BEFORE A HEARINGS PANEL OF THE GREATER WELLINGTON REGIONAL COUNCIL AND MASTERTON DISTRICT COUNCIL

[GWRC Ref: WAR 070077]

IN THE MATTER	of resource consent applications to Greater Wellington Regional Council pursuant to section 88 of the Resource Management Act 1991
AND	
IN THE MATTER	of a Notice of Requirement to Masterton District Council pursuant to section 168, 168A and 181 of the Resource Management Act 1991
BY	Masterton District Council
FOR	the proposed upgrade of the Masterton Wastewater Treatment Plant

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SUPPLEMENTARY STATEMENT OF EVIDENCE OF GRAEME PROFFITT ON BEHALF OF MASTERTON DISTRICT COUNCIL

RESPONSE TO OFFICERS' REPORT

Subject Area: Groundwater effects

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1. INTRODUCTION

1.1 The technical review reports and the Officer's Report raise various concerns with respect to the groundwater modelling and predicted effects on the groundwater quality and consequent effects on surface quality. Various consent conditions are proposed to address these concerns. My response to the stated concerns in the Officer's Report is set out below. I use the report section numbers where relevant.

2. PERCEIVED MODELLING UNCERTAINTY

2.1 In section 12.4.1 of the Officer's Report it is concluded that:

> "*There is a high degree of uncertainty over the land irrigation operation and therefore the effects on the receiving environment given the uncertainty with the modelling ….".*

2.2 I disagree that the modelling is uncertain as the Officer's Report implies. The officers would appear to be basing this conclusion on the technical review report prepared by Duffill Watts Consulting Group. I largely restrict my comments to the PDP modelling.

2.3 An expressed uncertainty is whether the modelling incorporated the changes to the scheme since the initial consent application in 2007. The changes were indeed incorporated, as is explained in Section 4.2 of PDP's 2008 Revised Groundwater Modelling Report. Paragraph two of that section notes that HortResearch re-ran their model for the then proposed 29 irrigated plots. Table 1 of the PDP report shows the new and the old modelled areas, clearly showing 29 modelled plots covering 149.4 hectares as well as the original 11 plots of the old scheme totalling 74.7 hectares. Some subsequent minor adjustments to plot areas were insignificant and were not re-modelled.

2.4 A further expressed uncertainty with respect to drainage to the aquifer is that:

> " *… in reality, there will be a one-off slug of water entering groundwater on the day of irrigation, with lesser volumes on following days. It is unclear how this would change the mounding predictions and what the consequence would be, especially in terms of soil health."* (Section 12.4.3(c)(ii)).

2.5 HortResearch modelled these pulse loading effects and to talk of a "one-off slug" of water entering the groundwater is misleading and misunderstands the processes of infiltration and the subsequent reaction of the groundwater flow regime. I understand Dr Steve Green will explain the infiltration processes in more detail and I will restrict my comments to groundwater effects.

2.6 As is explained in PDP's Revised Groundwater Report (in Section 4.3) and my evidence, a transient groundwater model was employed but the daily outputs from the HortResearch modelling could not be used as the model was simply too complex for it to run in a reasonable time. Instead the inputs were averaged over each month to obtain seasonal variability. Even then, each model run took a day to complete.

2.7 To check this approximation, the model was also run using a period of a few years daily data (which was not computationally excessive) and compared with the same period of monthly input data. The comparison was good. This is not surprising. Travel times in the aquifer tend to be large – of the order of hundreds of days from top to bottom of the site. The effect of irrigation at a particular point is not just from irrigation at that point but a summation of all the up-gradient effects. However, time must be taken into account, so that the summation includes up-gradient effects removed in time varying from a short period through to many days. This has the effect of averaging out variations at any particular point.

2.8 A further complexity is that the modelling assumed every irrigated plot would be loaded simultaneously, and drain down for a period before being reloaded. In reality, irrigation will be cycled around the plots, with loading of different plots occurring on different days. This will result in further temporal and spatial averaging, with the effect that peak concentrations will be lower than modelled. It is not possible to model this irrigation cycling because at the conceptual stage of design the detail of plot cycling is simply not known, and will not be fully known until operational experience is gained.

