IN THE MATTER OF	the Resource Management Act 1991
AND	
IN THE MATTER OF	resource consent applications by Southdown Holdings Limited, Five Rivers Limited and Killermont Station Limited to take and use water in the Upper Waitaki Catchment.

QUALIFICATIONS AND EXPERIENCE

1. My name is Melissa Clare Robson and I am an environmental scientist.

2. I recently joined Ryder Consulting Limited. Prior to that appointment I was employed by GHD for a period of 18 months. I hold a Bachelor of Science (Honours) in Tropical Environmental Science conferred by the University of Aberdeen, a Masters of Science in Integrated Water Management and Advanced Irrigation conferred by Cranfield Institute of Water Management at Silsoe, and a Doctorate in Plant and Soil Science conferred by the University of Aberdeen, the Aberdeen Centre for Organic Agriculture and the Scottish Agricultural College.

3. I have completed the UK Fertiliser Advisers Certification & Training Scheme (FACTS)**:** An independent, non-statutory certification scheme for advisers in plant nutrient management. I have also completed the Fertiliser and Lime Research Centre Intermediate and Advanced Sustainable Nutrient Management Course.

4. I have 10 years of post graduate experience and since 2004 have been working specifically to reduce diffuse pollution from agriculture both in a regulatory role and through voluntary schemes. In 2004 – 2005 I worked as an Agricultural Environment Officer for the Environment Agency working specifically with farmers to reduce nitrate losses and meet regulations with respect to nitrate losses, groundwater protection, slurry, silage and fuel oil, pesticide use and containment and general pollution prevention. During this time I conducted a catchment campaign aimed at reducing nutrient pollution from dairy farmers.

5. At the same time I began working on the Environment Agency's 'Landcare' project. This project was initiated to address the degradation from diffuse agricultural sources that was

evident in the Avon Catchment, a chalk stream system regarded as one of the finest in Europe and one that is subject to numerous sites of special scientific interest, special areas of conservation and other designations for both flora and fauna characteristic of this low nutrient environment. The chalk aquifer underlying the catchment is a key water source in the area and supplies water to the cities of Bournemouth and Bath.

6. From 2005 to 2008 I worked full time on the Landcare project, determining and addressing diffuse pollution problems in the catchment and providing on farm advice and direction on methods, options and planning mechanisms to reduce farm losses. In 2006 the Landcare project format was adopted and rolled out as part of a UK-wide project to address diffuse pollution from agriculture as part of the England Catchment Sensitive Farming Delivery Initiative. This initiative is now a principal tool to address diffuse water pollution from agriculture used to deliver water quality improvements required under the European Union Water Framework Directive.

7. Since February 2008, when I was employed with GHD, I have worked in New Zealand, predominantly on the Upper Waitaki Water Quality Study (WQS) to assess the cumulative effects of increased nutrients on water quality from agricultural intensification. I have worked as the project leader for on-farm mitigation strategies to reduce soil and nutrient losses and developing farm management planning strategies to achieve environmental targets. I wrote the mitigation toolkit with assistance from Laura Buckthought[1], from GHD Ltd. This toolkit is designed to illustrate that the nutrient thresholds set in the WQS can be met through on-farm mitigation, to offer land managers guidance for formulating a Farm Environmental Management Plan to deliver nutrient mitigation required by the WQS, and to provide a suite of options for reducing diffuse pollution from site specific environmental risks identified on their farms.

8. Since May 2009 I have been involved in putting together property specific Farm Environmental Management Plans (FEMPs) and in this time I have worked on full FEMPs for eight properties and have given limited assistance in the formulation of partial FEMPs for a further 20 properties in the Upper Waitaki Catchment.

9. In preparing this evidence, I acknowledge that I have read the code of conduct for Expert Witnesses in the Environment Court Consolidated Practice Note (2006). I agree to comply with this Code of Conduct. This evidence is within my area of expertise, except where I

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1 Environmental scientist with GHD Ltd. BSc Hons Environmental Science. Honours thesis on nitrate pollution of the Ashburton River.

state I am relying on what I have been told by another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

SCOPE OF EVIDENCE

10. I have been asked by South Down Holdings Limited ("SHL"), Five Rivers Limited ("FRL") and Killermont Station Limited ("KMT") to prepare and present evidence on their Farm Environmental Management Plans.

11. My evidence covers the following topics:

(a) The purpose and structure of the Farm Environmental Management Plans.

(b) Building a FEMP and data dollection for SHL/FR/KMT plans.

(c) Site specific issues and FEMPs for SHL/FR/KMT.

(d) Response to concerns raised in Section 42a Officer's Reports.

(e) Response to concerns raised by submitters.

PURPOSE AND STRUCTURE OF THE FEMPS

12. The FEMPs have been written to serve two purposes:

(a) to ensure that the proposed farm system can meet the nutrient requirements set out by the Water Quality Study; and

(b) to identify and mitigate other farm specific environmental risks that arise from the inherent characteristics of the farm or from the proposed farm system and its management.

13. These farm specific risks include uncontrolled discharges from the agricultural operation that are not included in the farm nutrient budgeting modelling but that may still have an environmental effect.

14. Each FEMP is divided into six principal sections:

(a) *Introduction*.

(b) *Farm description* - describing the farm location, soils, climate and topography.

(c) *Environmental context* - describing the property's receiving environments, both in terms of the wider catchment and on-farm and local receiving environments.

(d) *FEMP development section*:

(i) Mandatory Good Agricultural Practices (MGAPs) that need to be implemented across the farm, and include the base assumptions of the OVERSEER model[2]. This helps to validate the use of the model on the property;

(ii) Water Quality Study mitigation requirements and the farm's nutrient discharge allowance for both N and P; and

(iii) The identification of site specific environmental risks.

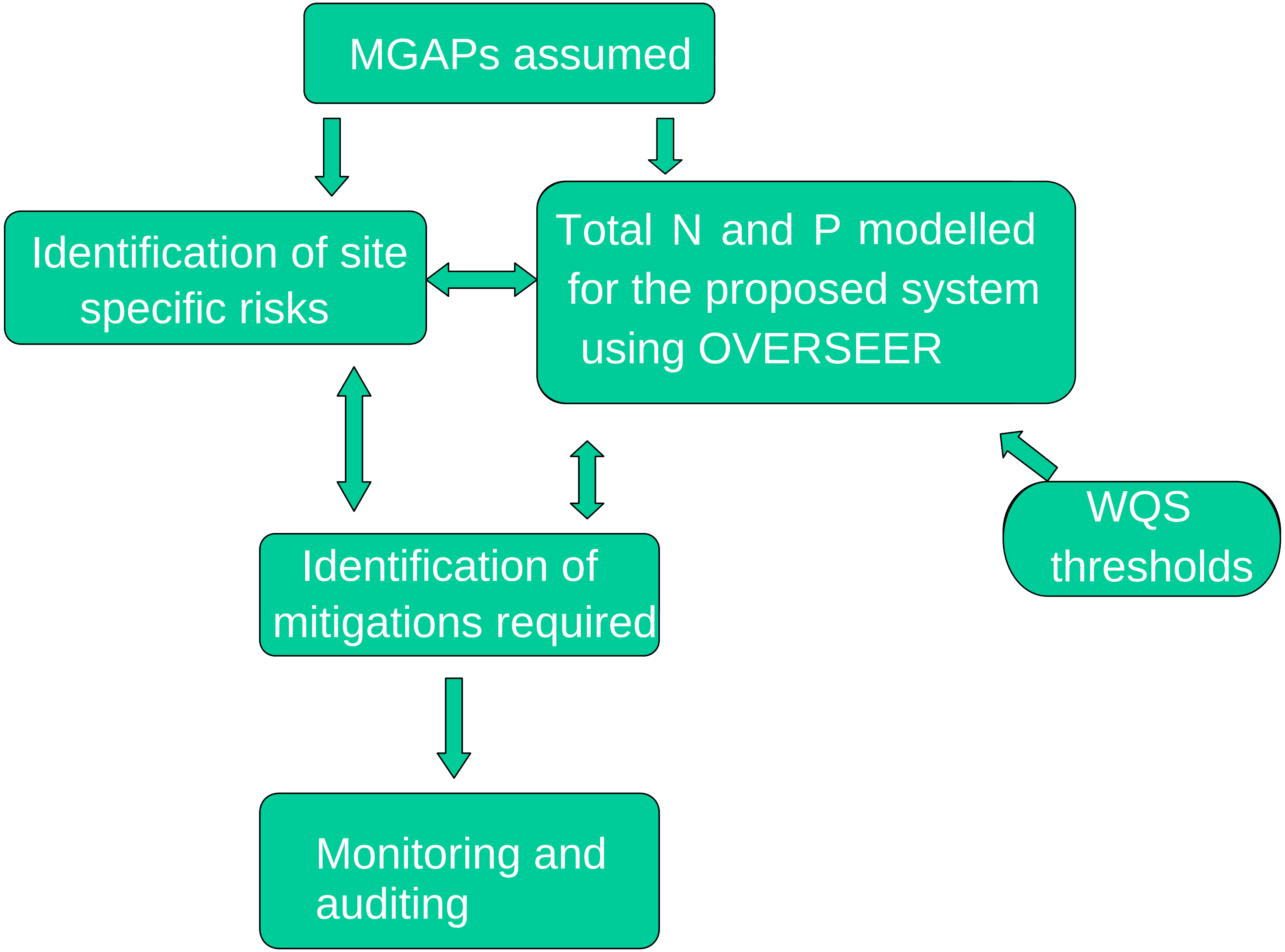
(e) *Proposed farm system with mitigations* - describes the proposed farm system with the mitigation and management measures that are required to be implemented to meet both the WQS thresholds and mitigate the identified site specific environmental risks.

