
in the matter of: the Resource Management Act 1991

and

in the matter of: a number of applications to take and use water from
the Upper Waitaki catchment

Brief of evidence of Robert John Potts on individual applications

Dated: 30 November 2009

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BRIEF OF EVIDENCE OF ROB JOHN POTTS ON INDIVIDUAL APPLICATIONS

INTRODUCTION

- 1 My full name is Robert John Potts.
- 2 My qualifications and experience are set out in my brief of evidence dated the 16th of September 2009.
- 3 I have been engaged by Meridian Energy Limited (*Meridian*) to provide evidence in relation to the individual applications to take and use water from the upper Waitaki Catchment.
- 4 I confirm that I have read the Environment Court's Code of Conduct for expert witnesses and this evidence has been prepared in accordance with that code. I agree to comply with the code's terms. In that regard, I confirm that the statements made in this evidence are within my area of expertise (unless I state otherwise) and I also confirm that I have not omitted to consider material facts which might alter the opinions stated in this evidence.
- 5 In preparing this evidence I have reviewed:
 - 5.1 the supplementary evidence of **Mr Kyle** on behalf of Southdown Holdings Limited, Five Rivers Limited and Killermont Station Limited dated the 15th of October 2009; and
 - 5.2 the evidence of **Mr Gimblett** on individual applications on behalf of Meridian.

SCOPE OF EVIDENCE

- 6 In this evidence I outline recommended amendments to the consent conditions proposed by **Mr Kyle** for Killermont Station Limited, Five Rivers Limited and Southdown Holdings Limited and the reasoning behind the recommended changes.
- 7 I anticipate that the set of conditions proposed by **Mr Kyle** for the above applicants will be standard across all consents, should they be granted (subject to the amendments discussed by Mr Gimblett in his evidence).

PROPOSED CHANGES TO THE CONSENT CONDITIONS SUGGESTED BY MR KYLE

- 8 I have reviewed the consent conditions proposed by **Mr Kyle**. I consider that the proposed conditions will go a long way in

addressing my concerns with the modelling and to minimise the effects on the environment that I described in detail in paragraphs 47 – 56 of my farming systems evidence (dated the 16th of September 2009). However, I am of the opinion that some of the conditions should be further enhanced to ensure that they are able to achieve the environmental objectives desired, and also to make them easier to understand and to measure for compliance.

- 9 I have created Table 1 (in Annexure 1) to highlight points that I think need further attention in order to make the conditions more robust and fit-for-purpose. In the first column are **Mr Kyle's** conditions and in the second column I highlight my concerns or amendments that I consider should be made.
- 10 These concerns have been worked into amended conditions and these will be provided by **Mr Gimblett** in his evidence.

SUMMARY

- 11 The conditions proposed by Mr Kyle in his supplementary evidence for Southdown Holdings, Five Rivers Limited and Killermont Station Limited offer a good starting point for avoiding and mitigating potential water quality effects. However, I consider that a number of amendments to these conditions are required to reflect best agricultural practice and to remove uncertainty with regard to their implementation. A complete set of conditions, incorporating the amendments I am recommending are attached to the evidence of **Mr Gimblett**.

Dated: 30 November 2009

Robert Potts

ANNEXURE 1 – COMMENTS ON CONDITIONS

TABLE 1 - Comments on updated conditions for caucusing / supplementary evidence:

Condition in John Kyle’s supplementary Evidence (Killermont)	Rob Potts’ commentary																														
<p>3. The consent holder shall take all practicable steps to:</p> <p>(a) Ensure that the volume of water used for irrigation does not exceed that required for the soil to reach field capacity; and</p> <p>(b) Avoid leakage from pipes and structures; and</p> <p>(c) Avoid the use of water onto non-productive land such as impermeable surfaces and river or stream riparian strips.</p> <p>(d) If the irrigation system used to distribute water taken in terms of this permit is used to distribute effluent, fertiliser or any other added contaminant, a backflow preventer manufactured in accordance with AS 2845.1 (1998) or the American Society of Sanitary Engineers standards shall be installed within the pump outlet plumbing or within the mainline, to prevent the backflow of water into the bore.</p> <p>(e) The backflow preventer shall be tested to the standard set out in AS 2845.3 (1993) or an equivalent method within one month of its installation and annually thereafter by a suitably qualified person. A test report shall be provided to the Canterbury Regional Council, Attention: RMA Compliance and Enforcement Manager, within two weeks of each inspection.</p>	<p>The modelling work that was undertaken by Aqualinc was quite specific with respect to the application depths and the trigger soil moisture levels. These are not reflected in Condition 3 or any of the other conditions. Without these it will be difficult to achieve the environmental benchmarks proposed by the applicants. Condition 3(a) will require individual farm soil moisture monitoring along with nearby rainfall and evapotranspiration measurement to enable conversion of the soil moisture in the monitored paddock to the paddock that is actually being watered that day. This will need to be recorded to show compliance. Unless there is a reasonable soil moisture deficit, then it may also require the farmer to adjust the application depth of the irrigator or delay irrigation. This is easier to do with some application systems and difficult with others. I recommend that Condition 3(a) be re-worded to include the modelling thresholds for the different soil classes as shown in the extract, below, from the Aqualinc report¹.</p> <p><i>Table 2: Assumed irrigation parameters as a function of soil depth and system type</i></p> <table border="1" data-bbox="958 916 1818 1161"> <thead> <tr> <th>PAW (mm)</th> <th>Application depth (mm)</th> <th>Return interval (day)</th> <th>TSML⁽¹⁾ (% of PAW)</th> <th>UCC⁽²⁾</th> </tr> </thead> <tbody> <tr> <td colspan="5" style="text-align: center;"><i>Centre pivot</i></td> </tr> <tr> <td>30</td> <td>10</td> <td>2</td> <td>50%</td> <td>0.80</td> </tr> <tr> <td>60</td> <td>20</td> <td>4</td> <td>55-60%⁽³⁾</td> <td>0.75</td> </tr> <tr> <td>90</td> <td>20</td> <td>4</td> <td>60%</td> <td>0.75</td> </tr> <tr> <td>130</td> <td>20</td> <td>4</td> <td>60%</td> <td>0.75</td> </tr> </tbody> </table>	PAW (mm)	Application depth (mm)	Return interval (day)	TSML ⁽¹⁾ (% of PAW)	UCC ⁽²⁾	<i>Centre pivot</i>					30	10	2	50%	0.80	60	20	4	55-60% ⁽³⁾	0.75	90	20	4	60%	0.75	130	20	4	60%	0.75
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¹ Irrigation & Drainage Modelling of Upper Waitaki Basin - Aqualinc Groundwater Report – GHD

