IN THE MATTER	**of the Resource Management Act 1991 and The Environment Canterbury (Temporary Commissioners and Water Management) Bill 2010**
AND	
IN THE MATTER	**of the Hearing of Submissions on the Proposed Land and Water Regional Plan**
BY	**Irrigation New Zealand Incorporated**
	Submitter
TO	**COMMISSIONERS OF THE CANTERBURY REGIONAL COUNCIL**
	Local authority

BRIEF OF EVIDENCE OF ANDREW ROBERT CURTIS ON BEHALF OF IRRIGATION NEW ZEALAND INCORPORATED

Dated: 8th March 2013

INTRODUCTION

Qualfications and Experience

1. My name is Andrew Curtis. I am the Chief Executive of Irrigation New Zealand Incorporated (INZ). I hold an upper second class BSc(Hons) degree (Physical Geography and Environmental Biology) from Oxford Brookes University and a PGDip (Environmental Management) from the University of Surrey. I also hold a New Zealand National Certificate in Irrigation Evaluation, and Massey University Certificates of Completion in Sustainable Nutrient Management in New Zealand Agriculture for both Intermediate and Advanced courses.

2. Alongside the advocacy role I fulfil for INZ I also provide a technical expert one and it is in this capacity I am presenting my evidence. My experience and knowledge of irrigation in NZ is considerable, in terms of both land uses (pastoral through horticulture and viticulture) and irrigation systems (drip-micro and spray). Whilst at INZ I have co-authored the irrigation industry code of practices and standards for design, installation and evaluation and I have also co-authored the irrigation operator and manager training resource. I was also the owner operator of a vineyard whilst in Hawke's Bay and successfully managed both a frost protection and drip irrigation system for eight years.

3. I have much recent experience of water policy development. For example, as a representative of INZ I have been actively involved in the Land and Water Forum process - plenary, small group and water quality management infrastructure and water allocation working groups since 2009. The multi-stakeholder water allocation working group explored a number of topics including, the nature of rights, allocation methods (administrative through market), over-allocation and water accounting.

4. My previous New Zealand (NZ) work experience includes six years employment for Hawke's Bay Regional Council, initially as an extension officer with a focus on irrigation and then as Strategic Advisor – Water. In this role I helped lead the development of the Hawke's Bay regional water strategy. This had a strong non-

regulatory focus (including water storage, water user groups, water metering) to complement and better enable traditional regulatory pathways.

5. Prior to my employment with Hawke's Bay Regional Council I was employed in a variety of horticultural (in NZ) and a mixed cropping/sheep and beef (United Kingdom) orchard and farm management roles.

(a) Code of Conduct

6. I have read the Environment Court Code of Conduct for expert witnesses and agree to comply with it.

7. I confirm that I have not omitted to consider materials or facts known to me that might alter or detract from the opinions I have expressed.

SCOPE OF EVIDENCE

8. My evidence provides additional technically-based observations to rebut some of the conclusions reached by Ms Dewes in her evidence for Fish & Game.

9. My evidence will cover the following matters:

   (A) *Water Metering Uptake (paragraph 77)*

   (B) *Cost of Achieving 'Active Irrigation' (paragraph 84)*

   (C) *Soil Moisture Deficit Irrigation & 'Active Irrigation' (paragraph 23, 80 & 84)*

   (D) *Rainfall Drainage*

   (E) *The Use of OVERSEER for Irrigated Agriculture (paragraph 33 & 189-205)*

(A) Water Metering Uptake

10. The evidence of Ms Dewes in paragraph 77 understates the actual uptake and more importantly the good will towards water metering in Canterbury. Whilst implementation has been slower than desired, the numbers given in her evidence are not a true indication of uptake to date. "There are 8,390 takes in Canterbury equating to approximately 11,000+ meters. Of this there are 5,875 takes over 20l/s (4,855 groundwater and 1,020 surface water). There are presently 3,850 takes with meters (65%) and 2,025 without meters (35%). Of the takes without meters 70 are industrial, 135 are TLA's, 600 have been granted temporary waivers until 30th June 2013, 770 are on the industry register to be installed before the end of this water year, and 450 are under investigation. By the start of the 2013-14 irrigation season it is estimated 90% of the total number will be installed"[1]. This is an impressive uptake rate.

11. The logistics of installing 5,875 takes with water meters (estimated at 7,000+ in total) in two years has resulted in capacity and administrative challenges for the irrigation service industries, and also for the regulator.

12. The focus of water metering in Canterbury has been on quality installations with quality equipment - providing quality data. Unfortunately quality water metering is not as simple as 'sticking on a water meter' – site specific conditions have to be understood and provided for.

