause adverse effects on water quality in water courses and streams and sediment deposition which can adversely affect biota in a number of ways
 - adversely affect the Turitea water supply reservoir and/or the treatment plant operation and/or quality of water supplied to Palmerston North
 - adversely affect the mauri of the streams
- slope instability caused or triggered by the proposed construction works which would have an adverse effect on water quality in water courses, streams or the water supply reservoir
- damage to watercourses or streams from installation of culvert crossings, including from associated sediment discharges
- interruption of fish passage in streams from installation of culvert crossings

- the following discharges, which may have adverse effects on water courses, streams and/or the Turitea water supply
 - wastewater, process and wash water and stormwater from two concrete batching plants
 - sewage generated during construction at various locations on the site
 - nutrients from stockpiled vegetation or from bunds comprising significant proportion of vegetation
 - cement or cement washings during concrete works such as turbine foundations, installation of culverts
 - hydrocarbon contamination of soil or surface water from:
 - lubricant leakage from construction vehicles
 - spillage of fuel during refuelling on site
 - plant and equipment failure
 - oil leak from a transformer at the substations
- leakage or spillage of hazardous materials such as paint, bitumen based products, concrete admixtures
- dust from construction operations.

10 Avoidance, remedy or mitigation of potential adverse effects

In this section of the report the assessed likelihood and significance of each potential effect is discussed, based on the evidence presented and my assessment. The appropriateness of the applicant's proposed environmental management including mitigation measures is then discussed based on my assessment. This discussion includes assessment of whether adverse effects can be avoided, remedied or mitigated and commentary on the adequacy of the mitigation measures proposed by the applicant.

10.1 Increase in stormwater runoff flow rates and volumes

The increase in stormwater runoff flow rates and volumes from roads and platforms with resulting adverse effects on watercourses and streams by erosion and/or deposition is discussed below.

These potential effects are dependant primarily on the proportion of impervious area to total contributing catchment area at any location. Given that the proposed impervious areas which are associated with proposed roading and substations are of limited size I consider that such effects can be adequately avoided or mitigated by ensuring stormwater runoff from earthworked areas is controlled in a manner such that all discharges are:

- attenuated through sediment ponds, or
- physically spread out over a sufficient area by the use of multiple separate discharges or by flow spreaders.

I consider that specific criteria for engineering design of stormwater discharges to ensure they are either attenuated or spread out to avoid adverse effects needs to be developed as part of the construction management plan.

10.2 Sediment discharges

Sediment discharges caused by erosion of roads, platforms, spoil dumps, other earthworks and exposed surface soils adjacent to earthworks resulting in adverse effects on streams and the water supply reservoir are discussed below.

10.2.1 General comments

I note that all spoil dump sites are now proposed to be located outside the Turitea water supply catchment. This is considered good practice to minimise potential effects of sediment and nutrient discharges on the streams within the Turitea Reserve and the water supply.

I consider that successful revegetation of earthworked areas can be achieved, based on the primary and rebuttal evidence of W. Shaw, the evidence of existing vegetation apparent during the site visit and the revegetation proposal within the draft Construction and Environmental Management Plan (CEMP), June 2009. This will be dependant on appropriate revegetation details being prepared by suitably qualified persons as part of detailed SEMP (site environmental management plans).

I note the statement that “weather permitting, works will continue through the winter period” (Section 14.3 (h) of the draft CEMP June 2009). I am not aware of any other discussion in the applicant’s evidence on erosion and sediment control that specifically discusses the requirement for winter works. This is a significant issue with respect to designing appropriate erosion and sediment controls.

There are seasonal controls on earthworks in several places around New Zealand. Controls may be applied in winter for sediment-related water quality reasons; or in summer, such as for dust control. In the Auckland Region the ARC defines the earthworks season as being from 1 October until 30 April, and applicants need specific approval by way of resource consent condition for winter works. This is based on considerations relating to low winter soil temperatures that inhibit vegetative establishment and surface stabilization and the combination of high winter rainfalls on clay soils that are difficult to work in wet weather. In recent years, a wide range of alternative site stabilization methods have become available and flocculation has become more widely accepted as trials indicate its effectiveness at removing fine textured sediments such as clay. The Auckland Regional Council does grant approvals for winter works in appropriate circumstances and chemical treatment can help address the potential environmental effects in such situations.