2.9 The Officer's Report expresses concern in a number of places that, because of the modelling uncertainties and seepage from the new ponds, greater than expected effects on the stream and river will occur. For example in Section 12.4.2 the report states:

> *"There is significant potential for greater than anticipated nutrient inputs into both the Makoura Stream and the Ruamahanga River via seepage through groundwater underneath the proposed land irrigation area and the base of the new oxidation ponds."*

2.10 There are two parts to this; the modelling and the pond seepage, which I will consider in turn.

Modelling

2.11 It is acknowledged there are uncertainties in all modelling exercises. Consequently, it is standard practice to be conservative in choosing the various inputs to the model so that the predictions err on the safe side. Conservative aspects of the modelling include:

(a) the HortResearch modelling assumed a soil column 1m deep in which attenuation of nutrients and bacteria occurs. In reality the surface silt layer is typically thicker. This means that greater adsorption of nutrients, particularly phosphorus, and die-off and filtration of bacteria will occur, as the effluent has a greater travel path through the soil than assumed in the modelling.

(b) using maximum likely rates of irrigation continuously throughout the modelled period, as in Table 23 of the AEE. This will not occur in reality.

(c) modelling the maximum available area, including the potential future area. The potential future area is not included in the current consent application.

(d) not modelling all the attenuation effects that will actually occur in the aquifer because of the difficulty of applying appropriate attenuation factors. For example, there will be considerable adsorption of phosphorus on the finer aquifer materials. Laboratory or field tests could have been carried out to obtain estimates of "retardation" factors, but the cost (ranging from low tens to low hundreds of thousands of dollars, the higher cost being for field tests) and uncertain reliability of the results (which would have inevitability resulted in questions) led to the decision to choose the more conservative option.

(e) with respect to phosphorus, using the long-term results (after 30 years) for the assessment. Concentrations after say 15 years, are predicted to be only about a third of those predicted for 30 years.

2.12 I am confident that the various conservative aspects of the modelling mean that the predictions will be higher than reality. This has been PDP's experience with similar modelling exercises.

Pond seepage

2.13 With respect to seepage from the new ponds, this was not included in the model as at the time of the modelling exercise the details of the lining had not been finalised. A judgement was made at the time that seepage would be sufficiently low to have minimal effects on the receiving waters relative to the existing pond leakage and therefore modification of the model to include this was not required. It was recognised at the time that this omission was unconservative but it was considered small enough to be outweighed by the various conservative estimates built-in to the model.

2.14 Beca have calculated a range of seepage rates through the proposed 0.4 m thick silty clay liner of 150 to 750 m^3/day, presumably reflecting the five-fold range in target hydraulic conductivity of 1 to 5 x 10^{-9} m/s. I note that 1 x 10^{-9} m/s is commonly used as a design target for earth landfill liners. Underlying the liner are the natural silts and clayey silts with a variable thickness of at least 1 m and typically thicker.

2.15 The liner and underlying soil will considerably impede transport of bacteria through filtration and die-off. Further attenuation will occur in the 270 m between the new ponds and the river. Nitrogen impacts from the irrigation are predicted to be small therefore a further, smaller increment from minor pond seepage will not change that situation greatly.

2.16 Phosphorus is the principal concern for the receiving waters. HortResearch has not modelled the passage of seepage water through the pond liner and underlying soil. However, there will be considerable adsorption of phosphorus by the silt and clay, and further adsorption within the aquifer between the ponds and the river. I expect that reduction will be at least an order of magnitude. Adsorption will increase and seepage will decrease as sludge builds up in the base of the ponds.

2.17 A starting phosphorus concentration of 2.5 mg/L within the ponds (the assumed concentration for the irrigation modelling) when reduced ten-fold after passing through the liner and underlying soil equates to 0.25 mg/L. This is the equivalent to a mass flux of 37.5 g/day for leakage of 150 m^3/day. This is less than 5% of the predicted mass flux from irrigation of more than 800 g/day after thirty years.