13. The market created by the water measurement regulation also has problematic characteristics for irrigation services industries. An initial logistical boom (75% of meters fitted within two years) followed by a far lesser amount of new and on-going replacements.

(B) Cost of Achieving 'Active Irrigation'

14. Ms Dewes evidence as to the implementation costs of 'Active Irrigation' is simplistic. I refer you to the evidence in paragraph 84. Achieving 'Active Irrigation', from flood to spray for example, is not solely related to upgrading an irrigation

[1] *Colin Bird, Environment Canterbury pers comm*

system and its associated farm infrastructure. The nature of the water supply to the irrigation (water take and distribution system characteristics) must also be considered. IrrigationNZ[2] has estimated that over $2billion of infrastructure investment (modernisation of the distribution systems and associated water storage) will be required in the Canterbury region to deliver 90%+ water supply reliability – the generally accepted level of certainty required.

15. Reliability, as recognised in the Canterbury Water Management Strategy, is the key driver for both environmental improvements and water use efficiency gains. It gives certainty and thus allows investment in and operation of precision technologies. Reliability also provides for a full diversity of land use, subject to land physical and climatic limitations. For example poor water supply reliability at critical growth stages means the risk of crop failure from water stress is high and thus the economic viability of growing the crop is compromised.

16. It is difficult to place a price per hectare on this, as the actual costs will be zone and scenario specific. However as a 'typical' example, the Valetta scheme in Mid Canterbury has recently piped its open races. This when combined with the new buffer ponds now allow for an 'on demand' reliable water supply. The total cost was $30million or $6,800ha to the incumbent shareholders. The selling of new water created through efficiency gains (piping) has subsidised the cost to the incumbent.

17. The nexus between limiting land use change and a reliable water supply to allow investment in improved performance is crucial. Incumbents are reliant on selling new water from efficiency gains which in turn requires land use change. Without this the economic viability of creating reliability and thus improved performance and land use diversification is compromised – not affordable.

18. In summary the doubling ($14,000 - 18,000) of Ms Dewes assumptions of $8,800ha would provide a realistic cost for universally achieving 'Active Irrigation'.

[2] *John Donkers, IrrigationNZ pers comm*

(C) Soil Moisture Deficit Irrigation & Active Irrigation

19. When designed, installed, operated and maintained well, irrigation will optimise plant growth throughout the growing season and also from season to season. Well-managed irrigation replaces the soil water used by plants (the soil moisture deficit) once a predefined trigger has been reached. The trigger and amount applied is defined by soil water holding characteristics, soil temperature, the crops' physiological characteristics (water use and drought tolerance) and climatic conditions (evapotranspiration and rainfall).

20. Ms Dewes notes at paragraph 80 of her evidence that if "active water management" is selected in OVERSEER, it is assumed that only 5% of the applied water is not used efficiently. Firstly this statement cannot be proven as the size of the impact is yet to be determined (see paragraph 41). Secondly the assumptions that OVERSEER makes through the selection of its 'Active Irrigation' option are likely not realistic.

21. Table 1 is taken from a New Zealand (NZ) based Lincoln Environmental study[3] and highlights the range of typical losses from irrigation. The NZ data is consistent with international findings. From this it is obvious that a range of factors drive efficiency, and that when each of the factors that drive efficiency (leaks, evaporation, wind drift, canopy interception, surface run-off, system uniformity (evenness of application), excessive application depths and application rates in excess of the soil's infiltration rate) are combined, 95% application efficiency is unrealistic.

Table1: The Drivers of irrigation Application Efficiency

Loss component	Range	Typical
Leaking pipes	0-10%	0-1%
Evaporation in the air	0-10%	<3%
Wind blowing water off target (drift)	0-20%	<5%
Interception (canopy losses)	0-10%	<5%
Surface runoff (spray irrigation)	0-10%	<2%
Uneven application and/or excessive application depths and rates	5 - 80%	5 - 30%

[3] *Lincoln Environmental 2002. Irrigation Efficiency Enhancement - Stage 1. Report No 4452/16a*

22. Table 2 is taken from a 2011 University of Nebraska 'know how know now' extension sheet on 'Irrigation efficiency and uniformity, and crop water use efficiency'[4]. This extension sheet has been peer reviewed. The University of Nebraska, Lincoln is one of the world's leading irrigation research facilities and is supported by two of the five main centre pivot manufacturers (T-L and Valley). These typical values for well-designed and well-managed irrigation systems again demonstrate that 95% application efficiency is not realistic.