The applicant proposes to use the Greater Wellington Regional Council Erosion and Sediment Control Guidelines for the Wellington Region, an area that does not regulate earthworks over winter. There are physical limitations to earthmoving over the winter period with more rainfall, and more sediment can be mobilised and discharged from measures that can never be completely efficient. The ecological values of the receiving environments become an important consideration in this regard as well. When considering whether to approve winter works (and if so when setting consent conditions), consideration needs to be given to (among other things) the areas to be

exposed, the nature of the soils and subsoils to be worked, level of risk of erosion, the values of the receiving environments, detailed erosion and sediment controls with consideration of the need for chemical treatment to remove clays from discharges and the proposed methods of site stabilization.

After consideration of the potential area that could be exposed (approximately 150 hectares), the erodible soil types of the site, its elevated nature and resultant winter conditions, the values of the receiving environments, and the fact that control measures are never completely efficient, my opinion is that consideration should be given to the imposition of control of land disturbing activities over the winter period subject to an appropriate approval process for particular activities. This would effectively result in the controlled staging of works on this large project through the vulnerable winter season with an aim of achieving better environmental outcomes.

In my opinion there are a number of other deficiencies in the currently proposed erosion and sediment control plan (ESCP) methodology and measures, and associated evidence supporting those measures. These are described in following sections.

10.2.2 Soil type

Most of the surficial soils, i.e. most soils to about 1m depth (which are likely to comprise a significant proportion of the soils involved in the proposed earthworks) have significant silt and clay content, as demonstrated in Section 8 above. This is in contrast to paragraph 5.2 of G. Levy's rebuttal evidence dated 5 June 2009 in which he states: "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..... given the nature of the soils on this site I do not envisage that flocculation will be needed on this project".

I do not agree with this part of Mr Levy's evidence and consider that an appropriate form of chemical treatment may be needed due to presence of significant proportions of silt and clay in much of the soils proposed to be earthworked and the sensitivity of the receiving environments.

10.2.3 Sensitivity of receiving environment

The statement of evidence of B. Coffey states in para 3.14 that "the upper Turitea Stream and the Kahuterawa Stream support very high quality aquatic habitat that is highly sensitive to reduced water quality /elevated suspended solids loadings" and in para 4.14 that "I consider the headwaters of the Kahuterawa, Otangane and Tainui Streams, the southern headwater catchment of Matarua Creek and the Palmerston North City water supply reservoirs should be considered significant habitats of indigenous fauna, in accordance with Section 6 (c) of the Resource Management Act 1991 (RMA)."

My opinion is that the sensitivity of these receiving environments and the level of erosion and sediment control required to protect them has not been adequately addressed in the erosion and sediment control measures proposed by the applicant because the need to prevent and minimise discharges of clay and silt has been underestimated.

10.2.4 Criteria for road design that minimise earthworks

I consider that specific site-wide criteria need to be developed to implement the stated erosion and sediment control principle to “minimise disturbance” for aspects of road design that relate to the area of disturbance. For example for road fills in steep vegetated areas, control of sediment will be difficult due to lack of space for installation of devices or measures without disturbing adjacent vegetation. In such locations a case can be made for using retaining walls, gabions, reinforced earth walls or other construction techniques to minimise extent of fill and associated area of disturbance and the associated size or extent of erosion and sediment control measures. I therefore consider that criteria need to be developed for guiding the type of road fill edge design that takes into account minimising the extent of disturbance in such areas.

10.2.5 Device options and choice

I consider the range of devices listed in section 14.4 of the draft CEMP is unnecessarily restricted. There are several recently available devices or measures that should be considered in preparation of ESCPs. These include the use of compost-filled filter socks, which can be used in a variety of configurations that in my experience are likely to be well-suited to this project. Also, I suggest the use of vegetated retaining walls to reduce erosion of steep slopes should be considered.

I question the proposed use of grit traps as the “primary control for the access tracks where they are positioned” as described on page 31 of the applicant’s Construction Effects Report. I note that sediment discharges from earthworks during construction where the upper 1m of soil is removed can be expected to contain significant proportions of silt and clay due to the nature of the soils as summarized in Section 8 above. Grit traps are not devices recommended or described within the Greater Wellington Regional Council Erosion and Sediment Control Guidelines. There are no design criteria in the applicant’s proposal or other reporting and evidence of guidelines for grit traps. It is my opinion that traps designed to trap grit (larger particles) are unlikely to be effective at removing silt and clay particles.

10.2.6 Criteria for planning erosion and sediment control measures and choosing devices

I consider that there is a lack of discussion or recognition of the varying receiving environments and ground conditions adjacent to road and turbine platforms and how these influence the selection of erosion and sediment control measures and devices.

The requirement for works in winter also needs to be carefully addressed.