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<p>Farm Management Standards</p> <p>4. The Nutrient Discharge Allowance for Killermont Station shall be:</p> <table border="1" data-bbox="159 347 920 579"> <thead> <tr> <th>Node Point</th> <th>Total N Discharge from this Farm (kg/year)</th> <th>Total P Discharge from this farm (kg/year)</th> </tr> </thead> <tbody> <tr> <td>Ahuriri groundwater</td> <td></td> <td></td> </tr> <tr> <td>Ahuriri River at Ahuriri Arm of Lake Benmore (periphyton)</td> <td></td> <td></td> </tr> <tr> <td>Ahuriri River at Ahuriri Arm of Lake Benmore (ANZECC)</td> <td></td> <td></td> </tr> <tr> <td>Ahuriri Arm of Lake Benmore</td> <td></td> <td></td> </tr> </tbody> </table> <p>Nutrient losses from the farm shall be monitored at each node point by the consent holder in accordance with condition 5, to verify that nutrient losses remain below the specified allowance.</p>	Node Point	Total N Discharge from this Farm (kg/year)	Total P Discharge from this farm (kg/year)	Ahuriri groundwater			Ahuriri River at Ahuriri Arm of Lake Benmore (periphyton)			Ahuriri River at Ahuriri Arm of Lake Benmore (ANZECC)			Ahuriri Arm of Lake Benmore			<p>As presently drafted condition 4 will only indicate whether the individual farm leaching losses are an issue, as downstream nodes will not be specific for that farm (as there are other farms also feeding drainage water to the downstream monitoring nodes).</p> <p>There needs to be a condition tying each individual farm in with other farms to achieve the targets at the downstream monitoring points. It also needs to be stated that the mitigation required to meet environmental thresholds/triggers can only be implemented among the current applicants and not existing users.</p> <p>I therefore suggest that Condition 4 should include the downstream nodal criteria as well.</p> <p>4. The Nutrient Discharge Allowances <u>from for [farm] Killermont Station and the combined nutrient discharge from all the other properties in the [X Node]</u> shall be:</p> <table border="1" data-bbox="947 691 2112 1233"> <thead> <tr> <th rowspan="2">Node</th> <th colspan="2">Total Discharge from this Farm (kg/year)</th> <th colspan="2">Total Discharge from All Farms in the Node (kg/year and mg/L concentration)</th> </tr> <tr> <th>N</th> <th>P</th> <th>N</th> <th>P</th> </tr> </thead> <tbody> <tr> <td>Modelled Farm Leachate</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Node A</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Node B</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Node C</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Other (More nodes if farm straddles across one nodal point)</td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table> <p>(a) Nutrient losses from [farm] farm shall be such that the combined nutrient losses from all farms contributing to the [X Node] are less than or equal to the combined total discharges in table 2 above.</p> <p>(b) Nutrient losses from [farm] and all the other farms in the [X Node] shall the be monitored</p>				Node	Total Discharge from this Farm (kg/year)		Total Discharge from All Farms in the Node (kg/year and mg/L concentration)		N	P	N	P	Modelled Farm Leachate					Node A					Node B					Node C					Other (More nodes if farm straddles across one nodal point)				
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	<p>at each node point set out in Table 2 by the consent holder and by the group of consent holders <u>[insert list of relevant consent holders]</u> respectively in accordance with Condition 5, to verify that nutrient losses remain below the specified allowances.</p>
<p>5. Monitoring of compliance with the Nutrient Discharge Allowance at each node as identified in condition 4 shall be undertaken by the consent holder by:</p> <p>(a) annual use of OVERSEER, or an approved equivalent, with relevant details from the farm management diary, to estimate annual nutrient losses; and</p> <p>(b) continuous monitoring of nutrient losses using approved monitoring methods and annual analysis of the data to calculate the annual nutrient loss at farm scale.</p>	<p>Continuous monitoring (5b) will require gravity lysimeter installation and monitoring. The number of these, their location in both irrigated and dryland (including hills/mountains) areas (dryland as the NDA is "whole farm"), their methodology for installation and monitoring needs to be outlined.</p> <p>However, I note that during the caucusing meeting that occurred on the 12th of October it was agreed that not every farm would need to be monitored if they met certain modelling conditions. I have provided further information on lysimeters in Attachment 1 and I recommend their methodology for construction is included in a condition.</p> <p>I recommend that condition 5 be reworded to:</p> <p>5. Monitoring of compliance with the Nutrient Discharge Allowance at each node for [farm] as identified in condition 4 shall be undertaken by the consent holder by:</p> <p>a) annual use of OVERSEER, or an approved equivalent, with relevant details from the farm management diary, to estimate annual nutrient losses; and</p> <p>b) continuous monitoring of nutrient losses using approved monitoring methods and annual analysis of the data to calculate the annual nutrient loss at farm scale.</p> <p><u>(a) An "approved method" shall be used to model the nutrient leaching on the farm and to prepare a nutrient budget for the "subject land" for that prior 12 month period, including;</u></p> <p><u>i Records shall be maintained throughout the year of the farm management practices and associated data, for [farm] that will be used as input to the "approved method"; and</u></p> <p><u>ii Predictions shall be made of the farm management practices that will be used for the following 12 month period to provide input data to the "approved method" having regard to the need not to exceed the total</u></p>

Condition in John Kyle's supplementary Evidence (Killermont)	Rob Potts' commentary
	<p style="text-align: center;"><u>Nutrient Allowable Discharge in a node.</u></p> <p><u>(b) A record of the predicted and measured input data, including continuous monitoring of nutrient losses, the calculations undertaken and the calculated nitrate-nitrogen concentration for [farm] shall be:</u></p> <ul style="list-style-type: none"> <u>i prepared by 31 August each year; and</u> <u>ii certified as an accurate record by a suitably qualified independent person; and</u> <u>iii maintained for the property for the duration of the consent; and</u> <u>iv the minimum number of gravity lysimeters (or equivalent) is three replicates of three (nine in total) per soil type or management regime and these shall be located in both irrigated and dryland areas, using methodology outlined in Annexure 2. They shall be sampled on a frequency not less than monthly for total N and total P; except that should modelling (using OVERSEER) be undertaken using soils that are "Highly Developed" and the predicted NDA is less than the on-farm limit in Table 2, Condition 4, then the continuous monitoring is not required; and</u> <u>v. provided to the Canterbury Regional Council, Attention: RMA Compliance and Enforcement Manager, by 30 September each year, or upon request.</u> <p><u>(c) For the purposes of this condition an "approved method" is:</u></p> <ul style="list-style-type: none"> <u>i The most recently published version of 'Overseer' (AgResearch); or</u> <u>ii Any other method approved by the Canterbury Regional Council.</u>