2.18 The leakage is expected to be greatest when the ponds are first filled; however, it is at that stage when effects from phosphorus in the irrigation are least, of the order of only 10 – 15% of the long-term mass flux. If the pond leakage in the early stages is five times more than the long-term leakage estimate (i.e. the high estimate of 750 m^3/day) the combination of the early stage mass flux from leakage and mass flux from irrigation is less than half of the long-term flux from irrigation alone. It is therefore reasonable to conclude from this basic analysis that incremental effects from pond leakage are small and the uncertainty of not modelling the effects of leakage is less than the conservatism built in to other aspects of the modelling.

Monitoring

2.19 The Officer's Report in 12.4.3(c)(v) proposes a programme of monitoring to deal with perceived uncertainties, stating:

> "*Consequently an approach is proposed which requires groundwater samples not to exceed a specified target, and if they do, then immediate modification to the land application system is required."*

and:

> *"As the quantification of the mass loading requires further clarification, to provide for constructive advancement of this*

application a tiered approach to groundwater monitoring is provided in the recommended conditions."

2.20 The proposed groundwater monitoring and actions to be taken are set out as recommended conditions 36 to 40 and 46 to 48 of Schedule 2. There are a number of practical difficulties with both the conditions and their application.

2.21 Condition 36 sets out monitoring well locations to be monitored. The nomenclature suggests these are the locations of existing monitoring wells, although the wording suggests these are to be new installations with the same numbering as existing (except for BB13, unless this was intended to be HB13?).

2.22 If the intention is that the monitored wells are to be existing wells, then the apparent intended location and purpose will not be fulfilled by some of the chosen wells. For example:

(a) HB31 is stated as an upgradient well but it is actually adjacent to the treatment area (and within the potential future area) and might be subject to effects.

(b) HB12 is stated as a downgradient well. I infer that the purpose of this well is to measure the quality of groundwater flowing eastward towards the river in the northern part of the site, although this is not clear in the condition. If this is the intent, until the design is finalised it is not clear whether HB12 is ideally placed. A more representative location is probably eastward and further southward by two or three hundred metres.

(c) HB1 and HB4 are given as downgradient of the proposed sludge landfill. HB1 is only marginally downgradient and HB4 not at all. It is my view that dedicated monitoring wells should be installed for the landfill.

(d) HB28 is stated as being within the land treatment area but it is actually within the potential future area.

(e) HB23 is stated as being downgradient, but it is too far west to be a good indicator of downgradient effects of the currently proposed land treatment area. It is downgradient of the potential future area but no consents are sought for that area.

2.23 I set out suggested amended locations further below.

2.24 Recommended Condition 37 sets out the parameters to be monitored while Condition 40 sets out the standards to be achieved. Condition 40 applies to only four of the 12 parameters to be monitored. I am a firm believer in only monitoring what is necessary to be monitored for specific purposes. A large part of Condition 37 appears to be monitoring for the sake of monitoring, as there is no requirement for eight of the parameters to comply with anything in particular. As it stands the results will be reported and the Regional Council has no mechanism within the conditions to determine whether the results are good, bad or indifferent. Either the additional parameters should be dispensed with, which I favour, or clarification as to their purpose (and hence interpretation) should be given.

2.25 There is overlap within groups of wells within Condition 36. Consequently, there are duplications within the table given in Condition 38. For example, HB1 is apparently to be monitored three times in January, which is clearly not the intent. The table should be clarified/simplified.

2.26 No rationale is given for the frequency of monitoring in Table 38. Monitoring should be at a frequency that has a likelihood of picking up important fluctuations. Because I do not expect rapid fluctuations (rather than a seasonal cycling) it is not obvious to me why monthly monitoring of wells within the treatment area (Group 1c) is necessary. Further, it is not obvious why water quality monitoring is required in these wells at all, as it is difficult to relate the results to effects in the receiving waters.