(f) *Farm Environmental Management Plan* - describes, through a series of tables and maps, the mitigations, monitoring and auditing requirements of the plan. The first table lists each of the mitigation and management measures adopted along with an annotated map to highlight key mitigation locations. The second table lays out the environmental monitoring plan for the property along with an annotated map to indicate where site specific measures should be monitored, and the third table lays out a proposed audit plan for the property that would form the basis of an annual report to ECan.

15. A schematic of the FEMP development is shown in Figure 1.

[2] In the future, should an alternative model be used, the assumptions for that model would need to be specified in this good agricultural practice section.

Figure 1 An overview schematic of the process of building a Farm Environmental Management Plan



BUILDING A FEMP AND DATA COLLECTION

16. This section of my evidence lays out the process of building a FEMP and collecting the necessary data for the plans.

17. The first stage is that Mandatory good agricultural practices, shown in Table 1, are committed to. These have been described more fully in paragraph 20 of my evidence on behalf of MWRL given in the first week of this hearing.

Table 1 Mandatory good agricultural practices

Mandatory good agricultural practices
Fertilisers applied according to code of practice for fertiliser use
Use a fertiliser recommendation system and account for all sources of nutrients including applied effluents and soil reservoirs accounted for
Fertiliser application applied evenly
Irrigation and effluent applied evenly
Crop, cultivation, nutrient inputs and yield records kept per farm management unit
Good design of irrigation systems
Robust irrigation scheduling
Supplement and feeding out management
Winter grazing management

18. Current and proposed farm systems (without additional mitigation) are described and modelled and mitigation requirements are derived based on what is needed to comply with the WQS. The scale of mitigation required will indicate what type of measures will be needed to meet the WQS thresholds. Where large reductions are necessary, a farm system change may be required, whereas smaller reductions may be met through changes to farm management.

These options and the scale of mitigation required are discussed with the farmer and new farm system or systems are proposed (described as proposed farm system with mitigation).

19. This new farm system (with mitigation) must be modelled to ensure that it meets the WQS mitigation requirement. Where the proposed farm system is materially different to the current land practices, there is no alternative to modelling to predict the nutrient losses of the proposed system. In these cases the use of OVERSEER is an appropriate tool as long as reasonable inputs are used.

20. A draft of this farm system was submitted to the farmer and was also used to form the basis of an economic assessment of the proposal, and a farm feasibility assessment, and in the case of SHL, FR and KMT both these assessments were carried out by Mr Engelbrecht. Modelling farms using OVERSEER to assess Regional Council compliance with a threshold or nutrient discharge allowance has a precedent in both Environment Waikato and Horizons Regional Council.

21. Once a viable proposed farm system was decided upon, a site visit took place. Prior to the site visit, a desktop review was conducted. The proposed irrigation design and farm layout was overlaid onto topographic maps and soil maps to assess likely areas of environmental risk, areas where verification of information is required and possible monitoring points. At this stage and through the development of the FEMP, farm reports on aquatic ecology, avifaunal ecology and terrestrial ecology were consulted and practical mitigations identified. Where relevant, these mitigations were included in the FEMP.

22. The initial phase of the site visit included a discussion with the farmer as to their current practices (to assess the risks of current practices) and proposed systems.

23. The remainder of the site visit involved assessment of each management block in terms of a Farm Environmental Risk Assessment (FERA), soil testing for depth, compaction and chemical analyses[3], and the closer examination of the local receiving environments and potential risks from proposed activities.

24. The purpose of the FERA exercise is to identify areas of environmental risk on the farm and in the farm practice. Some risks pertain to inherent risks on the

[3] Soil depth and analyses were conducted on WHL Killermont, Ohau Downs and Glen Eyrie Downs.

farm and others arise from the way that the farm is managed. Additionally, some risks may be answered immediately such as 'are soils left bare over winter?' and others will require a cursory investigation such as 'are there compacted, consolidated or capped soils?'

25. There are nine sections in the FERA covering soils, cropping, effluent/infrastructure, fertiliser, water, chemicals, biodiversity/natural features, stock nutrient losses and track management/runoff. The guide questions given in the FERA are not exhaustive and should other issues become apparent during the site visit these should be included. For example, if a farm dump is found to be sited next to a bore hole, or a field silage clamp is found to be sited next to a watercourse, these are clearly risks and would need to be recorded and mitigated.

26. In terms of soil testing, soil transects were generally located on each soil type on the farm. A visually representative area was chosen (e.g. not in a depression, gateway or stock gathering area) and an initial GPS reading was taken. Ten soil samples were augured at 10 m spacing along the transect and soil samples divided into 0-10 cm and >10 cm. The 10 samples were thoroughly mixed and a representative bulked sample was taken, bagged and labelled for analysis. These samples were kept chilled and sent to the laboratory for analysis. Along the transect the soil was probed approximately 300 times using a soil penetrometer to assess layers of compaction and consolidation and also to assess soil depth to C horizon. A visual inspection was conducted of the soil surface to assess for soil surface compaction. Two to four verification soil pits were dug along each transect to more closely examine the nature of any compaction or consolidation and also to assess soil texture. This testing was necessary to gain an understanding of the soils current conditions and the likely risks when intensified.

27. Local and on farm receiving environments were identified on maps and visited, and their current condition assessed in terms of impacts of current farming practices and where soil maps indicated waterlogged riparian margins, these were verified.

28. Where possible a secondary meeting was held with the farmers to discuss the outcomes of the FERA and possible consequent mitigation measures.

29. Once the proposed farm system and the site specific environmental risks had been identified, a list of mitigation measures was drawn up and an annotated

map created to indicate the locations of the key mitigation measures. For each of these individual mitigation measures a monitoring/auditing option is given. The proposed farm system is modelled and a report of the inputs and outputs of the model are generated and attached in the appendices of the FEMP.

30. An environmental monitoring plan was created indicating the type, location and frequency of monitoring and the parameters to be tested, and an annotated map was created to show monitoring locations. The monitoring plan also includes triggers for each monitoring parameter and immediate contingency plans should the trigger be exceeded. The inclusion of the triggers is an important addition to the FEMPs, as it provides a point of reference or action for the monitoring programme. Where triggers are exceeded, the immediate contingency plans laid out should be implemented while a 'root cause' analysis is carried out. Any further mitigation measures to be adopted as a result of monitoring should be added to the FEMP.

31. The simple 'root cause analysis' process is laid out below:

(a) Is the current mitigation option implemented correctly?

(i) No – Implement and monitor

(ii) Yes – to (b)

(b) Has anything changed in the farm system?

(i) Yes – remodel and monitor

(ii) No – to (c)

(c) Have there been abnormal conditions at the time of trigger breach?

(i) Yes – continue monitoring to see if trigger breach continues

(ii) No – Seek advice of suitably qualified person to further investigate root cause and suggest appropriate further mitigation.

(d) Finally, an auditing plan was proposed. The auditing process allows both the farm operator to illustrate, and other interested parties to have confidence, that the management practices and mitigations planned for the farm are being implemented. In addition, the audit shows that there is a mechanism for the adaptive management of the property should the chosen mitigation or management not perform to expectations, as it lays out actions to be taken in the case of non-compliance while a root cause analysis is conducted.

32. An annual audit is proposed, and requires both external and in-house input. The annual audit should be completed and submitted to Environment Canterbury by end of July each year.

33. These FEMPs have been reviewed by Buddy Mikaere and have been found to meet cultural concerns as well as environmental ones associated with the proposal to intensify land use on these farms.

INDIVIDUAL FARM PLANS

34. The following section describes each of the individual farm plans prepared for the properties, in terms of:

(a) The WQS receiving environment;

(b) The local receiving environment;

(c) The WQS thresholds;

(d) The proposed farm system with mitigation; and

(e) The proposed monitoring and auditing plans.

GLEN EYRIE DOWNS STATION

Glen Eyrie Downs - Receiving environments

35. Glen Eyrie Downs Station, lies in both the Wairepo Creek and the Quail Burn groundwater and surface water catchments (Appendix A and B) identified in the WQS (GHD, 2009).

36. The potential local receiving environments not captured in the WQS are the Serpentine Creek, Six Mile Creek, the QE II covenant land on Ohau Downs and the DoC Kettleholes Reserve, as shown in Appendix C.

37. The direction of groundwater flow, as predicted by the detailed groundwater modelling described in the evidence of Dr John Bright, indicates that the groundwater is moving from west to east, however in the southern part of the property (below the DoC wetland) the flow turns to a southeasterly direction, following the general direction of the Serpentine Creek.