In my opinion the following criteria are likely to be appropriate:

- all sediment ponds at spoil dump sites that have high value streams downstream are to have appropriate chemical treatment systems
- road cross-drainage to be used to the maximum extent practicable to divert stormwater discharges from the access road out of the water supply catchment
- where stormwater from road or other construction discharges to areas with valuable vegetation, the footprint of sediment interception devices on vegetated areas is to be minimized. Possible ways to achieve this include the use of frequent turnouts, using stormwater inlets and culverts as necessary to keep sub-catchment areas small

- the use of filter socks or other products to intercept sediment at various locations on or adjacent to the earthworked areas.

In my opinion the applicant needs to review the proposed use of grit traps and develop alternative measures that will effectively trap silt and clay.

10.2.7 Effects of residual floc washout from sediment ponds

This issue relates to residual floc in sediment ponds where flocculation and enhanced settling of sediment within ponds is achieved by dosing with chemicals. It particularly responds to three sections of B. Coffey’s rebuttal evidence of 5 June 2009 as set out in 10.2.7.1-3 below.

10.2.7.1 Section 4.2 of B. Coffey’s rebuttal evidence

I disagree with the statement: “spent alum floc is very much more of an issue in terms of adverse effects listed in paragraph 4.32 of Dr Blaschke’s evidence than the inorganic suspended solids that would be associated with the need to use this material.”

I note that the ecotoxicological and environmental risk of release of residual coagulants has been reviewed by the Auckland Regional Council (ARC) and reported in their Technical Publication no. 226 “Overview of the effects of Residual Flocculants on Aquatic Receiving Environments”. This document is available on the ARC website. Sections of the executive summary of this report which in my opinion refute Section 4.2 of B.Coffey’s evidence are reproduced in italics as follows:

2. *“The overall conclusion is that there appears to be a small risk to the natural aquatic environment arising from potential losses of unbound residual flocculants from treatment ponds on construction sites. Impacts are likely to be low level and also likely to not be significant in relation to other factors which govern the health of aquatic communities. The benefit of reduced sediment levels in discharges is considered to outweigh the risk of any low level impacts attributable to residual flocculants.*
5. *“Other key findings of the review can be summarized as follows:*
 - *“The potential toxicity of cationic polymers is well recognized but is seldom realized in the field. There is a large body of evidence indicating that these polymers are inactivated by sorption to naturally occurring dissolved and suspended organic matter and clays and their potential toxicity thereby greatly diminished, effectively to non significant levels*
 - *“Polyelectrolytes do not bioaccumulate, are highly biodegradable and so are not persistent in the environment. Bound residues pose no hazard to sediment biota and do not break down into toxic residuals*
 - *“Aluminium in flocculated sludges is tightly bound under a wide range of redox conditions and is stable other than in severely acidified situations. The latter conditions are unlikely to occur naturally or be induced by the use of aluminium flocculants which themselves reduce pH.”*

10.2.7.2 Section 4.3 of B. Coffey's rebuttal evidence

In response to Section 4.3 of B. Coffey's rebuttal evidence in which he states: "There may be specific situations where some silt retention ponds are best treated with flocculants but such ponds would require de-silting programmes and diversion channels to ensure there is no washout of spent floc to the headwaters of streams during storm events".

My response to this statement is that design and operation of sediment ponds as per the Greater Wellington Regional Council's Erosion and Sediment Control Guidelines for the Wellington region provides for storage of settled flocculated sediment in the dead storage zone at the base of the pond, which comprises 30% of the total storage volume of the pond. Ponds are required to be desilted when sediment accumulation is 20% of the total storage volume. Thus if ponds are designed and operated according to these criteria there is little risk of washout of spent floc. Design and operation of such ponds is well established in the Auckland region. Several chemicals are available for removing fine particles from sediment discharges and the selection of an appropriate choice needs detailed consideration.

10.2.7.3 Section 4.4 of B. Coffey's rebuttal evidence

I disagree with the statement that "The consequences of failure for stormwater ponds treated with flocculants relative to stormwater ponds that are not treated with flocculants are much higher in terms of adverse impacts on instream biota and I therefore do not support Dr Blaschke's recommendation". I consider that B. Coffey's statement is refuted by the executive summary of the ARC Technical Publication no. 226 as previously set out in section 10.2.7.6.1 above.

10.3 Slope instability

Slope instability caused or triggered by the proposed construction works, which would have an adverse effect on water quality in water courses, streams or the water supply reservoir is discussed below.