2.27 The proposed requirement appears to be based on the belief that frequent monitoring will give the opportunity for quick corrective action in the event of non-compliance *"… by immediate modification to the land application system …"* (12.4.3(c)(v)). This belief is misplaced. Because travel times are lengthy, it will be months if not years for the groundwater quality at the southern end of the site to respond to a change in application rates or applied effluent quality. This is illustrated by the modelling, which shows an initial "ramping up" of concentrations over a period of a year or two at the start of the irrigation, after which the longerterm behaviour becomes evident. Hence, effects of an immediate modification to the land application system will not be seen for some extended period of time.

2.28 Condition 40 sets out compliance conditions for all monitored wells that, on the face of it, will prevent irrigation, which I presume is not the intent. Again the rationale for the compliance conditions is not given. However, it would appear that the allowable concentration of nitrogen and phosphorus have been set at close to the average existing river quality, meaning that the groundwater entering the river will have effectively zero effect on the river. Dilution provided by the river is ignored. Further, this condition applies to all monitoring wells, including points within the treatment area, where existing groundwater quality is already non-complying with the condition.

2.29 Groundwater compliance conditions should be set based on the desired outcome at a point of compliance, which I assume to be the receiving surface waters. The compliance requirement within a particular well should be back-calculated from the point of compliance in the surface water, taking into account dilution and attenuation.

2.30 This calculation cannot be carried out until the conflict between the applicant's desired receiving water DRP limit of 0.03 mg/L and the Officer's Report recommendation of 0.012 mg/L is resolved. It is a complex "chicken and egg" situation.

2.31 However, I suggest some amendments to the tiered approach to assessing groundwater quality. Firstly, water quality triggers should only be set in wells that provide useful warning of unacceptable effects in the receiving waters. This generally applies to wells immediately adjacent to the receiving waters plus some upgradient wells to provide background concentrations.

2.32 I generally agree with the two tiered approach of primary and secondary values, but as noted above disagree with the values given as being unreasonably low.

2.33 I suggest that once the groundwater quality has reached a reasonable equilibrium after startup (noting that there will be a ramping up of groundwater quality changes over many months, overlaid with cyclic variations, the duration of ramping up depending on location) the performance of the system should be reviewed against the modelled predictions. Data should then be available to calibrate the model to provide better predictions of groundwater concentrations and hence effects on the stream and river. If the actual performance is significantly better than predicted, then a review of the monitoring conditions and groundwater quality triggers should be considered.

2.34 Conditions 46 to 48 propose the actions to be taken in the event of non-compliance of groundwater quality value. While I agree with the general intent, I disagree with the detail. As noted previously, the lag between groundwater effects and receiving water effects means that there is time to determine why the trigger has been exceeded without having to take immediate corrective action, but on the other hand the triggers have to be set at a level that provides time for any action to be effective.

2.35 If a water quality trigger is exceeded, the first action should be to confirm the non-compliance rather than trigger steps to ensure compliance. This would involve repeating the monitoring, or increasing the frequency of monitoring over a short period, to ensure the non-compliance is not a one-off aberration. As written Conditions 46 to 48 do not provide for such confirmation. If the non-compliance is confirmed then action may be appropriate, and I agree with the conditions that a reason for the non-compliance should be determined.

Summary of recommended modifications to conditions

2.36 Conditions 36 and 37 need to be modified with each monitoring point better defined as to its purpose and what it should be monitored for to fulfil that purpose.

(a) One upgradient monitoring well is insufficient to establish upgradient conditions (noting BH31 is not upgradient). A second upgradient well should be established west of the Makoura Stream for this purpose. These should be monitored for all parameters that have compliance standards set in Condition 40, plus water level.