Condition in John Kyle's supplementary Evidence (Killermont)	Rob Potts' commentary
<p>6. The consent holder shall prepare a nutrient budget annually for Killermont Station. A nutrient budgeting tool will be used to determine fertiliser requirements and inputs from non-fertiliser sources of nutrients. Records shall be maintained throughout the year (including farm management practices and associated data) that will be used as input to the approved method of nutrient budgeting.</p>	<p>If the Commissioners choose to adopt the suggested Condition 5 above, then I recommend that Condition 6 be deleted as it would already be adequately covered in Condition 5.</p>
<p>7. The consent holder shall ensure that fertiliser is applied in accordance with 'The Code of Practice for Nutrient Management (With Emphasis on Fertiliser Use) NZFMRA 07'. Fertiliser spreaders shall be tested and calibrated by the consent holder at least annually, and every 5 years by an appropriately qualified independent auditor.</p>	<p>I generally agree with this condition although I note that minor amendments to the condition are provided in Mr Gimblett's evidence.</p>
<p>8. The consent holder shall ensure that all new irrigation infrastructure shall be designed and accredited by a qualified professional, and installed in accordance with the accredited design. The design shall take into account the specific requirements of Killermont Station soil types.</p>	<p>I generally agree with this condition although I note that minor amendments to the condition are provided in Mr Gimblett's evidence.</p>
<p>9. If existing irrigation infrastructure is being used, the consent holder shall obtain an evaluation report prepared by a certified irrigation evaluator. The evaluation shall determine the system's current performance in accordance with the Code of Practice for Irrigation Evaluation 2005. This report shall be obtained within three months of the first exercise of the consent. Any recommendations identified in the report shall be implemented within 12 months from the date of receipt of the report. A copy of the report shall be given to the Canterbury Regional Council: attention the Compliance and Enforcement Manager.</p>	<p>I generally agree with this condition.</p>
<p>10. The consent holder shall ensure that all irrigation infrastructure shall be tested and calibrated by the consent holder once during the first year and then every 5 years in accordance with the Code of Practice for Irrigation Evaluation 2005 by a certified irrigation auditor. The irrigation auditor shall prepare a report outlining its findings and recommendations. Any recommendations identified shall be implemented within 12 months from the date of receipt of the report. A copy of the report shall be given to the Canterbury Regional Council: attention the Compliance and Enforcement Manager.</p>	<p>I generally agree with this condition.</p>

Condition in John Kyle's supplementary Evidence (Killermont)	Rob Potts' commentary
<p>11. The consent holder shall maintain records for Killermont Station in relation to the type of crop, cultivation methods, nutrient inputs and yields. Such records are to be used as inputs to the OVERSEER model.</p>	<p>I recommend re-wording the condition to remove reference to a specific tool so that it reads:</p> <p>The consent holder shall maintain <u>ongoing and complete</u> records for [farm] Killermont Station in relation to the type of crop, cultivation methods, nutrient inputs and yields. Such records are to be used as inputs to the "<u>approved method</u>" <u>as described in Condition 5(c) OVERSEER model</u>, and shall be made available to the Canterbury Regional Council on request.</p>
<p>12. The consent holder shall ensure that nitrogen fertiliser is not be applied to land between 31st May and 1st September in any year.</p>	<p>I generally agree with this condition.</p>
<p>13. The consent holder shall ensure that once every three years soil testing is undertaken to account for all sources of nutrients, including applied effluents and soil reservoirs and shall achieve the following standards:</p> <p>(a) Representative average soil concentrations of Olsen P shall not exceed 25 mg phosphorous per kilogram of soil (dry weight).</p>	<p>I recommend that the sampling be undertaken annually within the months September to November, rather than every three years. Annually is standard practice for soil nutrients whereas 3-yearly is too infrequent should an issue be observed. Other minor amendments are provided by Mr Gimblett.</p>
<p>14. The consent holder shall ensure that all fertiliser brought onto the property and stored in a covered area that incorporates all practicable measures to avoid accidental spillages of fertiliser entering waterways.</p>	<p>I generally agree with this condition although I note that minor amendments to the condition are provided in Mr Gimblett's evidence.</p>
<p>15. The consent holder shall identify within the property a fertiliser filling area, the identified fertiliser area shall be at least 50m from a watercourse, spring or bore and will have no drains that discharge to clean water or that can discharge straight to ground.</p>	<p>I generally agree with this condition although I note that minor amendments to the condition are provided in Mr Gimblett's evidence.</p>
<p>16. If liquid fertilisers are used, the consent holder shall ensure that the fertiliser is stored in a bunded tank to avoid any discharge to surface or groundwater and such that it is also protected from vehicle movements.</p>	<p>I generally agree with this condition but would recommend adding in the requirement for 110% bunding as outlined in the TRP Bylaw No 2 10(g)(i) which states that:</p> <p><i>"a bund with a capacity of at least 110% of the volume of the tank, or where there is more than one tank, at least 110% of the volume of the largest tank; and a stormwater management plan that ensures that no less than 100% of the volume of the largest tank</i></p>

Condition in John Kyle's supplementary Evidence (Killermont)	Rob Potts' commentary
	<i>can be held within the bund at all times"</i>
<p>17. The consent holder shall ensure that a no grazing riparian margin of at least 3 metres shall be maintained adjacent to the irrigation race on the subject property.</p>	<p>I recommend that this condition be reworded to cover all water courses to stop stock from uncontrolled entry into waterways (also refer to explanation for Condition 18 below):</p> <p><i>The consent holder shall ensure that a no grazing riparian margin of at least 3 metres <u>width</u> shall be maintained adjacent to the <u>any</u> irrigation race <u>or surface water body</u> on the subject property.</i></p>
<p>18. The consent holder shall ensure that stock is excluded from entering all surface water bodies on the property by fencing and or other effective means. For water bodies that only flow on a temporary basis, only temporary electric fencing shall be required to exclude stock when water is flowing.</p>	<p>There is a need to fence stock off from the water body regardless of whether water is flowing, as flow may start in the middle of the night following rainfall while stock are in that paddock, or at some time after shifting stock out. Both these scenarios will result in direct entry of nutrients and microbiological contaminants into the water body. I would recommend amending the condition as follows:</p> <p><i>The consent holder shall ensure that stock is excluded from entering all surface water bodies on the property by fencing and/or other effective means, <u>irrespective of whether the water bodies are perennial or ephemeral</u>.</i></p>
<p>19. The consent holder shall ensure that all riparian margins identified in condition 17 are planted with appropriate plant species to achieve nutrient stripping requirements. The planting shall consist of, but not limited to:</p> <p>(a) Trees and shrubs along the outer zone of the riparian planted area; and</p> <p>(b) Sedges, flaxes, indigenous grasses along the stream margin.</p>	<p>My recommended amendments to this condition, due to other recommended changes is:</p> <p>The consent holder shall ensure that all riparian margins to surface water identified in condition 17 <u>16 excluding ephemeral areas and irrigation races</u> are planted with appropriate plant species to achieve nutrient stripping requirements. The planting shall consist of, but not <u>be</u> limited to:</p> <p>(a) Trees and shrubs along the outer zone <u>portion</u> of the riparian planted area; and</p> <p>(b) Sedges, flaxes, indigenous grasses along the stream margin</p>