38. The Six Mile Creek runs across the northern tip of the property. Historic modifications to the creek appear to have occurred within this section as the creek flows through a swampy area, including several ponds, in an area of wilding pine (Ryder Consulting, 2009). The southern tributary of the creek is reported to only run after heavy and prolonged wet conditions (R Peacocke, *Pers Comm*. 2009). The Six Mile creek, once leaving the property enters the QE II covenant area on the neighbouring property, Ohau Downs Station. The groundwater is also modelled to move in this direction.

39. The Serpentine Creek and a tributary of the Serpentine traverse the western and southern areas of the farm. The creek meanders through the lowest part of the valley and is associated with ephemeral wetlands along the stream course (Mitchell Partnership, 2009) as well as periodically waterlogged riparian margins. The Serpentine Creek discharges into the Quail Burn beyond the property boundary.

40. The DoC Kettleholes Reserve was established in 2004 when the tenure review process for the property was completed and the area was recognised as a priority area of conservation (Mitchell Partnership, 2009). The modelled direction of the groundwater suggests that only the westernmost area of the property would impact on groundwater concentrations below the DoC reserve. The kettleholes are not thought to be groundwater fed, but are a result of

impermeable or slowly permeable material capturing surface and shallow subsurface flow.

Glen Eyrie Downs - WQS thresholds

41. Table 2 below shows the proposed whole farm losses from WQS, the WQS thresholds and the OVERSEER modelling outputs (modelling the proposed system with mitigations). To recap, the WQS thresholds (or NDA) are derived from the proposed losses from the farming system as calculated by the WQS (not including any mitigations) minus the calculated mitigation requirements for that sub-catchment or area. For each sub-catchment, the most stringent mitigation requirement should be adopted. For this farm, the N mitigation requirements are the most stringent for groundwater and the P mitigations are most stringent for the Ahuriri Arm. These WQS mitigation requirements set Glen Eyrie's nutrient discharge allowance at 38,139 kg N per annum and 1,621 kg P per annum. A full table showing the mitigation requirements for each receiving environment and the original predicted losses are given in each FEMP attached to this evidence.

Table 2 Total N and P losses modelled by OVERSEER for the proposed farming system on Glen Eyrie Downs WQS thresholds and original WQS proposed farm losses.

	Proposed losses from WQS	**WQS threshold kg/year**	**OVERSEER modelling outputs kg/year**
Total N leaching/runoff	72,054	38,139	31,155
Total P leaching/runoff	3,792	1,621	1,603

42. On a per hectare basis over the entire farm, this gives an N loss of approximately 14 kg/ha and a P loss of approximately 0.7 kg/ha. These losses are less than half of the range quoted for typical dairy farms in New Zealand of 30-50 kg N/ha and 3-5 kg P/ha (OVERSEER).

43. At a highly developed setting, the modelled N losses increase to 58,042 kg N. As this setting allows for no immobilisation of N, the losses become highly sensitive to inputs, an increase in the length of time housed and a reduction in N fertiliser inputs is likely to deliver the required reduction. Just a reduction in the inorganic fertiliser N input from 130 kg N/ha to 103 kg N/ha delivered the

required reduction in N losses (total farm N loss at 37,631 kg/year). It is understood that the housed period proposed here and losses associated with the housing time will be possible to be modelled with the next version release of OVERSEER.

44. Where stations do not already meet their threshold using the highly developed scenario, it is imperative that they monitor soil organic matter development and rate of accumulation.

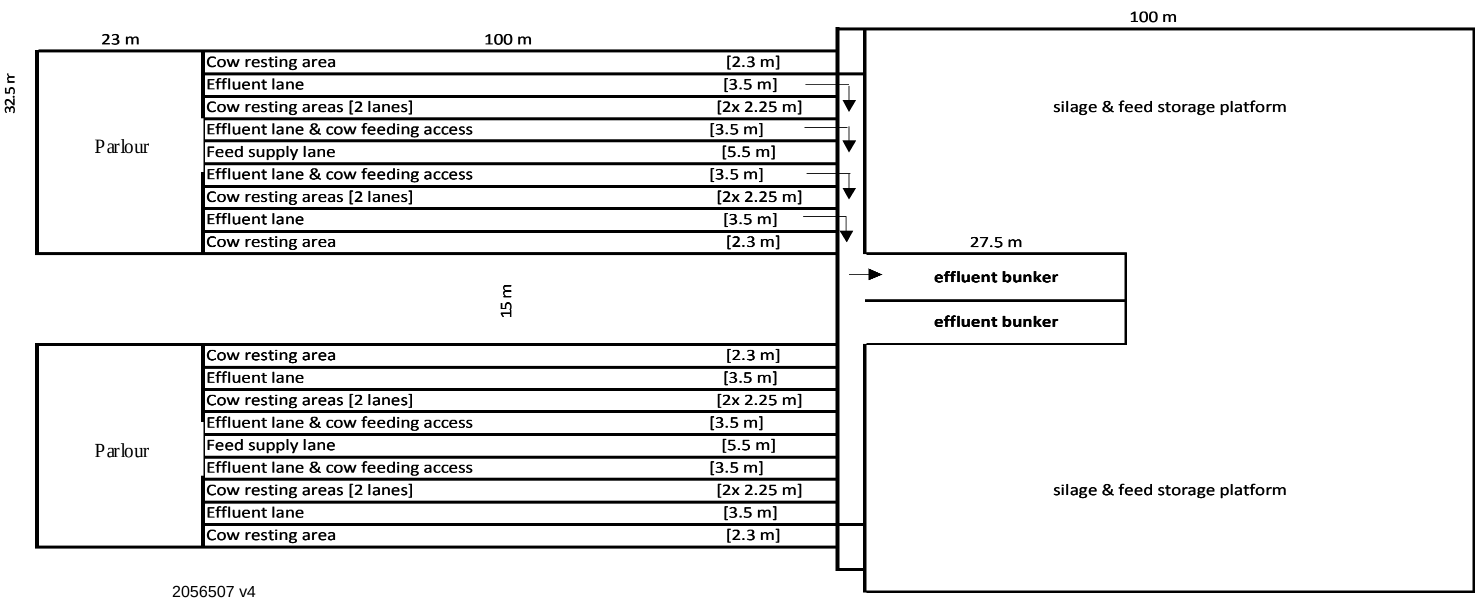
Glen Eyrie Downs - Proposed farm system with mitigations

Farming operation

45. The proposed farming system is an irrigated dairy farm with stock wintered on the farm using a cubicle stable system. The stock are planned to be housed full time for 8 months of the year and housed partially (12 hrs/day) for the remaining four months of the year. However, this system allows housing up to 365 days per year. The farm will primarily operate a cut and carry system to bring pasture to the herd in the barns. Pasture will be cut, conserved and fed to the herd throughout the year along with imported supplement (Engelbrecht, 2009).

46. The layout of the cubicle stable is shown below in Figure 2. The plan view shows the milking parlour on the left and the layout of the cubicles in the centre interspersed with alternative effluent lanes and feeding lanes. Effluent is dry scraped along the effluent lanes and into the effluent bunker to be separated and then stored. Also draining to the effluent bunker are the silage clamps, on the right. The whole unit is covered by a roof.

Figure 2 Proposed layout of the cubicle stables including silage clamp and effluent collection facility



Soils

47. The FERA highlighted **current** soil issues from the clearance of groundcover and the areas of land that have been left bare, the consolidation of soil as a result of the land clearance, and soils with high exchangeable-Al concentrations (Aluminium toxicity) that can affect plant growth. **Potential** soil issues arising include the vulnerable nature of the soils to erosion, the grazing of stock over winter and the possibility of trafficking soils when wet.

48. A map showing the key mitigation measures is shown in Appendix D

49. The proposed soil mitigation measures are:

(a) Irrigation and consequent full ground cover to protect the soil from erosion;

(b) Increase pH to avoid Al toxicity problems;

(c) The housing of stock over the winter period to remove potential for soil damage from grazing stock in adverse conditions; and

(d) No trafficking of soils when wet, and as this is not always possible, the annual monitoring and identification of soil compaction in hydrologically connected areas and documented remedial actions taken.

Stock

50. The dairy herds will consist of both Holstein and Holstein Cross cows, making a total herd size of 7000 cows at a stocking rate of 3.5 SU/ha. Young stock will be grazed off farm from weaning as will dry stock. Only milking cows will be present on the farm and milking cow numbers will be maintained throughout the year (B. Engelbrecht, *Pers Comm*, 2009).

51. The FERA highlighted potential stock issues arising from the non-exclusion of stock from watercourses, the non-control of dietary N and P, no provision for fallen stock and the partial grazing of stock over winter with no further provision for reducing these losses. The proposed mitigation measures are:

(a) The exclusion of stock from watercourses by planting and fencing dual function riparian margins. The outermost area of the margin will be densely planted to aid attenuate flow and promote infiltration and sedimentation. The periodically waterlogged inner area of the margin will be protected and maintained in this waterlogged state to promote conditions favourable to denitrification. A minimum distance of 5 m from the outside bank of the watercourse has been agreed, although due to the meandering nature of the streams, the margins are usually greater than 5 m. The ecological benefits of this planting are described in the evidence of Dr Ryder and Dr Bartlett.