(b) Downgradient wells close to receiving waters are appropriate to act as early warning of potential excessive effects in the receiving waters. HB1 is too far east and should be replaced by HB2, but HB4 and HB 11 are appropriate to the south. The modelling shows relatively little mass flux of contaminants goes into the north-south reach of the river to the east, however HB16 and a new well two or three hundred metres south of

HB12 are appropriate to confirm the model predictions in this area. HB23 is not appropriate as it is too far from the receiving waters to provide a sensible warning. No wells adjacent to the drain or Makoura Stream where the modelling shows significant contaminant mass fluxes enter the stream have been specified in Condition 36. HB21, a new well across the Makoura Stream from HB21 and another new well further west adjacent to the drain would be appropriate. These should be monitored as for the upgradient wells.

(c) Monitoring of wells within the land application area for water quality parameters will not provide effective warning of excessive effects in the receiving waters and should be dispensed with. Monitoring the water level in such wells is appropriate to check the mounding predictions and for on-going irrigation management. The wells recommended above will also serve this purpose, therefore few additional wells are required within the land application area. HB28 is not appropriate, but HB24, HB29 and HB6 are appropriate.

(d) A new well upgradient and two new wells downgradient of the sludge landfill are required.

(e) Wells upgradient and downgradient of the new ponds should be monitored to establish the incremental effects of seepage. HB21 and HB6 are appropriate as upgradient wells. HB9 is appropriate as a downgradient well if it survives the construction process and one further downgradient well is required. Monitoring of these wells should be reviewed after two years if limited effects are apparent.

2.37 As previously noted, Condition 38 should be simplified and clarified.

2.38 Condition 40 should be deleted and replaced with a larger table specifying high and low triggers for specific wells or groups of wells adjacent to receiving waters. As noted above, these cannot be determined until receiving water quality standards are determined.

2.39 Conditions 46 to 48 should be modified to allow for the non-compliance to be confirmed before detailed reporting as to the cause is required. An initial notification of the non-compliance is reasonable. A condition should be inserted that provides for a review of performance and determination of whether the groundwater triggers are reasonable after a period of monitoring data has been collected and assessed against the predictions. That period should not be less than three years to allow for the initial “ramping up” of concentrations.

3. MIXING ZONE

3.1 The Officers Report at 12.4.4(a) discusses mixing zones and recommends that Wardell’s Bridge becomes the point of compliance for when direct discharge to the Ruamahanga River is not occurring. I have no comment on this other than to point out that there are two indirect discharges to the river as a result of groundwater discharges. The first is a diffuse discharge to the river over a several hundred metre length of the river from adjacent to the northern extent of the site to a point about 300 m downstream of the current Pond 3/4. Mixing in the river will occur throughout the length of this discharge. There will then be no significant nutrient addition to the river until the confluence with the Makoura Stream, at which point the effects of drain flows and seepage to the stream will enter the river as a point discharge.

4. EFFECTS ON MAKOURA STREAM

4.1 The Officer’ Report expresses concerns regarding effects on the Makoura Stream, stating (at 12.4.4(f)):

> “*The drain is expected to provide rapid drainage of nutrient-rich groundwater directly to the stream with little or no treatment.”*

4.2 I disagree with this statement. The drain is taking water principally from the gravel aquifer. The relatively much lower permeability of the overlying soil means that very little water will travel through the soil directly to the drain. Effluent cannot enter the groundwater (or the drain) without passing through the surface soil. The effluent will therefore be receiving treatment as it passes through the soil and then is diluted by the groundwater. To talk of nutrient-rich groundwater going directly to the stream is alarmist.

4.3 The Officer's report goes on to say in 12.4.4(f)(b):

> "*It is considered that the nutrient seepage to Makoura Stream could be higher than predicted given the concerns raised about the land disposal. For this reason it is considered appropriate to monitor water quality, stream flow and aquatic life.*"

4.4 For reasons stated above, it is my view that nutrient seepage to the Makoura Stream is likely to be lower than predicted because of the conservatism of the modelling. However, I agree that it is reasonable to monitor the stream water quality to confirm the predictions. I recommend this in my evidence.

Graeme Proffitt
Director, Pattle Delamore Partners Limited
23 February 2009