My opinion is that the proposed works will not trigger or cause slope instability that impacts on water quality in water courses, streams or the water supply reservoir. This is based mainly on the rebuttal evidence of G. Alexander and S. Vaughan. It is also dependant on further geotechnical investigation, analysis and design being undertaken during the detailed design phase and throughout the wind farm construction as recommended in section 51 of the rebuttal evidence of G. Alexander dated 5 June 2009. The effects from minor slipping of cut batters can in my opinion be avoided or satisfactorily mitigated by appropriate erosion and sediment control procedures.

10.4 Damage to watercourses or streams

Damage to watercourses or streams from installation of culvert crossings, including from associated sediment discharges, is discussed below.

10.4.1 General

The evidence of G. Levy states in Section 44: "Five culverts are required for the construction of roads within the site. The majority of these will be over ephemeral

(intermittent) streams at the extreme headwaters of the catchments and located in relatively small catchments, though two of the catchments are larger. The sizes of the catchments range from 2 hectares to approximately 65 hectares. The locations of these culverts are shown in Appendix A.” Appendix A is the Water Catchment Plan drawing 0848RK 233 rev A.

Principles for construction of all works within water courses are contained in Section 14.5 of the Construction and Environmental Management Plan, draft, June 2009 (CEMP). The CEMP principles appear appropriate although there is no mention of requirements for fish passage.

The proposed culvert locations shown in this map together with catchment descriptions are shown in Table 1. The applicant does not appear to have provided estimates of earthworks extent or volumes required for installation of each culvert.

Table 1 Culvert locations and catchments

Reference per dwg 0848 RK 233 rev A	Location	Down stream catchment	Contributing catchment area (ha) Note 1
C2-A	In farmland between turbines # 0077 and # 0078	Upper Turitea water supply dam approximately 600 m downstream	2.6
C9-A	Near turbine # 00 77	Upper Turitea water supply dam approximately 600 m downstream	2.0
C7-B	In farmland between turbines # 0067 and # 0095	Un-named tributaries of the Manawatu River	18.8
C6-A	South-east of proposed Browns Flat substation	headwaters of Upper Turitea Stream –water supply catchment	4.6
C4-C	At southwestern extent of wind farm, providing access to turbines # 0117 and #0118	Headwaters of Kahuterawa Stream catchment	64.7 ha

Note 1: per evidence of C. James

Inspection of the Site Layout Sheet 2 of 4 drawing no. 0848RK203 rev G indicates that the road leading to proposed turbine No. 0092 may cross two gullies which will require culverts. There is no discussion in the information provided by the applicant to date regarding a culvert crossing at this location. I assume that a culvert is required at each of these locations. Photographs of these locations have been provided to me by the applicant on 23 June. These photographs show incised gullies that could be expected to require significant volumes of fill to form a road. The streams at these locations appear to be likely to be ephemeral streams and appear to have relatively low value and be currently adversely affected by stock access. I therefore consider that adverse effects from construction of culverts at these locations can be expected to be low, provided appropriate erosion and sediment control measures are in place during construction.

10.4.2 Culverts at locations C2-A and C9-A

I have inspected the locations of these culverts. They are within grazed farmland. The stream gullies have steep longitudinal grade but have reasonably wide bases allowing relatively easy working conditions. This, together with the small catchment areas of 2.6ha and 2.0ha respectively should ensure the risk of discharge of sediment downstream and other adverse effects from during construction is low, provided appropriate erosion and sediment control measures are in place during construction. I note that the Turitea water supply reservoir is immediately downstream and I consider it prudent to ensure a particularly high level of erosion and sediment control measures at this location in order to minimise sediment discharges into it.

10.4.3 Culvert at location C7-B

I have not inspected the site of this culvert. Inspection of Site Layout Sheet 2 of 4 Rev G indicates it is within grazed farmland. I can make no further comment as no other detail has been provided to me at the time of writing.

10.4.4 Culvert at location C6-A

I have not inspected the site of this culvert, however the Topographic Relief Slope Analysis map shows ground slope of between 0 and 10 degrees at this location and the contributing catchment area is small and from inspection of Site Layout Sheet 3 of 4 Rev F, it is within grazed farmland. For these reasons the stream channel is likely to have low value for aquatic habitat and the risk of discharge of sediment downstream and other adverse effects from construction should be low provided construction is carried out in accordance with the CEMP.

10.4.5 Culverts at location C4-C

A Memorandum from Chris James to P. Laurenson dated 22 June 2009 advises that the access road serving turbine Nos 0117 and 0118 has been amended to provide access from the north. This avoids the need for this culvert.