23. Therefore, even with the introduction of precision technologies, such as Variable Rate Irrigation alongside soil moisture monitoring, it would be extremely unlikely 95% application efficiency would be achieved. It should be noted the industry benchmark, from the IrigationNZ Design Standards[5] is 80% for application uniformity and on a per system basis for application efficiency.

Table 2. Typical "*typical*" application efficiencies for well-designed and well-managed irrigation systems.

Irrigation System	*"Typical" Application Efficiency (%)*
Sprinkler Irrigation Systems	
LEPA	80 - 90
Linear move	75 - 85
Center pivot	75 - 85
Traveling gun	65 - 75
Side roll	65 - 85
Hand move	65 - 85
Solid set	70 - 85
Surface Irrigation Systems	
Furrow (conventional)	45 - 65
Furrow (surge)	55 - 75
Furrow (with tailwater reuse)	60 - 80
Basin (with or without furrow)	60 - 75
Basin (paddy)	40 - 60
Precision level basin	65 - 80
Microirrigation Systems	
Bubbler (low head)	80 - 90
Microspray	85 - 90
Micro-point source	85 - 90
Micro-line source	85 - 90
Subsurface drip	> 95
Surface drip	85 - 95

[4] *University of Nebraska Lincoln, Extension 2011. Irrigation Efficiency and Uniformity, and Crop Water Use Efficiency EC732*
[5] *IrrigationNZ 2012. Design Standards for Piped Irrigation Systems in New Zealand*

24. The issue of the ‘Active Irrigation’ option within OVERSEER has been discussed with the OVERSEER owners and the primary industry. As a result there is now a protocol that clearly states the ‘Active Irrigation’ option within OVERSEER should not be used. The evidence of Ms Dewes in paragraphs 23 and 84 demonstrating 30 - 50% leaching reductions is therefore unsound.

25. In paragraph 80 Ms Dewes states that water use may be up to 33% lower with Variable Rate Irrigation. This statement is misleading. Hedley[6] clearly stated that water savings were between 4 - 7% for simulated comparisons made between 2004 - 2009. More recent field studies have indicated savings of between 9 - 20%. The level of savings is very much linked to the degree of soil variability. Variable Rate Irrigation is not a silver bullet - it is a mitigation that will help provide solutions for specific cases.

26. Ms Dewes also refers to soil moisture monitoring and specifically tensiometers as part of ‘Active Irrigation’. Soil moisture monitoring is becoming commonplace in Canterbury, particularly for pastoral farmers (soil moisture monitoring is more suited to semi-permanent pasture rather than annual cropping because of the practical issues cultivation creates)[7] and with the advent of telemetry for water meters (live data can be sent through to the home computer or web), however not with tensiometers. It is common knowledge tensiometers are not well suited to stony soils as they rely on good instrument to soil contact to effectively operate – to create the tension. They are however commonly used in Australia as they are well suited to their homogeneous silt and clay loam soil types.

27. Again, soil moisture monitoring is not a silver bullet - it is a mitigation that will help provide solutions for specific cases. Other scheduling options include water budgets and crops models. Simple rules of thumb have also been developed by experts at Landcare research. For example the electric fence standard method works well in the Downlands of South Canterbury where a diversity of soil types and depths makes traditional soil monitoring or water budget methods extremely complex – slope and aspect variations have to be added to soil type variability.

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[6] *Hedley 2010. Spatial irrigation scheduling for variable rate irrigation. Proceedings of the New Zealand Grassland Association 72*

[7] *David Boraman, Boraman Consultants pesr comm*

(D) Rainfall Drainage

28. Irrigation creates more rainfall drainage by increasing the time that soil water is at field capacity. As it frequently rains during the irrigation season in NZ, particularly on the shoulders, the incidence of rainfall drainage can be significant.

29. This fact has been included within many of the developing scheme modelling considerations. For example the Central Plains Water development returns water to the environment through the introduction of alpine water – directly converting groundwater to surface takes and increased land drainage losses from irrigation (application efficiency and rainfall drainage)[8]. The increased incidence of rainfall drainage from irrigation has also been used to allocate water in Canterbury. Examples of this are given in the evidence of Mr McIndoe.

30. There are strategies to reduce rainfall drainage, such as engaging deficit irrigation. This means not filling up to field capacity when you irrigate and therefore leaving room for rain. Such an approach creates risk as it reduces the numbers of days of before a plant is impacted upon by water stress. This is a workable strategy during the shoulders of the irrigation season when evapotranspiration rates are lower and it is possible to 'catch up' if a period of unusually dry weather occurs. Obviously an irrigation system with a short return period (1 -3 days) is required for this. However, it is not a feasible strategy at peak. Irrigation system capacity (the maximum amount of water that can be applied per day) has an economic optimum beyond which it is not viable to design. Water allocation also has to be considered in this, as providing for higher system capacity potentially ties up water unnecessarily (particularly for flow rate based allocations from surface water).