(b) The closer management of the herd due to housing allows the feeding of animals according to their requirements (phase feeding).

(c) All fallen (dead) stock will be collected and removed off farm.

(d) The housing of stock inside over the winter period will eliminate winter stock nutrient losses.

Production

52. The irrigated area will be under ryegrass/white clover, fescues and chicory. Pasture production is expected to be approximately 13 tonnes dry matter/ha on irrigated and fertilised land. An 85 % pasture utilisation rate has been assumed as the mechanical harvesting and feeding of silage in the cubicle stables will result in greater utilisation rates, and the lack of pasture damage from stock will enhance pasture production (Engelbrecht, 2009). Milk Solids production is expected to be approximately 350 kg MS/cow[4]. The close management possible with housed herds will permit all year round calving and milking, taking advantage of the winter milk premium (Engelbrecht, 2009).

Effluent

53. Manure production - The stock are expected to be housed full time for 8 months and for 12 hours per day for 4 months. The effluent and manure collected includes some dilution from dairy washings.[5]

54. Manure handling - In the cubicle stables, alleys and other stocked areas will be regularly dry scraped to deliver effluent to a sump at one end of the stables (Figure 2). From the sump, the effluent will be pumped to an effluent press and separated into liquid and solid fractions. Any leachate from around the effluent press area will drain into the liquid effluent collection system.

[4] 400 kg MS is reported to be achievable in this system. This would increase modelled N losses to 33,080 kg N and 1,605 kg P.
[5] Milking will either be done using a rotary bale or robotic milkers. Both will be undercover and with minimal water used in cleaning.

55. The FERA highlighted potential effluent issues arising from no clean and dirty water separation on the yards. The proposed management measure is that clean water will be separated in any uncovered yards and roof water either diverted and discharged to ground or collected and used.

56. Manure storage - There will be seven months storage in lined facilities for the liquid fraction. A freeboard of at least 750 mm will be maintained at all times. The solid fraction will have 12 months storage available and it will be stored on covered concrete pads and will drain to the effluent storage facility.

57. Manure application - Effluent will be applied through the centre pivots and the solid fraction will be spread using a calibrated muck spreader or exported. Effluent will be injected to irrigation water prior to being irrigated. Effluent will be applied at the most appropriate times for crop uptake, during active pasture growth in the spring and summer. Effluent application depth will be determined by soil moisture deficit and a minimum soil moisture deficit will be maintained.

58. No effluent will be applied within 20 m of a watercourse. All applications will be recorded and accounted for when determining fertiliser requirements.

59. The FERA highlighted potential effluent issues arising from close to 200 kg/ha /year of organic N being applied. However, improved storage and prolonged housing (e.g. if, due to poor weather conditions, the stock are required to be housed for an additional few weeks), may increase the effluent to be recycled to land. A total effluent loading rate of less than 200 kg/N/year permits this activity to maintain a consented activity status under ECan's dairy effluent rules. This threshold is in compliance with the consent for effluent application lodged for this property.

60. The proposed management measures are:

    (a) To test effluent nutrient concentrations during spreading season, and record cumulative applications;

    (b) If cumulative applications indicate that more than 200 kg N of organic manure will be added should all the remaining effluent and solid manure be applied, the solid fraction will be exported; and

    (c) A farm map showing no spread areas should be clearly displayed in the farm office and if effluent is spread by tractor, it should be carried in tractor cabs.

Silage production

61. The FERA highlighted potential effluent issues if silage liquor is not collected and spread to land and direct discharges are made from the silage pits. The proposed management option is that silage is stored on a concrete pad and drains to the effluent collection facility (Figure 2). The silage liquor will be recycled to land along with effluent.[6] Due to the unknown nutrient concentrations in the liquor, the effluent will be regularly tested during spreading and cumulative applications recorded.

Fertiliser use

62. Specific fertiliser recommendations will be produced on an annual basis using a recommended system. Plant nutrient supply will be estimated from both organic and inorganic fertilisers as well as N fixation using a nutrient budgeting system. The effluent and solid manure collected from the sheds will provide an important part of the nutrient requirement.

63. Nitrogen losses may occur during collection, storage and application of effluent and also when solid manure is applied, as not all of the nutrients, especially the N, will be immediately available to the plant. However, the quantities of effluent proposed to be applied would be sufficient to meet over half of the P and K requirements of a silage field with four cuts taken (MAFF, 2000).

64. Although a significant amount of N will be recycled, inorganic fertiliser will also be required. The P fertilisation strategy will be to build soil P concentrations to between 20 and 23 Olsen P, and to maintain them in this range. Full account will be taken of the organic fertiliser inputs of phosphorus through the use of a nutrient budget. The FERA highlighted potential fertiliser issues arising from more than 50 kg fertiliser N being applied in a single application, N applications occurring in autumn and winter, fertiliser spreaders not being calibrated and no suitable storage and filling area having been identified. The proposed mitigation measures are:

(a) No N fertiliser to be applied in autumn and winter;

(b) N fertiliser applications to be split to less than 50 kg N/ application;

(c) Soil Olsen P levels to be maintained at or below 23;

[6] The concrete will need to be an appropriate specification for containing silage as the liquor is highly corrosive.

(d) Fertiliser spreaders to be on-farm calibrated annually and optimised;

(e) Fertiliser will be stored in a covered area;

(f) The identified fertiliser filling area will be at least 50 m from a watercourse of spring or bore and will have no drains that discharge to clean water or that can discharge straight to ground; and,

(g) If liquid fertiliser used, fertiliser will be stored in a bunded tank and also protected from vehicle movements.

Chemical storage and management

65. The FERA highlighted that no chemical management strategy was in place. To satisfy the issues raised, the proposed management strategies are:

(a) Where chemicals are used on farm, these will be stored in a secure shed. Containers and foil caps will be disposed of as hazardous waste, or triple rinsed and disposed of as non-hazardous;

(b) The services of a professional crop adviser or other suitably qualified person will be used to advise on pesticide options, doses and tank mixes;

(c) Sprayers will either be filled on a concrete yard draining to a sealed tank, or a biobed, or in the field. When filling, a portable bund will be placed beneath the induction hopper;

(d) Back siphoning prevention measures will be used when filling sprayers, for example through the use of bowsers;

(e) Tank washings will be resprayed to the same fields ensuring no exceedance of dose;

(f) Sprayer washdown area will drain to sealed tank or biobed or sprayers should be stored under cover; and

(g) ‘No spray’ areas will be clearly marked on a map and displayed in the farm office and in the sprayer cabs. An emergency ‘in case of a spillage’ procedure should be clearly displayed in office, chemical store and sprayer filling area. A bucket of sand will be available in the sprayer filling area to be used on any spills.

Cultivations and trafficking

66. After initial cultivation for the establishment of permanent pasture, little cultivation is expected. Re-establishment of pastures is not expected to involve inversion tillage.

67. The FERA highlighted potential soil risks arising from trafficking soil when wet. The proposed mitigation measure is:

(a) Compaction caused by machinery movement in hydrologically connected areas will need to be identified on an annual basis between late autumn and mid spring, excluding times when land is frozen. Compaction is identified both through visual inspection (of the soil surface and plant stress indicators) and through testing for compaction using a soil penetrometer and digging verification pits. Identified compaction should be removed at the earliest opportunity with an appropriate technique for the depth of compaction.

Water and runoff

68. 2,068 ha of the farm is planned to be irrigated at a rate of 600 mm/year. Final pivot design has avoided crossing watercourses as much as possible. In the one case where this is not possible, bridges will be constructed at wheel crossing points.

69. The FERA highlighted potential water and runoff risks arising from tracks running through streams and discharging runoff directly, pivot tracks going over watercourses, the possibility of runoff from grazed areas reaching a watercourse, stock access to watercourses and the grazing of stock over winter. The proposed mitigation measures are:

(a) Riparian fencing will prevent stock encroachment of waterways;

(b) Dual function riparian zones will be planted up to attenuate and remove nutrients entering the waterways.

(c) Runoff from all tracks will be prevented from entering watercourse;

(d) No effluent will be irrigated over watercourses and a 20 m layback will be observed; and

(e) The restriction of stock access to waterways will require stock water facilities to be provided. However, due to the very restricted grazing system proposed, soils are not expected to be seriously damaged around troughs. Where damage does occur, this will be assessed during the annual soil compaction assessment, and remedial action taken if necessary.

Biodiversity

70. Mitigation measures to protect ecology are discussed in full by Dr Ryder and Dr Bartlett. In brief, riparian planting and fencing is proposed to prevent stock access, enhance remaining ecological value through planting and protection of indigenous species shade waterways, provide cover and habitat for fish and invertebrates and stabilise banks. Measures to protect avifauna include controlling pest species and predators. This is covered in full in the evidence of Dr Ryder.

Glen Eyrie Downs - Monitoring and auditing

71. The environmental monitoring plan for Glen Eyrie Downs Station is shown in Table 3 below. An annotated map of the monitoring points on Glen Eyrie Downs Station is shown in Appendix E.