10.4.6 Interruption of fish passage in streams from installation of culvert crossings

This can be avoided by requiring all culvert installations to be designed and constructed to provide for fish passage.

10.4.7 Other discharges

Other discharges which may have adverse effects on watercourses, streams and/or the Turitea water supply are discussed below under the following headings:

- wastewater, process and wash water and stormwater from two concrete batching plants
- sewage generated during construction at various locations on the site
- nutrients and colour from stockpiled vegetation, from vegetative bunds or from mulch
- cement or cement washings during concrete works
- hydrocarbon contamination of soil or surface water

- leakage or spillage of hazardous materials such as paint, bitumen based products, concrete admixtures
- dust from construction operations.

10.4.7.1 Wastewater, process and wash water and stormwater from two concrete batching plants

The applicant has provided information on concrete batching plant wash-down water in Attachment 15 of the S92 Request for Further Information - Consolidated Response, January 2009.

This information states that:

“[E]ach concrete batching plant will be surrounded by an earth bund to ensure that clean water is diverted around the batching plant and back into its natural path without becoming contaminated by activities within the earth bund.

“The area within the bund surrounding the concrete batching plant will be managed as follows. At each plant, a concrete lined settling pond will be constructed. This pond will receive all stormwater from within the bund. This includes stormwater from hard stand areas where cement is stored and handled and any wash or process water from the concrete batching process. This water will be a mixture of stormwater, cement, gravels and other fine particulates.

“The volumes of discharge generated will be limited to that created on the site by stormwater falling within the banded area and any wash and process water. The pond will be sized accordingly.

“It is expected that gravels and cement material will settle out in the bottom of the pond with surface water being collected and re-used in the concrete batching process on a daily basis. Similarly, settled material will be reused in the concrete batching process. Any surplus cement left at days end will be mixed with a retarding agent to prevent hardening for re-use the following day. Surplus cement that cannot be used will be cast into blocks and removed off-site. We note that these methods have been used successfully during the construction of other wind farms, including Te Apiti. Following construction, the concrete batching plants and lined ponds will be removed and the area reinstated.

“As a result of the above recycling methods and the use of an impermeable settling pond, the concrete batching plant is not expected to result in any discharge of water to either land or water.”

My comment is that following the above construction and operation procedures will avoid, remedy and mitigate the adverse effects on watercourse and streams from the proposed batching plants.

10.4.7.2 Sewage generated during construction at various locations on the site

The section 92 Requests for Further Information – Consolidated Responses, January 2009 states that all sewage during construction will be taken off site. This will require all toilet facilities to have holding tanks, as stated in section 14.13 of the draft CEMP.

Provided these facilities are properly installed, operated and regularly emptied by a competent contractor the risk of discharges to the environment will be minimal. Sewage removal contractors should have appropriate procedures and equipment to adequately deal with any spill of sewage while transporting it off site.

10.4.7.3 Nutrients and colour from stockpiled vegetation, from vegetative bunds or from mulch

This matter, with respect to adverse effects on the PNCC water reservoir and supply, is addressed in Mr Levy's rebuttal evidence of 5 June 2009. In Section 2.6 of his evidence he states that the applicant has removed any spoil disposal sites from within the water supply catchment and it is proposed that vegetation from site clearance not be stockpiled in the water supply catchment area except where it may be used as mulch cover to avoid erosion and trap sediment. In sections 4.17 to 4.20 of his rebuttal evidence he provides results of estimates of increases in nutrient loads, which are in the same order as those carried by Mr Male as reported in his evidence. I have not carried out independent assessment of nutrient loads, but given the reasonable agreement of those carried by Mr Levy and Mr Male, I accept that their estimates are likely to be sufficiently accurate for assessing likely effects.

Mr Levy then refers to rebuttal evidence of Mr Watson of the implications of the increases in nutrients for the water supply reservoir.

Mr Levy in section 4.22 of his rebuttal evidence states that "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". I concur with this statement.

Mr Watson in his rebuttal evidence of 12 June 2009, Section 3.8, implies there is not a current reservoir water quality model for the water supply reservoir. He then states: "Typically without a water quality model, it is difficult to predict the impact of increasing nutrients on the incidence of blooms. However, usually a reservoir with nutrient concentrations of the order that are already present in the upper dam would face a minor increase in the risk of blooms occurring with a minor increase in nutrients." In Section 3.9 of his evidence he states: "I would note that reservoir de-stratification has proven successful in a number of water supply reservoirs for reducing the risks of algal blooms occurring and could be considered by PNCC for Turitea as a risk mitigation measure."