(E) OVERSEER and Irrigation

31. In its present form it would create much risk to use OVERSEER as a nutrient (nitrate) allocation mechanism for irrigated agriculture. In summary the model is not capable of accounting for the wide range of drainage characteristics displayed

[8] *Environment Canterbury 2012 Technical Summary Surface Water Quantity - Scenario 2 http://ecan.govt.nz/publications/Plans/selwyn-tewaihora-tech-summary-hydrology-310512.pdf*

by irrigation systems. This is important as it is the drainage model that drives nutrient losses (nitrate outputs) within OVERSEER.

32. OVERSEER while a valuable tool to guide and assist farmers to improve farm profitability, optimise meat and milk solid production, optimise nutrient use and minimise impacts on air, soil and water quality it does not currently adequately account for irrigation performance.

33. Simplistically, Overseer relies upon mean annual data inputs for climatic quantities;

- Mean Annual Rainfall,
- Mean Annual Potential Evapotranspiration (PET),
- Mean Annual Temperature, and
- Assessment (monthly distribution) of the seasonal variation of rainfall and PET**.**

Use of an Actual Volume for Irrigation

34. If an actual irrigation volume is used the model requires depths to be input per month. This can be a relatively simple task for mono-cultural pastoral agriculture, but extremely complex for arable farming where multiple crops, planting dates and harvest dates are involved. It should be noted however, with the introduction of fertigation (ability to inject effluent or fertilisers and use them strategically through any of the often multiple irrigation system types on farm) accurate nutrient budgets for pastoral farms are also becoming more complex.

35. Use of mean annual rainfall, temperature and PET, and entering in an annual volume for the past seasons irrigation is inconsistent. As highlighted above mean annual rainfall, temperature and PET are the drivers for the drainage model. The annual volume must therefore also be the mean annual volume required for irrigation. There is presently no easy method for the ‘average’ user to do this (converting the actual irrigation volume used to a mean volume). However it is possible for an expert to calculate this through the use of other external models.

36. Over time (10+ years) it may be possible to derive an accurate mean irrigation annual volume from measurement. However, as measurement has only been compulsory since 2012 it will be at least 2022 before this is possible. NZ has much seasonal variation in irrigation requirement and also typically has inter-decadal weather patterns (wet to dry) so this needs to be considered.

37. In summary data inputs to the model have to be consistent, otherwise outputs from the model become a statistical contradiction and result in aberrant outcomes.

38. For reasons of consistency as outlined above, the industry protocol states that an irrigation volume should not presently be used when undertaking an OVERSEER budget. The risk of aberrant outcomes from the irrigation volume approach cannot currently be easily managed.

Use of Method Only for Irrigation

39. The industry protocol states that a volume should not presently be entered for OVERSEER. However it is important that the limitations this then creates for the models outputs are then recognised.

40. OVERSEER contains a limited number of irrigation system types (currently 3 – border, gun, and pivot) with questionable assumptions (80, 90 & 95% efficiency) around them. There is also an 'active irrigation' option that assumes 100% efficiency. This is not adequate for an allocation regime. Ideally, an irrigation systems design characteristics need to be accounted for alongside a full range of system types - as these are the factors that drive potential application efficiency:

- Potential irrigation depth
- Potential irrigation rate
- System capacity
- Return period

41. When using method only OVERSEER assigns 'rainfall drainage' due to irrigation, "depending on rainfall, soil moisture content and soil AWC. Adding method only in

spring or autumn is more likely to result in additional drainage as the profile is wetter. Overall this effect is likely to be higher under high rainfall environments, and low AWC soils scenarios. However, this is an emergent property of the model where the size of the impact is yet to be determined"[9] and more importantly ground-truthed.

42. The water supply characteristics also need to be accounted for in OVERSEER – particularly if the irrigation system is subject to frequent intermittent water supply interruptions that are not provided for in the farm system characteristics. This will impact upon plant productivity and thus nutrient uptake.

43. Based on the above evidence it is currently unadvisable to allocate nutrient (nitrate) for irrigated agriculture using the OVERSEER model. Therefore Ms Dewes evidence (paragraphs 189 – 205) that recommends an allocation approach is unsound.

44. Instead, as per the government's recent 'Freshwater Reform 2013 and Beyond' discussion document a 'Good Management Practice' framework is the most appropriate way forward, particularly in the short to medium term.

EVIDENCE ENDS

Andrew Curtis, Chief Executive Irrigation New Zealand Incorporated

8th April 2013

[9] David Wheeler, Agresearch pers comm