Condition in John Kyle's supplementary Evidence (Killermont)	Rob Potts' commentary
<p>19(a) To achieve the obligations set out in condition 19 a planting plan shall be prepared by the consent holder, having taken advice from an appropriately qualified ecologist in order to assist in the preparation of this Plan. This plan shall be submitted to the Canterbury Regional Council for certification prior to giving effect to this consent.</p>	<p>I generally agree with this condition although I note that minor amendments to the condition are provided in Mr Gimblett's evidence.</p>
<p>20. The consent holder shall implement a monitoring and maintenance programme to ensure the planting undertaken in condition 19 is successful. The monitoring and maintenance programme shall consist of:</p> <p>(a) Three monthly monitoring for mortality of any plants during the first year post implementation of the farm system, and then six monthly for a period of two years. Any gaps in the vegetation cover will be replaced.</p> <p>(b) Six monthly monitoring for visible woody weeds (eg gorse, broom, pines). Any woody weeds detected within the riparian buffer zone shall be removed. Once full vegetation cover required by condition 20 has been achieved monitoring for woody weeds can be reduced to annually.</p> <p>(c) Monitoring specified in (a) and (b) shall continue until 90% vegetation cover has been achieved.</p>	<p>I generally agree with this condition although I note that minor amendments to the condition are provided in Mr Gimblett's evidence.</p>
<p>Farm Environmental Management Plan (FEMP)</p> <p>21. The consent holder shall prepare for the approval of the Canterbury Regional Council a FEMP as is required to give effect to this consent. The objectives of the FEMP are to:</p> <p>(a) ensure the proposed farm system for Killermont Station can meet the nutrient requirements set out in condition 4 above, and</p> <p>(b) identify and mitigate other farm specific environmental risks that are unique to Killermont Station and the farm management system that is proposed for this property.</p>	<p>There are number of unknown's with this condition. In this respect, how does approval occur? What is the timing for preparation and approval? And what happens if the Canterbury Regional Council does not approve the FEMP? In my opinion, the FEMP should be provided (and agreed to) prior to the consent being implemented and it should state that it specifically relates to the whole property. It also needs to tie in with the downstream node criteria, as added to Condition 4 above. I therefore recommend this condition be reworded to read:</p> <p><i>The consent holder shall prepare for the approval of the Canterbury Regional Council a FEMP as-is-required-to give effect to this consent. <u>The FEMP shall be approved prior to the exercise of this consent and shall apply to the entirety of [farm] (including all land beyond the irrigated areas).</u></i></p> <p><i>The objectives of the FEMP are to:</i></p>

Condition in John Kyle’s supplementary Evidence (Killermont)				Rob Potts’ commentary		
				<p>(a) <i>ensure the proposed farm systems for [farm] can meet nutrient requirements based on its nutrient discharges, and contribute to the achievement of the nutrient requirements for catchment NDA, set out in condition 4 above, and</i></p> <p>(b) <i>identify and mitigate other farm specific environmental risks that are unique to [farm] and the farm management system that is proposed for this property.</i></p>		
22. The FEMP shall set out the approach to farm management, monitoring and mitigation that will be implemented by the consent holder to address the actual and potential effects on water quality arising from nutrient runoff.				I generally agree with this condition.		
23. The FEMP shall include use of OVERSEER or an alternative industry standard to model current and proposed (without additional mitigation) farming systems on Killermont Station to determine the nutrient reduction required, and changes to farm management practices or farm systems.				<p>I am not sure why “without additional mitigation” was included in the condition. I would have thought that if changes are required, then these also need to be modelled. I therefore recommend this condition be reworded to read:</p> <p><i>The FEMP shall include use of OVERSEER or an alternative industry standard <u>an “approved method” as described in Condition 5(c) to model current and proposed (without additional mitigation) farming systems on [farm] to determine the nutrient reduction required and changes to farm management practices or farm systems, [or to remain within the NDA].</u></i></p>		
24. The FEMP shall include a Farm Environmental Risk Assessment (FERA) for the identification and mitigation of site specific environmental risks and triggers unique to Killermont Station.				I generally agree with this condition.		
25. The FEMP for Killermont Station shall include an on-farm monitoring plan describing the location, frequency and parameters to be monitored and the ‘triggers’ if applicable to require a specific mitigation task to be adopted. On farm monitoring and mitigation by the consent holder shall be in general accordance with Table 1 below.				I generally agree with the offered monitoring. The additions/amendments below to Table 1 are to match the other recommendations I have made:		
Table 1 -On Farm Monitoring						
On-	Parameter	Location	Frequency	Measured Parameter	Triggers	Mgt & Mitigation

Condition in John Kyle's supplementary Evidence (Killermont)				Rob Potts' commentary		
Farm						
Soil	Soil Nutrient Testing	All blocks in rotation	<u>Annually within September to November</u>	As per original	As per original	As per original
Soil	Soil compaction survey	Hydrologically connected areas of Manuka Creek, Frosty Gully, and Ahuriri River.	Annually	Surface and subsoil compaction	Compaction, surface capping	Remove compaction with appropriate tool
Effluent	Irrigated effluent nutrient testing	All blocks receiving effluent	Regularly throughout spreading season	Total N, nitrate, ammonia, dissolved reactive phosphorous, BOD		
Effluent	Cumulative effluent application	All blocks receiving effluent	Record Each time effluent is applied	Application depth <u>based on PNRRP Rule 26 Table WQL26 Maximum effluent application depths for discharge on to land</u>	As per original	As per original
Water	Groundwater quality	On farm bore H39/0045	Annually at mid depth of aquifer	Total Nitrogen, nitrate, ammonia, total Kjeldahl nitrogen, total phosphorous, dissolved reactive phosphorous	>1 mg/l nitrate/N	If comparative groundwater analysis from upstream and downstream indicates an exceedance of 1mg/l due to on farm activities, the N application to land should be reduced or stock held withheld for longer until a root cause