The report of caucusing between John Male, Chris Taylor (GHD for PNCC) and Andrew Watson and Graham Levy (Beca for Mighty River Power) on 12 June 2009 demonstrated GHD's concern that frequency of algal blooms could increase significantly over time and there was not enough information to make a judgment. GHD also consider that it is not known how sensitive the reservoir is to nutrient loads and whether estimated increases in sediment and nutrients will take the reservoir through some threshold that changes the nature of and frequency of ecological response.

I do not have appropriate expertise to assess whether or not GHD's concerns are legitimate.

I consider that road cross-drainage should be implemented to the maximum extent practicable to divert stormwater discharges from earthworks for the access road away from the water supply catchment. This will assist in avoiding or minimizing increases in nutrient discharges to the water supply.

I also consider that water reservoir management and /or treatment plant mechanisms/operations are available to mitigate effects of nutrients should they become more than minor. I further consider that such a mitigation approach would be appropriate to address potential adverse effects.

10.4.7.4 Cement or cement washings during concrete works

This includes works such as turbine foundations and installation of culverts

The management of concrete is very important for the health of the aquatic environment as cement and cement washing have a very high pH, which can cause adverse effects.

This will require development and use of procedures by the contractor to avoid discharge of cement or cement washings to water courses or streams or to locations where they can subsequently be washed into or otherwise enter water courses and streams. Appropriate procedures need to be included in the CEMP.

10.4.7.5 Hydrocarbon contamination of soil or surface water

The likely sources of such contamination are:

- lubricant leakage from construction vehicles
- spillage of fuel during refuelling on site
- plant and equipment failure
- oil leak from a transformer at the substations

I consider that control of such sources is addressed adequately within the draft CEMP dated June 2009, with the proviso that the CEMP should also include requirements for spill kits and spill clean up procedures.

10.4.7.6 Leakage or spillage of hazardous materials such as paint, bitumen based products, concrete admixtures

I consider that control of such sources is addressed adequately within the draft CEMP dated June 2009, with the proviso that the CEMP should also include detailed requirements for spill clean up procedures including reporting to Horizons and PNCC.

10.4.7.7 Dust from construction operations

Dust management to avoid nuisance is covered in section 14.7 of the draft CEMP, June 2009. I consider that these management provisions should include the requirement for best practical options to minimise the discharge of dust from roads and areas of earthworks including soil stockpiles. I consider that specific requirements are needed in preparation of the SEMP, for example by setting quantitative speed limits for vehicles when conditions are dry. My opinion is that provided the above provisions are implemented then effects of dust on water quality will be minimal.

11 Other comments on evidence and information provided

11.1 WQMP and CEMP

The Water Quality Monitoring Plan (WQMP) and Construction and Environmental Management Plan (CEMP) are discussed below.

The introductions and general text of the August 2006 Water Quality Monitoring Plan (WQMP) and the CEMP (Section 16.4.1 Water Quality Monitoring) discuss the need for monitoring water quality only within the Turitea water supply catchment.

I note that Section 3.4 of the WQMP states that a wet-weather WQMP is required at the upstream limit of perennial flow in a total of 12 significant tributaries, which include streams outside the water catchment area. The subsequent sections 3.5 and 3.6 of the WQMP also provide for monitoring at locations including the 12 significant tributaries. I endorse this approach and note that when the WQMP and CEMP are updated relevant text should be amended to reflect they cover all the streams and catchments potentially affected by the construction and operation of the proposed wind farm.

In section 13 of the CEMP (SEMPs) it is not stated who shall prepare the SEMPs. I consider this should be stated.

In section 13.5 of the CEMP (ESCP Preparation) I consider that additional criteria for requiring inclusions within ESCPs should include:

Maps or plan to show:

1. contours at an appropriate interval that don't swamp the drawing - usually 1-2m intervals. It is also useful to have existing and proposed contours
2. permanently flowing watercourses (and drains/ephemeral watercourses where relevant)
3. ridgelines/catchment divisions
4. legal boundaries where relevant
5. relevant natural features such as archaeological sites, unstable areas, protected areas (if any), significant areas of vegetation, watercourses, wetlands, areas prone to flooding etc. This is to show the relationship of other relevant features of the site to the proposed earthworks
6. scale: preferably 1:1000 (but up to 1:2000) with a bar scale also provided.