Table 3 Location, frequency and parameters for monitoring on Glen Eyrie Downs

		Location	**Frequency**	**Measured parameters to include**	**Triggers**	**Contingency plan if triggers are exceeded**
Soil	Soil nutrient testing	All blocks in rotation	1 in 3 years	Standard suite of soil nutrients, pH C, N and organic matter	Olsen P of 23	Reduce or stop addition of P fertiliser to area and monitor.
Soil	Soil compaction survey	All hydrologically connected areas	Annually	Surface and subsoil compaction	Compaction, surface capping	Remove compaction with appropriate tool.
Soil	Wet weather survey	All blocks	Annually	Runoff from tracks and centre pivot tracks and overland flow through riparian margins	Runoff occurring	Immediately review current runoff mitigation options for pivot tracks. Introduce further runoff removal infrastructure. Runoff through riparian margins should be attenuated through placement of temporary barriers or detention pits for larger volumes until source of runoff can be identified and addressed.
Effluent	Irrigated effluent nutrient testing	All blocks receiving effluent	Regularly throughout spreading season	Total N, nitrate, ammonia, dissolved reactive phosphorus, BOD	NA	
Effluent	Cumulative effluent application	All blocks receiving effluent	Record each time effluent is applied	Application depth	200 kg/ha effluent N including solid fraction	Store solid fraction until exportation can be arranged. Export enough of solid fraction to maintain application at less than 200 kg.

		Location	Frequency	Measured parameters to include	Triggers	Contingency plan if triggers are exceeded
Water	Groundwater quality	On farm bore	2 x per year at mid depth of aquifer	Total Nitrogen, nitrate, ammonia, total Kjeldahl nitrogen, total phosphorus, dissolved reactive phosphorus.	> 2 mg/l nitrate-N increase from current	If groundwater analysis indicates an excedence of 2 mg/l above current, the N application to land should be reduced or stock withheld for longer until a root cause analysis can be conducted.
Water	Surface water quality	Entry and exit of Wairepo Creek and Serpentine Creek and main tributary on property boundaries	Monthly for first couple of years to establish patterns	Total Nitrogen, nitrate, ammonia, total Kjeldahl nitrogen, total phosphorus, 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 in house 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 in house and 1 in 5 years by an independent	Application uniformity		Optimisation of the spreader performance will be performed at the time of testing.
Pasture	Ground cover	All blocks	2 x per year until full cover	% Ground cover	>80 %	Soil nutrient and compaction testing should be performed to identify possible causes.

72. An annual auditing plan has been prepared for Glen Eyrie Downs Station. The audit plan addresses both the compliance with the WQS thresholds and the management options implemented to address identified site specific environmental issues. The audit table also includes the action to be taken in the case of non-compliance.

Table 4 Table showing proposed contents of an annual audit report for Glen Eyrie Downs

Audit measures	Action in the case of non-compliance
Additional auditing that must be done externally	
Check the clean and dirty water separation methods in and around the cubicle stables, parlour and yards, plus photographs	If any contamination of clean water is found all water should be directed to effluent store until problem is found and effective separation is verified
Check for evidence of direct discharges from the cubicle stables, parlour and yard area	Any direct discharge must be stopped immediately. Temporary barriers such as straw bales may be used to take up any discharges until permanent structures

Audit measures	Action in the case of non-compliance
	are in place
Riparian margins should be checked for signs of overland runoff through the margin.	Where there is evidence of runoff through the riparian margin, temporary barriers or detention pits should be dug (not in the riparian margin) to attenuate runoff while the source of the runoff is investigated and the integrity of the dense vegetation is inspected.
Check riparian planting and fencing is present where it should be and that it is intact, plus photographs	Any failure in the integrity of the fencing should be repaired immediately or a barrier placed around gap to prevent stock access until repair is made
Check the effluent press and liquid and solid fractions and also the destination of any liquid from the press area.	All liquid should drain into effluent storage. Any discharge must be stopped immediately. Temporary barriers such as straw bales may be used to take up any discharges until permanent structures are in place
Check the storage of liquid fraction for visible signs of discharge and maintenance of freeboard. When empty, the integrity of the lining should be checked and repairs made if necessary.	Any uncontrolled discharge of effluent must be stopped immediately. If a failure of the lining is suspected, the store must be pumped out and the lining inspected and repaired if necessary The freeboard should be maintained at all times.
Check the storage of solid fraction and destination of seepage if occurs	All liquid should drain into effluent storage. Any discharge must be stopped immediately. Temporary barriers such as straw bales may be used to take up any discharges until permanent structures are in place
Check the storage of silage for visible signs of discharge and destination of silage liquor	All liquid should drain into effluent storage. Any discharge must be stopped immediately. Temporary barriers such as straw bales may be used to take up any discharges until permanent structures are in place
Check fertiliser storage and filling area.	There should be no possibility of loss of fertiliser to drains or direct discharge to ground. Any drains should be covered, or the filling area moved to where no discharges will occur.
Annual audit of OVERSEER nutrient budget and report based on previous 3 years. Submission of compliance with thresholds	Should the OVERSEER report show losses exceeding the threshold, further mitigations should be adopted to effect a reduction in nutrient loss to below thresholds.
Fertiliser spreader and irrigation testing and calibration 1 in 5 years by independent auditor	Spreaders and irrigators not performing should be recalibrated

Audit measures	Action in the case of non-compliance
Additional auditing that can be done either externally or internally	
Reconciliation of fertiliser, effluent and soil records with nutrient budget and fertiliser recommendations	Where reconciliation is not possible and an over application has occurred, this should be rectified in the following year
Submission and brief interpretation of soil, effluent, water quality, supplement and machinery calibration tests	Where triggers have been exceeded, immediate contingency plans should have been effected and a root cause analysis conducted. The results of which should be presented here.
Submission of field records demonstrating fertiliser and effluent practice and nil and restricted grazing periods	Where field records show variation from proposed nil and restricted grazing, changes must be justified and the farm shown to remain within threshold limits, or the practice must revert to the proposed system
Submission of proof removal of solid manure fraction if required	If calculation indicate that a part of the solid fraction will have to be removed and no removal has occurred, spreading should cease and solids stored until a suitable recipient can be found.
Submission of silage clamp and effluent storage design plans	Once approved, the plans need only be submitted once
Submission of example irrigation schedules and calculated water use efficiency	Where calculated water use efficiency is such that the trigger is exceeded, remedial action of how the system is to be optimised should be submitted to ECan, and followed up in the next audit
Annual quadrat testing for % ground cover, submission broad findings	Where poor groundcover is found and cause assessed, the remedials should be implemented and followed up in the next audit
Annual soil compaction survey, submission of broad findings and remedial actions (e.g. spiking field A to remove surface compaction)	Where poor soil structure is found and cause assessed, remedial actions should be proposed and followed up in the next audit
Annual wet weather survey, submission of broad findings and remedial actions (e.g. flow diverters into fields to removed continuing runoff from track into creek)	Where runoff is found and cause assessed, the remedial action should be proposed and followed up in the next audit
Annual fertiliser spreader and irrigation testing and calibration	Spreaders and irrigators not performing should be recalibrated
Auditing that must be done internally	
Self certification for application of fertiliser according to code of practice	Any failures in observing the code of practice for applying fertiliser should be rectified and followed up in the next audit

Audit measures	Action in the case of non-compliance
Submission of proof of 'approved handler' status	Inappropriate handling of chemicals should cease until an approved handler is in place

Modelling limitations

73. The OVERSEER model in its current format is not able to model a complete cut and carry system as the model will only allow up to 50 % of the dry matter grown on a paddock to be cut, with the remainder having to be grazed. This limits the extent to which a restricted grazing model can be modelled, and in the case of Glen Eyrie Downs, a more restrictive system is proposed than that which can be modelled. The implications of this are that the nutrient losses modelled in OVERSEER are likely to be an overestimate. It is understood that this is being resolved for the December release of OVERSEER.

WHL KILLERMONT

WHL Killermont – Receiving Environments

74. WHL Killermont, according to the WQS (GHD, 2009), lies in Ahuriri and Omarama groundwater and surface water catchments (Appendix F and G).

75. Due to the very permeable nature of the soils and the low likelihood of overland flow or shallow interflow, the closest receiving environments are the Omarama Stream and Ahuriri River, beyond the property boundary. These two receiving environments are already considered as a part of the WQS and therefore no additional mitigation is required for other receiving environments, shown in Appendix H.

76. The Tara Hills irrigation race traverses the property, however, there is no groundwater connectivity with this race, therefore drainage losses from the farm will not be seen in the race. The flat topography and very well drained nature of the soils precludes the possibility of surface runoff. The only sources of contamination into the race, and consequently into the Omarama sub-catchment, are direct deposition from stock or effluent irrigation and runoff from the one centre pivot track that crosses the race. Mitigation measures have been adopted to prevent these discharges.

77. The Manuka Creek runs across the southern tip of the farm. In terms of the groundwater direction the Manuka Creek is 'upstream' of the farm therefore drainage losses from the farm will not be seen in the creek. The very well drained nature of the soils precludes the possibility of surface runoff. The only sources of contamination into the creek, and therefore into the Omarama Stream, are direct deposition from stock or effluent irrigation. Mitigation measures have been adopted to prevent these discharges.