Condition in John Kyle's supplementary Evidence (Killermont)				Rob Potts' commentary		
						analysis can be conducted.
Water	Surface water quality	Entry and exit (share with Killermont (WHL)) of Tara Hills race on property boundaries. Exit of Manuka Creek on property boundary (share with Killermont (WHI)).	Monthly for first two years to establish patterns.	Total Nitrogen, nitrate, ammonia, total Kjeldahl nitrogen, total phosphorous, dissolved reactive phosphorus, suspended solids.	No significant decrease in water quality.	If comparative surface water analysis indicates a decrease in surface water quality, the degraded determinands should be identified as these will indicate the likely cause of the Contamination, while a full root cause analysis is undertaken. If the determinands suggest effluent, then effluent irrigation should cease on the implicated pivots. If the analyses indicate stock encroachment, the stock should be withheld from the connected paddocks.
Water	Irrigation application		Annually by the consent holder and 1 in 5 years by an independent	Application uniformity	>80%	Optimisation of the irrigator performance will be performed at the time of testing
Fertiliser	Fertiliser application		Annually by the consent holder and 1 in 5 years by an independent	Application uniformity		Optimisation of the spreader performance will be performed at the time of testing.

Condition in John Kyle's supplementary Evidence (Killermont)				Rob Potts' commentary		
<u>Soil</u>	<u>Application depths</u>	<u>All soil types</u>	<u>Record each time irrigation water is applied</u>	<u>Application depth:</u> <u>Maximum depth to be based on PAWs in Condition 3a;</u> <u>Minimum irrigation frequency to be based on the values in Condition 3a for different PAWs</u>	<u>Trigger soil moisture levels in Condition 3a</u>	<u>Reduce application depths, increase irrigation frequency and maintain the irrigation trigger levels on which drainage modelling was based.</u>
<u>Soil</u>	<u>Soil Moisture</u>	<u>Representative of All soil types</u>	<u>Record each time irrigation water is applied</u>	<u>Soil moisture deficit prior to irrigation – either measured or calculated</u>	<u>Trigger soil moisture levels in Condition 3a</u>	<u>Reduce application depths, increase irrigation frequency and maintain the irrigation trigger levels on which drainage modelling was based.</u>
<u>Soil</u>	<u>Drainage</u>	<u>Representative of All soil types – both irrigated and dryland</u>	<u>Record monthly, or more frequent</u>	<u>Drainage water volume, TN and TP concentration</u>	<u>As per Condition 4</u>	<u>Change farm management practices</u>

Condition in John Kyle's supplementary Evidence (Killermont)	Rob Potts' commentary
<p>26. The consent holder shall engage an expert Environmental Scientist to review the FEMP for Killermont Station prior to its approval by the Canterbury Regional Council. The expert peer reviewer shall be nominated and appointed by agreement between the consent holder and the Canterbury Regional Council. The expert peer reviewer shall prepared a report detailing their findings, and this report shall be part of the documentation submitted to the Canterbury Regional Council.</p>	<p>I generally agree with this condition. Some minor amendments are provided in Mr Gimblett's evidence for Conditions 26 – 28 to cover timing of approval etc.</p>
<p>27. The FEMP for Killermont Station shall be prepared and submitted to the Canterbury Regional Council six months prior to giving effect to this consent.</p>	<p>I generally agree with this condition although I note that minor amendments to the condition are provided in Mr Gimblett's evidence.</p>
<p>28. The consent holder may without changing the objectives of a FEMP seek the approval of the Canterbury Regional Council for any necessary amendment to such a plan on the following terms:</p> <p>(a) The review shall be undertaken in consultation with and be approved by the Canterbury Regional Council.</p> <p>(b) Such review is necessary to give effect to the purpose of the FEMP for Killermont Station.</p>	<p>I generally agree with this condition.</p>
<p>29. The consent holder shall pay all actual and reasonable costs of the Canterbury Regional Council in connection with the review of the FEMP for Killermont Station prior to its approval.</p> <p><i>Advice Note:</i> Council approval will be forthcoming to be within 90 working days of receipt of the Farm Environmental Management plan or plans.</p>	<p>I generally agree with this condition.</p>
<p>30. The FEMP shall apply to Killermont Station and to any subsequent landholdings resulting from the subdivision of that property so long as that landholding relies on this consent.</p>	<p>Ms Appleyard has raised issue with whether the FEMP can legally apply to land that is subdivided off and sold to a third party.</p>
<p>31. The consent holder shall implement the FEMP from the date on which water is abstracted to give effect to this consent and henceforth, adhere to the requirements of the FEMP required by condition 21 for the duration of this consent.</p>	<p>I generally agree with this condition although I note that minor amendments to the condition are provided in Mr Gimblett's evidence.</p>

Condition in John Kyle's supplementary Evidence (Killermont)	Rob Potts' commentary
<p>32. The FEMP for Killermont Station shall include an annual independent auditing process with inputs from the farm operator and other interested parties, such as: the Department of Conservation, Ngai Tahu and New Zealand Fish and Game, to demonstrate that the management practices and mitigation measures planned for the farm are being implemented. The annual auditing process shall include (where appropriate) the following measures:</p> <ul style="list-style-type: none"> (a) Check the storage of silage for visible signs of discharge and destination of silage liquor (b) Check fertiliser storage and filling area (c) Audit of farm OVERSEER nutrient budget and submission of compliance with thresholds (d) Fertiliser spreader and irrigation testing and calibration 1 in 5 years (e) Reconciliation of fertiliser, effluent and soil records with nutrient budget and fertiliser recommendations <p>(f) Submission and brief interpretation of soil, water quality, supplement and machinery calibration tests, including trigger exceedances.</p> <p>(g) Submission of example irrigation schedules.</p> <p>(h) Annual quadrat testing for % ground cover, submission broad findings.</p> <p>(i) Annual soil compaction survey, submission broad findings and remedials.</p> <p>(j) Annual wet weather survey, submission broad findings and remedials.</p> <p>(k) Annual fertiliser spreader and irrigation testing and calibration.</p> <p>(l) Self certification for application of fertiliser according to code of practice</p> <p>(m) Submission of proof of "approved handler" status.</p>	<p>I agree with the intent of this condition but recommend the following changes to clarify roles of other parties, and to include stock number monitoring as this is an important part of the modelling. Further discussion on recommended changes to this condition is provided in the evidence of Mr Gimblett.</p> <p><i>The FEMP for [Farm] shall include an annual independent auditing process with inputs from the farm operator and other interested parties, such as: the Department of Conservation, Ngai Tahu and New Zealand Fish and Game, to demonstrate that the management practices and mitigation measures planned for the farm are being implemented.</i></p> <p><u><i>The annual auditing process shall incorporate inputs from the farm operator and any ongoing consultation with interested parties.</i></u></p> <p><i>The annual auditing process shall include (where appropriate) the following measures:</i></p> <ul style="list-style-type: none"> <i>(a) <u>Checks of the storage of silage for visible signs of discharge and destination of silage liquor</u></i> <i>(b) <u>Checks of the fertiliser storage and filling area/s for visible signs of discharge</u></i> <i>(c) <u>Auditing of the farm OVERSEER (or otherwise approved model) nutrient budget and submission of compliance with thresholds</u></i> <i>(d) <u>Records of Fertiliser spreader and irrigation testing and of calibration at least once every 1 in 5 years</u></i> <i>(e) <u>Reconciliation of fertiliser, effluent and soil records with nutrient budget and fertiliser recommendations</u></i> <i>(f) <u>Records of stock numbers and movements on and off the property</u></i>