Erosion and Sediment Control Detail

1. catchment limits of the various control measures
2. diversion systems (both clean and dirty water)
3. direction of flow
4. haul routes
5. soil stockpile locations and ESCP measures

6. notes on relevant erosion and sediment control notes e.g. programming/staging details, approval details, sign-off, preconstruction meetings, stabilisation details, relevant construction methodology etc.
7. description of device or control measures should include the relevant catchment areas, volume, dimension details including such detail as:
8. pond details (volume, decant number and elevations, shape, inlet and outlet positioning, outlet pipe sizing, spillway dimensions, inlet and forebay details, batter slope angles, pond stabilisation, etc.);
9. equivalent decanting earth bund and silt fence details;
10. chemical dosing details, e.g. roof size; header tank low and high flow pipe volumes
11. dimensions of diversion channels and stabilisation details; relationship to design flow. This should refer to both clean and dirty water and supporting calculations should be in the accompanying text:
 - dewatering procedures
 - outlet and stabilisation details
 - areas/facilities that comply/do not comply with the guideline/consent requirements and relevant details.

In summary, the drawings should be standalone drawings to provide sufficient detail to enable a contractor to construct and implement the erosion and sediment control measures.

11.2 Proposed resource consent conditions

I have reviewed the proposed resource consent conditions contained as part of P. Hindrup's evidence on behalf of Horizons. My comments on these conditions follow.

11.2.1 Manawatu-Wanganui (Horizons) Regional Council

Condition 6.8: The area or extent of works covered by each SEMP needs to be flexible and not prescribed by a consent condition.

Condition 10: This implies that the ESCP is to be part of an SEMP. However the draft CEMP (Section 13) states that the ESCP shall be a separate document prepared by the contractor parallel to the SEMP. This discrepancy needs to be resolved.

Condition 25: The scope of the WQMP needs to be revised, as per my comments in Section 11.1 above.

Condition 29: I consider that mechanisms for algal bloom management that may be attributed to increased nutrient loads associated with the wind farm could be included here.

Condition 29.3. Based on previous discussion it appears this condition could be deleted.

Conditions 35 to 39 for proposed culverts on an un-named tributary of the Kahuterawa Stream. I understand these culverts are not now proposed as discussed previously above so these conditions can be deleted.

11.2.2 General comment

The requirements of the CEMP, including recommendations made by me elsewhere in this report, should be checked, particularly for activities where discharges may occur to provide appropriate consent conditions where necessary.

12 Decommissioning effects

This section of the report has been based on:

- a brief discussion I had with Mike Omer of Mighty River Power during the site visit of 11 June regarding the activities required for future decommissioning of the wind farm, should it be required
- consideration of likely activities required for future decommissioning of the wind farm based on project information and evidence provided to date and on my assessment of potential effects from the proposed construction of the wind farm.

The likely activities required for future decommissioning of the wind farm that could result in potential effects on surface water in the adjoining streams and catchments are:

- earthworks associated with widening of the post construction access road carriageway width to accommodate transport of cranes and turbine tower sections
- earthworks for re-instatement of the access road after removal of turbines, to a carriageway width of approximately 5 metres
- earthworks on branch roads to turbine sites to decommission them and reinstate them with appropriate vegetative cover
- earthworks on turbine sites and substation sites to reinstate them with appropriate vegetative cover
- earthworks to remove and recover buried power cables, backfill and reinstate trenches
- sewage generated during construction at various locations on the site
- hydrocarbon contamination of soil or surface water from:
 - lubricant leakage from construction vehicles
 - spillage of fuel during refuelling on site
 - plant and equipment failure.

I have assumed that all the access roads serving turbine sites will need be widened from the proposed post constructional carriageway width of approximately 5 metres (refer Dwg 084RK97) to a carriageway width of 10 metres to allow transport of cranes and removed turbine tower sections. It has further been assumed that the principal access roads will be retained at their post construction dimensions. I anticipate that whether or not branch access roads serving turbine sites would be retained would depend on the adjoining land use, land ownership and associated future potential use of existing roads.

Likely earthworks operations would be:

- remove the soil mounds from each side of the post construction access roads and stockpile at suitable locations on farmland while decommissioning activities are being carried out
- replace soil mounds on post construction access roads after removal of turbines, other plant and electric cable are removed as required
- place soil from the stockpile on the roads which are to be to be decommissioned and reinstated to pasture or other vegetative cover
- remove above ground structures from substation sites and other facilities and remove off site
- use stockpiled soil or imported soil if needed to reinstate turbine sites and substation sites
- import topsoil for final cover on all reinstated areas
- revegetate all reinstated areas.