WHL Killermont – WQS thresholds

78. A table showing the proposed whole farm losses from WQS, the WQS thresholds and the OVERSEER modelling outputs (modelling the proposed system with mitigations) are shown below. For this farm, the Lake Benmore - Ahuriri Arm mitigation requirements are the most stringent. These mitigation requirements set WHL Killermont's nutrient discharge allowance at 35,262 kg N per annum and 551 kg P per annum. A reallocation of 1,500 kg of N has been made from WHL to the remainder of Killermont Station which reduces WHL's NDA to 33,762 kg N.

79. There is no environmental impact of this reallocation.

80. A full table showing the mitigation requirements for each receiving environment and the original predicted losses are given in each FEMP attached to this evidence.

Table 5 Total N and P losses modelled by OVERSEER for the proposed farming system on WHL Killermont, WQS thresholds and original WQS proposed farm losses.

	WQS whole farm proposed losses	**WQS threshold kg/year**	**OVERSEER modelling outputs kg/year**
Total N leaching/runoff	46,486	33,762	17,857
Total P leaching/runoff	1,669	551	442

81. On a per hectare basis over the entire farm, this gives an N loss of approximately 16 kg/ha and a P loss of approximately 0.4 kg/ha. These losses are considerably less than the range quoted for typical dairy farms in New Zealand of 30-50 kg N/ha and 3-5 kg P/ha (OVERSEER).

82. At a highly developed setting, the modelled N losses increase to 21,496 kg N. As this is still within the WQS threshold, no further mitigation will be required when soils have reached highly developed.

WHL Killermont – Proposed farming system with mitigations

83. The proposed farm system with mitigation is as indicated for Glen Eyrie Downs. Only the points of difference will be described. A map showing the key mitigations is shown in Appendix I.

Soils

84. There are no soil issues associated with land clearance on WHL Killermont, (although the soils are still vulnerable to wind erosion) or concerns with Al toxicity.

Stock

85. A minimum distance of 3 m layback from the banks of the Tara Hills Irrigation race will be implemented and no dual function riparian margin. The lack of

overland flow and the artificial nature of the irrigation race and lack of groundwater connectivity means that a riparian margin for nutrient removal would be ineffective. However, margins have more than a nutrient removal function and these have been proposed to keep stock out of water courses and for biodiversity reasons.

Fertiliser

86. Soil Olsen P, as reported in conventional soil test analyses, will be maintained below 25.

Water

87. 1,100 ha of the farm is planned to be irrigated at a rate of 600 mm/year. The source of the irrigation water is from Ahuriri River. Final pivot design has avoided crossing watercourses as much as possible. In the one case where this is not possible, bridges will be constructed at wheel crossing points.

88. The FERA highlighted potential water and runoff risks arising from stock having access to watercourses and pivot tracks going over watercourses. The proposed mitigation measures are:

   (a) Riparian fencing and planting will prevent stock encroachment of waterways;

   (b) Runoff from pivot tracks will be prevented from entering watercourse; and

   (c) Stock water facilities will need to be provided, however, due to the very restricted grazing system proposed, soils are not expected to be seriously damaged around troughs. Where damage does occur, this will be assessed during the annual soil compaction assessment.

Biodiversity

89. In brief, riparian planting and fencing is proposed to prevent stock access, shade waterways, provide cover and habitat for fish and invertebrates and stabilise banks. Measures to protect avifauna include controlling pest species and predators. A densely planted 3 m set back is proposed for Tara Hills Irrigation race and a densely planted 5 m set back is proposed for Manuka Creek.

WHL Killermont – Monitoring and auditing

90. The environmental monitoring plan for WHL Killermont is shown in Table 6 below. An annotated map of the monitoring points on WHL Killermont is shown in Appendix J.

Table 6 Location, frequency and parameters for monitoring on WHL Killermont

		Location	Frequency	Measured parameters to include	Triggers	Contingency plan if triggers are exceeded
Soil	Soil nutrient testing	All blocks in rotation	1 in 3 years	Standard suite of soil nutrients, pH C, N and organic matter	Olsen P of 25	Reduce or stop addition of P fertiliser to area and monitor
Soil	Soil compaction survey	All hydrologically connected blocks	Annually	Surface and subsoil compaction	Compaction, surface capping	Remove compaction with appropriate tool
Soil	Wet weather survey	All blocks	Annually	Runoff from tracks and centre pivot tracks	Runoff occurring	Immediately review current runoff mitigation options for pivot tracks. Introduce further runoff removal infrastructure
Effluent	Irrigated effluent nutrient testing	All blocks receiving effluent	Regularly throughout spreading season	Total N, nitrate, ammonia, dissolved reactive phosphorus, BOD	NA	
Effluent	Cumulative effluent application	All blocks receiving effluent	Record each time effluent is applied	Application depth	200 kg/ha effluent N including solid fraction	Store solid fraction until exportation can be arranged. Export enough of solid fraction to maintain application at less than 200 kg
Water	Groundwater quality	Two identified bores, H39/0914 and H39/0045	2 x per year at mid depth of aquifer	Total Nitrogen, nitrate, ammonia, total Kjeldahl nitrogen, total phosphorus, dissolved reactive phosphorus.	> 1 mg/l nitrate-N	If comparative groundwater analysis from upstream and downstream indicates an excedence of 1 mg/l due to on farm activities, the N application to land should be reduced or stock withheld for longer until a root cause analysis can be conducted
Water	Surface water quality	Entry and exit of Tara Hills race on property boundaries	Monthly for first couple of years to establish patterns	Total Nitrogen, nitrate, ammonia, total Kjeldahl nitrogen, total	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

		Location	Frequency	Measured parameters to include	Triggers	Contingency plan if triggers are exceeded
				phosphorus, dissolved reactive phosphorus, suspended solids.		undertaken. Or example, 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 in house 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 in house and 1 in 5 years by an independent	Application uniformity		Optimisation of the spreader performance will be performed at the time of testing
Pasture	Ground cover	All blocks	2 x per year	% Ground cover	> 80 %	Soil nutrient and compaction testing should be performed to identify possible causes

91. An auditing plan has been proposed for WHL Killermont. The audit plan examines both the compliance with the WQS thresholds and the management options implemented to address identified site specific environmental issues. The audit table also includes the action to be taken in the case of non-compliance.

Table 7 Table showing proposed contents of an annual audit report for WHL Killermont

Audit measures	Action in the case of non-compliance
Additional auditing that must be done externally	
Check the clean and dirty water separation methods in and around the cubicle stables, parlour and yards, plus photographs	If any contamination of clean water is found all water should be directed to effluent store until problem is found and effective separation is verified
Check for evidence of direct discharges from the cubicle stables, parlour and yard area	Any direct discharge must be stopped immediately. Temporary barriers such as straw bales may be used to take up any discharges until permanent structures are in place
Check riparian planting and fencing is present where it should be and that it is intact, plus photographs	Any failure in the integrity of the fencing should be repaired immediately or a barrier placed around gap to prevent stock access until repair is made

Audit measures	Action in the case of non-compliance
Check the effluent press and liquid and solid fractions and also the destination of any liquid from the press area.	All liquid should drain into effluent storage. Any discharge must be stopped immediately. Temporary barriers such as straw bales may be used to take up any discharges until permanent structures are in place
Check the storage of liquid fraction for visible signs of discharge and maintenance of freeboard. When empty, the integrity of the lining should be checked and repairs made if necessary.	Any uncontrolled discharge of effluent must be stopped immediately. If a failure of the lining is suspected, the store must be pumped out and the lining inspected and repaired if necessary The freeboard should be maintained at all times.
Check the storage of solid fraction and destination of seepage if occurs	All liquid should drain into effluent storage. Any discharge must be stopped immediately. Temporary barriers such as straw bales may be used to take up any discharges until permanent structures are in place
Check the storage of silage for visible signs of discharge and destination of silage liquor	All liquid should drain into effluent storage. Any discharge must be stopped immediately. Temporary barriers such as straw bales may be used to take up any discharges until permanent structures are in place
Check fertiliser storage and filling area.	There should be no possibility of loss of fertiliser to drains or direct discharge to ground. Any drains should be covered, or the filling area moved to where no discharges will occur.
Annual audit of OVERSEER nutrient budget and report based on previous 3 years. Submission of compliance with thresholds	Should the OVERSEER report show losses exceeding the threshold, further mitigations should be adopted to effect a reduction in nutrient loss to below thresholds.
Fertiliser spreader and irrigation testing and calibration 1 in 5 years by independent auditor	Spreaders and irrigators not performing should be recalibrated
Additional auditing that can be done either externally or internally	
Reconciliation of fertiliser, effluent and soil records with nutrient budget and fertiliser recommendations	Where reconciliation is not possible and an over application has occurred, this should be rectified in the following year
Submission and brief interpretation of soil, effluent, water quality, supplement and machinery calibration tests	Where triggers have been exceeded, immediate contingency plans should have been effected and a root cause analysis conducted. The results of which should be presented here.
Submission of field records demonstrating fertiliser and effluent practice and nil and restricted grazing periods	Where field records show variation from proposed nil and restricted grazing, changes must be justified and the farm shown to remain within threshold limits, or the practice must revert to the proposed system
Submission of proof removal of solid manure fraction if required	If calculation indicate that a part of the solid fraction will have to be removed and no removal has occurred, spreading should cease and solids stored until a suitable recipient can be found.
Submission of silage clamp and effluent storage design plans	Once approved, the plans need only to be submitted once
Submission of example irrigation schedules and calculated water use efficiency	Where calculated water use efficiency is such that the trigger is exceeded, remedial action of how the system is to be optimised should be submitted, and followed up in the next audit