Condition in John Kyle's supplementary Evidence (Killermont)	Rob Potts' commentary
	<p>(gf) <i>Submission and brief interpretation of soil, water quality, supplement and machinery calibration tests, including trigger exceedances.</i></p> <p>(hg) <i>Submission <u>Review</u> of example irrigation schedules.</i></p> <p>(ih) <i>Annual quadrat <u>quadrant</u> testing for % ground cover, submission and reporting of broad findings.</i></p> <p>(ji) <i>An <u>Annual</u> soil compaction survey, submission and reporting of broad findings and any remedial actions</i></p> <p>(kj) <i>An <u>Annual</u> wet weather survey, submission and reporting of broad findings and any remedial actions</i></p> <p>(k) <i>Annual fertiliser spreader and irrigation testing and calibration.</i></p> <p>(l) <i>Self certification for application of fertiliser according to code of practice</i></p> <p>(m) <i>Submission of <u>Proof</u> of "approved handler" status.</i></p>
<p>33. The annual auditing process shall include the preparation of a report to be submitted to the Canterbury Regional Council. The consent holder shall engage an expert Environmental Scientist to review the report prior to its submission to the Canterbury Regional Council. The peer review documentation shall be submitted to the Canterbury Regional Council as part of the annual audit report.</p>	<p>I generally agree with this condition although I note Mr Gimblett is recommending minor amendments.</p>

Condition in John Kyle's supplementary Evidence (Killermont)	Rob Potts' commentary
<p>Sub-catchment Monitoring and Mitigation</p> <p>34. Prior to the exercise of this consent the consent holder shall prepare a sub catchment monitoring plan with respect to the necessary off farm monitoring as outlined in the Table 2 below. This plan may be prepared in collaboration with other consent holders in the sub catchment in order to better achieve integrated management. The plan shall specify any pre-implementation monitoring required to confirm baseline conditions, and the required frequency of post implementation monitoring. It shall specify an appropriate methodology for conducting all off farm monitoring. This monitoring plan shall be reviewed and confirmed as being appropriate to meet its purpose by an appropriately qualified Environmental Scientist, prior to being submitted to Canterbury Regional Council for certification. Once certified, the consent holder shall implement this plan and shall continue the monitoring for the duration of the consent.</p>	<p>I generally agree with this condition although I note Mr Gimblett is recommending minor amendments.</p>
<p>Table 2</p>	<p>In Table 2, I recommend that the proposed change to the frequency of the groundwater monitoring from quarterly to twice per year does not reduce after 2 years. This is because there is likely to be seasonal fluxes coming through that would not be observed at 6-monthly intervals and it is also unlikely that the soils will be developed within 2 years, or that full irrigation has been implemented.</p>
<p>35. The consent holder shall be levied on an annual basis in order to meet the costs inherent in conducting the Upper Waitaki Catchment monitoring outlined in Table 3 below. This monitoring may be carried out (i) on a collective basis by a suitable body appointed by all consent holders in the Upper Waitaki Catchment and approved by the Canterbury Regional Council or (ii) by the Canterbury Regional Council. All necessary costs associated with this monitoring shall be met by the consent holders on a proportional basis.</p> <p><i>Advice Note:</i> <i>Where costs are to be met on a proportional basis, this means that an individual consent holder shall meet costs according to a ratio which accounts for the proportion of land irrigated by that consent holder as a percentage of all land irrigated in the Upper Waitaki Catchment.</i></p>	<p>No Comment</p>
<p>Table 3</p>	<p>No Comment</p>

Condition in John Kyle's supplementary Evidence (Killermont)	Rob Potts' commentary
<p>36. If the monitoring undertaken in accordance with the sub catchment monitoring plan in condition 34 indicates that the nodal readings of Nitrogen and Phosphorous have reached 75% of the value specified in table 4, then the sampling frequency at that site shall be increased to weekly.</p>	<p>I generally agree with this condition but with notification to Environment Canterbury that the trigger has been exceeded and weekly monitoring has commenced (wording is provided in the evidence of Mr Gimblett).</p>
<p>37. If the increased monitoring undertaken in accordance with condition 36 determines that the average of any five of those consecutive weekly results exceeds 75% of the value specified in table 4 then a report shall be prepared by an appropriately qualified Environmental Scientist and provided to the Canterbury Regional Council within one month of the receipt of such results. The purpose of the report shall be determine whether or not the cause of the exceedance is likely to be because of natural influences, or land use practices. The report shall include an assessment of:</p> <ul style="list-style-type: none"> (a) the likely reasons for the observed increase in nutrient levels, including likely source and contributors (natural sources, or land use influences); (b) the likelihood that the threshold in Table 4 will in fact be exceeded by land use practices; and (c) shall identify the best practicable remedial or management measures considered necessary to ensure the threshold is not exceeded by land use practices. 	<p>I generally agree with this condition but have concerns over the inclusion of land use practices and natural influences as the Applicants' Consultants have stated that these current set of applications will be responsible for meeting the subcatchments and lake thresholds, with no finger pointing at others. An allowable leaching figure has been calculated that uses up all the natural buffering capacity in the catchment that may have been able to assimilate natural variability in nutrient fluxes, thus natural variations need to be accounted for by the Applicants and remediated, if necessary. I agree that it is important to understand whether the exceedance is natural or as a result of land use practices as this may influence the nature of the remediation required.</p> <p>Suggested wording is:</p> <p><i>If the increased monitoring undertaken in accordance with condition 36 determines that the average of any five of those consecutive weekly results exceeds 75% of the value <u>threshold limit specified in table 4</u> then a report shall be prepared by an appropriately qualified <u>independent</u> Environmental Scientist and provided to the Canterbury Regional Council within one month of the receipt of such results. <u>These results shall all be completed and available to the Canterbury Regional Council within one month of the 5th weekly sample being taken.</u> The purpose of the report shall be determine whether or not the cause of the exceedance is likely to be because of natural influences, or land use practices.</i></p> <p><i>The report shall include an assessment of:</i></p> <ul style="list-style-type: none"> <i>(a) the likely reasons for the observed increase in nutrient levels, including likely source and contributors (natural sources, or land use influences); <u>and</u></i> <i>(b) the likelihood that the threshold <u>limit/s</u> in Table 4 will in fact be exceeded, by land use practices; and</i>