From consideration of the activities described above I consider that the effects on surface water in the adjoining streams and catchments can be adequately mitigated such that effects will be minor, provided the following is carried out:

- identify suitable soil stockpile areas that avoid damage to existing high value vegetation, avoid locations of potential slope instability and provide significant buffer distance to water courses and streams
- prepare and implement an appropriate CEMP for the works including addressing control of discharges of sewage and hydrocarbon contamination, in a similar manner to the current draft CEMP for the proposed construction works
- ESCPs for all earthworks activities are prepared by a suitably qualified and experienced person and implemented by suitably trained personnel.

13 Summary and conclusions

My review of the information, evidence and submissions provided to date for the proposed Turitea wind farm together with my site visit and consideration of potential and expected actual effects indicates that the construction effects of the proposed wind farm can be adequately avoided, remedied and mitigated.

I have a concern that the discussion of and currently proposed erosion and sediment control measures are deficient in a number of respects. My opinion is that the erosion and sediment control measures need to be reviewed and improved as discussed in this report.

I have made a number of recommendations throughout the report, which in my opinion are necessary to ensure that the construction related effects of the project are avoided, remedied or mitigated.

14 Recommendations

The recommendations contained in this report are summarised below. Note that there are other environmental management requirements in the draft CEMP and draft consent conditions with which I agree but which may not be included in these recommendations.

1. Stormwater discharges

Specific criteria for engineering design of stormwater discharges should be developed to ensure all discharges are either attenuated or spread out to avoid adverse effects. These need to be developed as part of the CEMP.

2. Erosion and sediment control

Criteria need to be developed for guiding the type of road fill edge design that takes into account minimising the area of disturbance in such areas.

Erosion and sediment control measures should include consideration of compost-filled filter socks and the use of vegetated retaining walls to reduce erosion of steep slopes.

Discussion or recognition is needed of the varying receiving environments and ground conditions adjacent to road and turbine platforms and how these influence selection of erosion and sediment control measures and devices. Considerations relating to works in winter also need to be carefully addressed.

The following erosion and sediment control criteria are likely to be appropriate:

- all sediment ponds at spoil dump sites that have high value streams downstream are to have appropriate chemical treatment systems
- road cross-drainage to be used to maximum extent practicable to divert stormwater discharges from the access road out of the water supply catchment.
- where stormwater discharges, from road or other construction, occur to areas with valuable vegetation, the footprint of sediment interception devices on vegetated areas is to be minimized. Possible ways to achieve this include:
 - the use of frequent turnouts, using stormwater inlets and culverts as necessary to keep sub-catchment areas small
 - the use of filter socks or other products to intercept sediment at various locations on or adjacent to the earthworked areas.

The applicant needs to review the proposed use of grit traps and develop alternative measures that will effectively trap silt and clay.

3. Slope stability

Further geotechnical investigation, analysis and design needs to be undertaken during the detailed design phase and throughout the wind farm construction as recommended in section 51 of the rebuttal evidence of G. Alexander dated 5 June 2009.

4. Culverts

Culvert design and construction needs to provide for control of sediment and provision for fish passage.

5. Construction of concrete batching plant

The design and construction of the concrete batching plant including control of wash-down water is to be carried out as set out in Attachment 15 of the S92 Request for Further Information - Consolidated Response (refer to section 10.4.7.1 of this report).

6. Sewage generated during construction at various locations on the site

All sewage during construction shall be taken off site. This will require all toilet facilities to have holding tanks, as stated in section 14.13 of the draft CEMP. These facilities shall be properly installed, operated and regularly emptied by a competent contractor. Sewage removal contractors should have appropriate procedures, and equipment to adequately deal with any spill of sewage while transporting it off site.

7. Control of algal blooms due to increase in nutrients due to construction

Cross-drainage should be implemented to the maximum extent practicable on all roads to divert stormwater discharges from earthworks for the access road away from the water supply catchment. Adverse effects of algal blooms can also be controlled by water reservoir management and/or treatment plant mechanisms/operations.

8. Cement washings from concrete works

Development and use of procedures by the contractor to avoid discharge of cement or cement washings to water courses or streams or to locations where they can subsequently be washed into or otherwise enter water courses and streams. Appropriate procedures need to be included in the CEMP.

9. Hydrocarbon contamination

This needs to be addressed in the CEMP and should include requirements for spill kits, spill clean up procedures and reporting to Horizons and PNCC.

10. Dust management

To be addressed in the CEMP, to include the requirement for best practical options to minimise the discharge of dust from roads and areas of earthworks including soil stockpiles. Specific requirements are needed in preparation of the SEMP, for example by setting quantitative speed limits for vehicles when conditions are dry.

11. WQMP and CEMP

These are to be amended or upgraded as per section 11.1 in this report.