Audit measures	Action in the case of non-compliance
Annual quadrat testing for % ground cover, submission broad findings	Where poor groundcover is found and cause assessed, the remedials should be implemented and followed up in the next audit
Annual soil compaction survey, submission broad findings and remedials	Where poor soil structure is found and cause assessed, the remedials should be implemented and followed up in the next audit
Annual wet weather survey, submission broad findings and remedials	Where runoff is found and cause assessed, the remedials should be implemented and followed up in the next audit
Annual fertiliser spreader and irrigation testing and calibration	Spreaders and irrigators not performing should be recalibrated
Auditing that must be done internally	
Self certification for application of fertiliser according to code of practice	Any failures in observing the code of practice for applying fertiliser should be rectified and followed up in the next audit
Submission of proof of 'approved handler' status	Inappropriate handling of chemicals should cease until an approved handler is in place

Modelling limitations

92. As noted for Glen Eyrie Downs, the OVERSEER model in its current format is not able to model a complete cut and carry system and in the case of WHL Killermont, a more restrictive system is proposed than that which can be modelled. The implications of this are that the nutrient losses modelled in OVERSEER are likely to be an overestimate and therefore even more buffer below the threshold is maintained. Despite this likely overestimate, this level of mitigation should be maintained unless new modelling and or measurements show otherwise.

OHAU DOWNS STATION

Ohau Downs – Receiving environments

93. The proposed irrigation area on Ohau Downs Station, according to the WQS, lies across the Ohau River and Wairepo Creek groundwater sub-catchments, and the Wairepo Creek surface water sub-catchment (Appendix K and L).

94. The potential local receiving environment not captured in the WQS is the Six Mile Creek. A map of receiving environments for the property is shown in Appendix M.

95. Six Mile Creek crosses the property from west to east on the southern side of Lake Ohau Road. The creek's riparian margins and surrounds support a limited number of indigenous species mixed with exotic pasture grasses and herbaceous species. In an environment like this, where almost all of the indigenous vegetation has been lost, this wetland and riparian margin can be considered to be of moderate value, providing connectivity between the wetland areas in the upper tributaries of the stream (the Raupo and Red Lagoon areas) and the environment further downstream which joins the Wairepo Creek (Mitchell Partnerships, 2009).

96. The proposed irrigation area will not impact on the QEII covenanted land, or the lagoons and ephemeral tarns as the movement of groundwater direction is in the opposite direction. The margins of Lake Ohau are likely to be impacted during the construction of the intake, however measures have been advised in Ryder Consulting (2009) and Mitchell Partnerships (2009) to minimise the damage and reinstate to the former condition.

97. The direction of groundwater flow as predicted by the detailed groundwater modelling (covered in detail in the evidence of Dr John Bright) indicates that the general groundwater is moving from west to east. In the northern part of the property, the groundwater is modelled to move in a south-easterly direction around Table Hill. Therefore any impacts seen in the Six Mile Creek in the irrigation command area are likely to be as a result of activities in that area and from the northern blocks of Glen Eyrie Downs.

Ohau Downs Station – WQS thresholds

98. Table 8 below shows the proposed whole farm losses from WQS, the WQS thresholds and the OVERSEER modelling outputs (modelling the proposed

system with mitigations). For this farm, the N mitigation requirements are the most stringent for groundwater in the Ohau River groundwater sub-catchment and the P mitigations are most stringent for the Ahuriri Arm[7]. These mitigation requirements set Ohau Down's nutrient discharge allowance at 55,954 kg N per annum and 3,793 kg P per annum. A full table showing the mitigation requirements for each receiving environment and the original predicted losses are given in each FEMP attached to this evidence.

Table 8 Total N and P losses modelled by OVERSEER for two proposed farming systems on Ohau Downs, WQS thresholds and original WQS proposed farm losses

	WQS whole farm proposed losses	**WQS threshold kg/year**	**OVERSEER modelling outputs kg/year**
Total N leaching/runoff	90754	55,954	44,357 (alternative system 49,804)
Total P leaching/runoff	5893	3,793	1,330 (alternative system 1,565)

99. On a per hectare basis over the entire farm, this gives an N loss of approximately 8.7 kg/ha and a P loss of approximately 0.3 kg/ha. These losses are in the range reported by AgResearch for irrigated beef and sheep paddocks in their modelling of stations in the Upper Waitaki (GHD, 2009), and is an increase of less than 4 kg/ha over the farm from the current farm system losses modelled by AgResearch (Snow et al., 2008).

100. At a highly developed setting, the modelled N losses increase to 56,030 kg N with a higher amount of N fertiliser used (150 kg N) and 47,643 kg N using the same as the under developed (100 kg N). An increase of the restricted grazing from two months to six months reduces the N losses to 52,363 kg N and is within the threshold at the higher fertilisation rate.

101. Under the alternative system (intensive beef/sheep and dairy support) at a highly developed status, losses of 57,003 kg N were modelled. In order to maintain this system under the threshold, an increase of the % of beef stock on the feed pad in the winter was modelled (to 100%). This gave a new loss of 52,714 kg N/ha, thus complying with the threshold or farm NDA.

[7] A proportion of the Wairepo Creek is diverted into the Willow Burn sub-catchment

Ohau Downs – Proposed farm system with mitigations

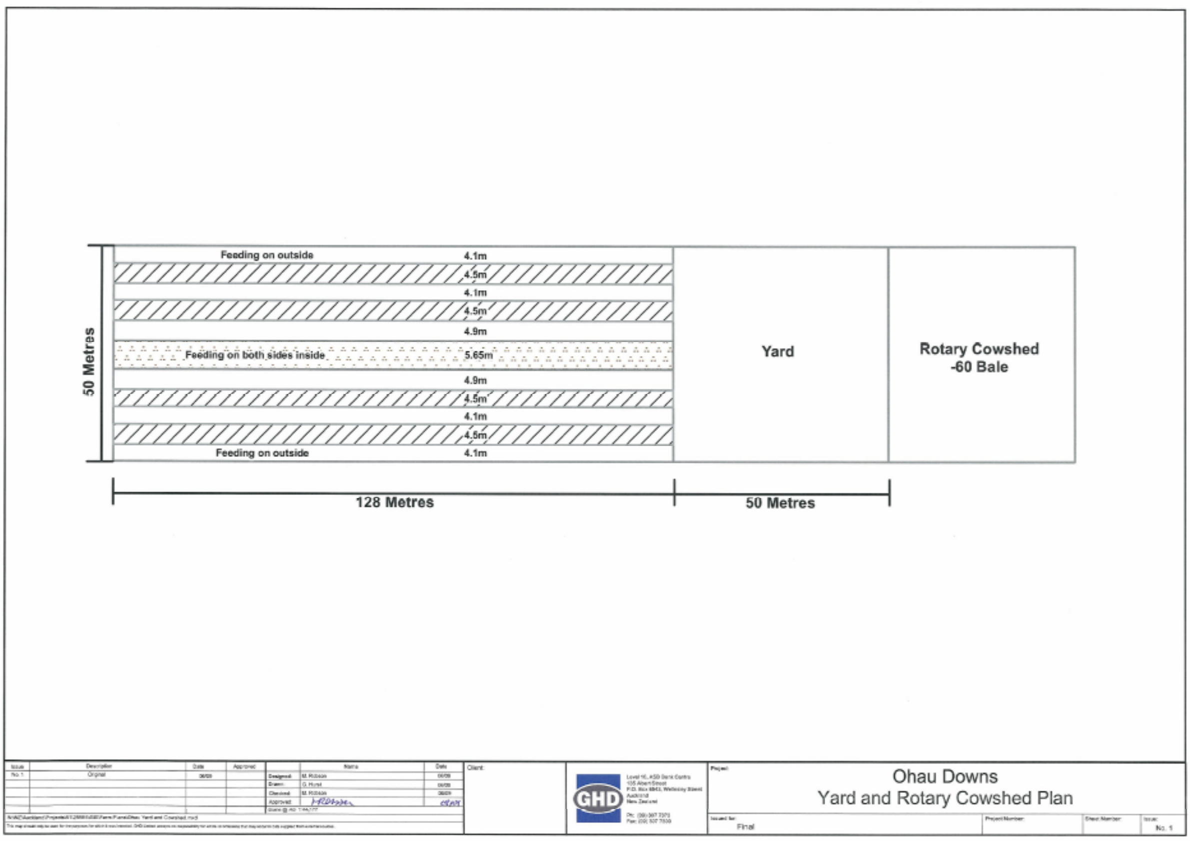
Farm operation

102. The proposed system on Ohau Downs is as for Glen Eyrie Downs. Only the points of difference will be described. An annotated map of the key mitigations is shown in Appendix N.