Condition in John Kyle’s supplementary Evidence (Killermont)	Rob Potts’ commentary																									
	<p><i>(e) — The report shall also identify the best practicable remedial or management measures considered necessary to ensure the threshold <u>limit/s</u> is not exceeded and the timeframes within which those measures shall be implemented by land use practices.</i></p>																									
<p>Table 4</p>	<p>Table 4 needs to cover all relevant downstream nodes. It also needs to include an immediate way of determining whether a threshold or trigger has been exceeded. I do not believe this can be achieved with the annual mass loading method as a full year of results are needed, particularly if there are seasonal fluxes. I therefore recommend that a concentration be included.</p> <table border="1" data-bbox="1032 724 2145 1023"> <thead> <tr> <th data-bbox="1032 724 1444 810"><u>Node</u></th> <th colspan="2" data-bbox="1444 724 1789 810"><u>Node Thresholds (kg/year)</u></th> <th colspan="2" data-bbox="1789 724 2145 810"><u>Node Thresholds (mg/L concentration)</u></th> </tr> <tr> <td data-bbox="1032 810 1444 863"></td> <th data-bbox="1444 810 1610 863"><u>N</u></th> <th data-bbox="1610 810 1789 863"><u>P</u></th> <th data-bbox="1789 810 1964 863"><u>N</u></th> <th data-bbox="1964 810 2145 863"><u>P</u></th> </tr> </thead> <tbody> <tr> <td data-bbox="1032 863 1444 916"><u>Node A</u></td> <td data-bbox="1444 863 1610 916"></td> <td data-bbox="1610 863 1789 916"></td> <td data-bbox="1789 863 1964 916"></td> <td data-bbox="1964 863 2145 916"></td> </tr> <tr> <td data-bbox="1032 916 1444 968"><u>Node B</u></td> <td data-bbox="1444 916 1610 968"></td> <td data-bbox="1610 916 1789 968"></td> <td data-bbox="1789 916 1964 968"></td> <td data-bbox="1964 916 2145 968"></td> </tr> <tr> <td data-bbox="1032 968 1444 1023"><u>etc</u></td> <td data-bbox="1444 968 1610 1023"></td> <td data-bbox="1610 968 1789 1023"></td> <td data-bbox="1789 968 1964 1023"></td> <td data-bbox="1964 968 2145 1023"></td> </tr> </tbody> </table>	<u>Node</u>	<u>Node Thresholds (kg/year)</u>		<u>Node Thresholds (mg/L concentration)</u>			<u>N</u>	<u>P</u>	<u>N</u>	<u>P</u>	<u>Node A</u>					<u>Node B</u>					<u>etc</u>				
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Condition in John Kyle's supplementary Evidence (Killermont)	Rob Potts' commentary
<p>38. If the monitoring and reporting undertaken in accordance with condition 37 determines that the consent holder is either solely or partly responsible for the increase in observed nutrient levels measured in the sub catchment, the consent holder shall be responsible for implementing (either wholly or partly, depending on the degree of culpability) the remedial measures outlined in the report prepared in accordance with condition 37(c). Monitoring shall continue on a weekly basis in accordance with condition 36 until such time as the results of that monitoring show that the nodal readings of Nitrogen and Phosphorus have returned to level below 75% of the value specified in table 4.</p>	<p>As outlined above for Condition 37, the responsibility for remediation lies with the consent holder as purported in evidence. Suggested wording is:</p> <p><i>If the monitoring and reporting undertaken in accordance with condition 37 determines that the consent holder is either solely or partly responsible for the <u>an increase above 75% of the threshold limit/s</u> in observed nutrient levels measured in the sub catchment, the consent holder shall be responsible for implementing (either wholly or partly, depending on the degree of culpability) the remedial measures outlined in the report prepared in accordance with condition 37(e) <u>and for providing notification to the Canterbury Regional Council of the implementation of those measures</u>. Monitoring shall continue on a weekly basis in accordance with condition 36 until such time as the results of that monitoring show that the nodal readings of Nitrogen and Phosphorus have returned to <u>a level/s</u> below 75% of the value <u>threshold limit/s</u> specified in table 4.</i></p>
<p>39. If the monitoring undertaken in accordance with the sub catchment monitoring plan in condition 34 indicates that the nutrient values outlined in table 4 have been exceeded then:</p> <ul style="list-style-type: none"> (a) The sampling frequency at that site shall be increased to weekly and; (b) If the average of any five of those consecutive weekly results exceeds the thresholds in table 4 above then a report shall be prepared by an appropriately qualified Environmental Scientist and provided to the Canterbury Regional Council within one month of the receipt of such results. The report shall include an assessment of the likely reasons for the observed increase in nutrient levels, including likely source and contributors. 	<p>I generally agree with this condition although I note that minor amendments to the condition are provided in Mr Gimblett's evidence.</p>

Condition in John Kyle's supplementary Evidence (Killermont)	Rob Potts' commentary
<p>40. If the monitoring and reporting undertaken in accordance with condition 39(b) determines that the consent holder is either solely or partly responsible for the threshold exceedance then:</p> <p>(a) the annual allocation of water to the consent holder shall reduce by 5% for the irrigation season that is current or which commences subsequent to the identification of the exceedance; and</p> <p>(b) the consent holder shall prepare on either a collective or individual basis a Remedial Action Plan, for the certification of Canterbury Regional Council.</p>	<p>Again, the responsibility for meeting the thresholds lies with the consent holder as indicated by a number of witnesses.</p> <p>Although I do not consider a reduction in allocation is a mitigation tool (unless the reduction is significant enough to result in stock numbers being reduced), it may end up in less plant growth nutrient uptake and less efficient irrigation. However, it is seen as a "stick" or encouragement to ensure that water quality is maintained below the specified thresholds. However, a 5% reduction of the annual allocation is not immediate enough and may not be a disincentive, as the consent holder will continue and perhaps shut off irrigation a little earlier in the season, and climate variables may mean that the full allocation of 6,000 m³/ha/year may not be required during a particular season/year. In addition, the exceedance may occur at the same time every season due to annual fluxes, thus the 5% reduction will not mitigate this. I recommend that the allocation reduction be based on the weekly volume. This would also be consistent with the derogation approvals provided by Meridian</p> <p>Recommended changes are:</p> <p><i>If the monitoring and reporting undertaken in accordance with condition 39(b) <u>shows</u> determines that the consent holder is either solely or partly responsible for the a threshold limit exceedance then:</i></p> <p>(a) <i>the annual <u>weekly</u> allocation of water to the consent holder shall reduce by 5% for the irrigation season that is current or which commences subsequent to the identification of the exceedance; and</i></p> <p>(b) <i>the consent holder shall prepare on either a collective or individual basis <u>a Remedial Action Plan, for the certification of Canterbury Regional Council within 3 months of the exceedance occurring.</u></i></p>

Condition in John Kyle's supplementary Evidence (Killermont)	Rob Potts' commentary
<p>41. The Remedial Action Plan shall prescribe the methods for altering and/or adapting farm practices on one or more of the farms within the affected sub catchment to ensure that the exceedance in water quality standards at the affected site are returned to a level that is below the thresholds identified in table 4. The Remedial Action Plan shall be verified by an appropriately qualified Environmental Scientist prior to being submitted to Canterbury Regional Council for certification.</p>	<p>I generally agree with this condition although I note that minor amendments to the condition are provided in Mr Gimblett's evidence.</p>
<p>42. Once the Remedial Action Plan prepared in accordance with conditions 40 and 41 has been certified by the Canterbury Regional Council, the consent holder shall implement any necessary changes to on farm management practices required by the Remedial Action Plan. The consent holder shall update their FEMP (if necessary) to include the changes in farm management to be adopted in accordance with condition 41.</p>	<p>I generally agree with this condition although I note that minor amendments to the condition are provided in Mr Gimblett's evidence.</p>
<p>43. The consent holder shall continue to monitor water quality at the affected site on a weekly basis, and if the monitoring shows that the threshold limits in table 4 are not exceeded for a period of 2 consecutive months then the 5% reduction can be lifted and weekly monitoring can cease. If this monitoring indicates that the thresholds in table 4 continue to be exceeded the annual allocation of water to the consent holder shall reduce by an additional 5% for every week that the thresholds are exceeded until monitoring shows that these thresholds are achieved.</p>	<p>I generally agree with this condition although I note that minor amendments to the condition are provided in Mr Gimblett's evidence.</p>
<p>44. Should the measures undertaken in accordance with condition 43 fail to achieve compliance with the thresholds in table 4, the Canterbury Regional Council shall review the consent in terms of section 128 of the Resource Management Act 1991.</p>	<p>I generally agree with this condition although I note that minor amendments to the condition are provided in Mr Gimblett's evidence.</p>

ANNEXURE 2

LYSIMETERS AND THEIR RELEVANCE TO COMPLIANCE MONITORING ACROSS THE MACKENZIE BASIN

- 12 In my farming systems evidence² I discussed the need for an effective and efficient monitoring regime and highlighted the recommendations of other expert witnesses on the importance of monitoring. For example:
- 12.1 in Paragraph, 44 I stated that adoption of best management practices (BMPs) will ensure efficient and reasonable use of water and at the same time help mitigate potential adverse effects as a result of the change in the farming systems;
 - 12.2 in Paragraph 58, I concurred with Dr Snow's point in Paragraph 49 of her evidence, that should consents be granted, the irrigators should be required to ensure that BMPs are followed and that consent conditions should require adequate monitoring to ensure that those practices are adhered to;
 - 12.3 in Paragraph 59, I noted that Dr's Bright and Robson's joint statement of evidence proposed a comprehensive monitoring programme in Table 12 and how Dr Robson's evidence also proposed similar measures in Table 3 and 4 of her evidence.
- 13 I also concluded that if consents are granted and the proposed monitoring regime is implemented, this will go a long way towards addressing my concerns regarding inadequacies in water quality modelling.
- 14 To monitor the extent of nutrient leaching and/or drainage, it was agreed in the caucusing meeting³ held on 12 October 2009 that lysimeters will be used.
- 15 It was also agreed that better quality results can be obtained by paired sampling on representative farms and soil types. All farms fitting into this category would have to agree to the results coming from that "representative farm". Farms would be levied to pay for this monitoring.

² Potts, R. J. (2009) "Brief of evidence (Farming Systems) of Robert John Potts in the matter of the a number of applications to take and use water from the Upper Waitaki catchment". Unpublished.

³ Nutrient Caucus (Attended by - Brent Clothier, Matt Ryan, Ross Monaghan, Rob Potts, Val Snow, Melissa Robson)

Brief Description of Lysimeters

- 16 Unlike laboratory experiments, lysimeters generally simulate actual field conditions. Lysimeters may be classified according to different criteria such as type of soil block used (monolithic or reconstructed), drainage (drainage by gravity or vacuum or a water table may be maintained), or weighing or non-weighing lysimeters. Figure 1 shows a schematic of the lysimeters at the Lincoln University Farm.
- 17 I propose that the lysimeters that will be used in this monitoring work be similar to those that have been used at Lincoln University.
- 18 I have conferred with the applicant's experts (Aqualinc) and we are in agreement over the methodology for the lysimeters. The standard lysimeters will be manufactured 700 - 750 mm deep plastic drums (or other practical material) and 500 mm in diameter. On land with large boulders or stones, larger lysimeters, up to 1.2 m in diameter, will be installed.
- 19 Typically, each lysimeter will have a collection area, 250 mm from the bottom and this is separated from the soil by a geofabric supported on a grate. Two hoses; air inlet and collection, run to the soil surface and leachate is collected by either gravity or a vacuum pump. An area slightly larger than the lysimeters is dug out during installation to minimise the disturbance of the soil and care is taken not to mix the soil profile.

Intensity of Use across the Mackenzie Basin

- 20 As I pointed out in Paragraph 14 and 15 above, it was agreed that lysimeters should be used for monitoring.
- 21 The number of lysimeters, their location in both irrigated and dryland (including hills/mountains) areas, their methodology for installation and monitoring were not specifically discussed during the caucusing.
- 22 The minimum number of gravity lysimeters (or equivalent) is three replicates of three (nine in total) per soil type or management regime and these are to be located in both irrigated and dryland areas, using methodology outlined in paragraphs 18 and 19 above. Sampling frequency should be not less than monthly for total N and total P.

Figure 1: Field Lysimeters at Lincoln University Farm (Source: Lincoln University – Centre for Soil and Environmental Quality)