103. Stock will be fully housed for six months and partially housed for a minimum of two months. On the dryland areas of the farm, the existing merino sheep enterprise will continue.

104. The layout of the cubicle stables is shown as follows. The layout of the cubicle stable is shown below in Figure 3. The plan view shows the milking sheds and yard on the right and the layout of the cubicles in the centre interspersed with alternative effluent lanes and feeding lanes. Effluent is dry scraped along the effluent lanes and into an effluent bunker to be separated and then stored (not shown), also draining to the effluent bunker are the silage clamps, also not shown. The whole unit is covered by a roof.

Figure 3 Proposed layout of the cubicle stables including silage clamp and effluent collection facility



Production

105. Pasture production is expected to be approximately 14 tonnes/ha on irrigated and fertilised land and the sheep flock are expected to produce 22,000 kg wool/year. A medium clover content has been used.

Effluent

106. Manure handling – Solid and liquid fractions of effluent are not separated on Ohau Downs Station.

Fertiliser

107. Soil Olsen P should remain within the agronomic target range and < 30. On the Irrigated Isolation block an Olsen P of 30 would generate higher P losses than from the Wairepo block due to the soil type, however they would still below the farm's nutrient discharge allowance.

Water

108. 1,493 ha of the farm is planned to be irrigated at a rate of 600 mm/year. The source of the irrigation water is Lake Ohau.

Ohau Downs – Monitoring and auditing

109. The environmental monitoring plan for Ohau Downs Station is shown below. An annotated map of the monitoring points on Ohau Downs is shown in Appendix O.

Table 9 Location, frequency and parameters for monitoring on Ohau Downs

		Location	**Frequency**	**Measured parameters to include**	**Triggers**	**Contingency plan if triggers are exceeded**
Soil	Soil nutrient testing	All blocks in rotation	1 in 3 years	Standard suite of soil nutrients, C, N and organic matter	Olsen P of 30	Reduce or stop addition of P fertiliser to area and monitor.
Soil	Soil compaction survey	All hydro-logically connected blocks	Annually	Surface and subsoil compaction	Compaction, surface capping	Remove compaction with appropriate tool.
Soil	Wet weather survey	All blocks	Annually	Runoff from centre pivot tracks	Runoff occurring	Immediately review current runoff mitigation options for pivot tracks. Introduce further runoff removal infrastructure.
Effluent	Irrigated effluent nutrient testing	All blocks receiving effluent	Regularly throughout spreading season	Total N, nitrate, ammonia, dissolved reactive	NA	

		Location	Frequency	Measured parameters to include	Triggers	Contingency plan if triggers are exceeded
				phosphorus, BOD		
Effluent	Cumul-ative effluent application	All blocks receiving effluent	Record each time effluent is applied	Application depth	200 kg effluent N including solid fraction	Store until exportation can be arranged. Export enough to maintain application at less than 200 kg.
Water	Ground-water quality	Any farm bores	Annually at mid depth of aquifer	Total Nitrogen, nitrate, ammonia, total kjeldahl nitrogen, total phosphorus, dissolved reactive phosphorus.	> 2 mg/l nitrate-N above current	If groundwater analysis indicates an excedence of 2 mg/l above current, the N application to land should be reduced or stock withheld for longer until a root cause analysis can be conducted.
Water	Surface water quality	Entry and exit of Six Mile Creek and Wairepo Creek on property boundaries.	Monthly for first couple of years to establish patterns	Total Nitrogen, nitrate, ammonia, total kjeldahl nitrogen, total phosphorus, 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 may 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 in house 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 in house and 1 in 5 years by an independent	Application uniformity		Optimisation of the spreader performance will be performed at the time of testing.
Pasture	Ground cover	Isolation Irrigated block	2 x per year until full cover	% Ground cover	>80%	Soil nutrient and compaction testing should be performed to identify possible causes if unexplained by management.

110. An annual auditing plan has been proposed for Ohau Downs Station. The audit plan examines both the compliance with the WQS thresholds and the management options implemented to address identified site specific environmental issues. The audit table also includes the action to be taken in the case of non-compliance.

Table 10 Table showing proposed contents of an annual audit report for Ohau Downs

Audit measures	Action in the case of non-compliance
Additional auditing that must be done externally	
Check the clean and dirty water separation methods in and around the cubicle stables, parlour and yards, plus photographs	If any contamination of clean water is found all water should be directed to effluent store until problem is found and effective separation is verified
Check for evidence of direct discharges from the cubicle stables, parlour and yard area	Any direct discharge must be stopped immediately. Temporary barriers such as straw bales may be used to take up any discharges until permanent structures are in place
Check riparian planting and fencing is present where it should be and that it is intact, plus photographs	Any failure in the integrity of the fencing should be repaired immediately or a barrier placed around gap to prevent stock access until repair is made
Check the storage of liquid fraction for visible signs of discharge and maintenance of freeboard. When empty, the integrity of the lining should be checked and repairs made if necessary.	Any uncontrolled discharge of effluent must be stopped immediately. If a failure of the lining is suspected, the store must be pumped out and the lining inspected and repaired if necessary The freeboard should be maintained at all times.
Check the storage of silage for visible signs of discharge and destination of silage liquor	All liquid should drain into effluent storage. Any discharge must be stopped immediately. Temporary barriers such as straw bales may be used to take up any discharges until permanent structures are in place
Check fertiliser storage and filling area.	There should be no possibility of loss of fertiliser to drains or direct discharge to ground. Any drains should be covered, or the filling area moved to where no discharges will occur.
Annual audit of OVERSEER nutrient budget and report based on previous 3 years. Submission of compliance with thresholds	Should the OVERSEER report show losses exceeding the threshold, further mitigations should be adopted to effect a reduction in nutrient loss to below thresholds.
Fertiliser spreader and irrigation testing and calibration 1 in 5 years by independent auditor	Spreaders and irrigators not performing should be recalibrated
Additional auditing that can be done either externally or internally	
Reconciliation of fertiliser, effluent and soil records with nutrient budget and fertiliser recommendations	Where reconciliation is not possible and an over application has occurred, this should be rectified in the following year
Submission and brief interpretation of soil, effluent, water quality, supplement and machinery calibration tests	Where triggers have been exceeded, immediate contingency plans should have been effected and a root cause analysis conducted. The results of which should be presented here.
Submission of field records demonstrating fertiliser and effluent practice and nil and restricted grazing periods	Where field records show variation from proposed nil and restricted grazing, changes must be justified and the farm shown to remain within threshold limits, or the practice must revert to the proposed system
Submission of silage clamp and effluent storage design plans	Once approved, the plans need only to be submitted once

Audit measures	Action in the case of non-compliance
Submission of example irrigation schedules and calculated water use efficiency	Where calculated water use efficiency is such that the trigger is exceeded, remedial action of how the system is to be optimised should be submitted, and followed up in the next audit
Annual quadrat testing for % ground cover, submission broad findings	Where poor groundcover is found and cause assessed, the remedials should be implemented and followed up in the next audit
Annual soil compaction survey, submission of broad findings and remedial actions proposed	Where poor soil structure is found and cause assessed, the remedials should be implemented and followed up in the next audit
Annual wet weather survey, submission of broad findings and remedial actions proposed	Where runoff is found and cause assessed, the remedials should be implemented and followed up in the next audit
Annual fertiliser spreader and irrigation testing and calibration	Spreaders and irrigators not performing should be recalibrated
Auditing that must be done internally	
Self certification for application of fertiliser according to code of practice	Any failures in observing the code of practice for applying fertiliser should be rectified and followed up in the next audit
Submission of proof of 'approved handler' status	Inappropriate handling of chemicals should cease until an approved handler is in place

KILLERMONT STATION (Mr and Mrs Thomas)

Killermont Station – Receiving environments

111. Killermont Station according to the WQS, lies in the Omarama and Ahuriri groundwater and surface water catchments, Appendix P and Q.

112. The local receiving environments not captured in the WQS are the Manuka Creek, Frosty Gully, Tara Hills Irrigation race and a small section of the Ahuriri River. The overall water quality in the Ahuriri River is considered by the WQS, however the on farm activities in Pebbly block could affect the immediate hydrologically connected area of the river. The receiving environments of Killermont Station are shown on a map in Appendix R.

113. Tara Hills water race diverts, takes and uses water from the Ahuriri River for stock and domestic water supply, irrigation and augmentation of the Omarama Stream. Water diverted from the Ahuriri River is conveyed to the research station via an open race that traverses the applicant's property and area proposed to be irrigated (Aqualinc, 2009).

114. Manuka Creek is a typical high country stream, consisting of one main channel and forms an ephemeral tributary of Omarama Stream. Flow in Manuka Creek is sourced from springs and snow melt. Flows in the upper catchment are continuous, however in the lower reaches, approximately 200 m below the proposed abstraction point, flows are lost to ground and only in periods of extremely high flows does Manuka Creek reach Omarama Stream (Aqualinc, 2009). The Manuka Creek was flowing at the time of my site visit.

115. Frosty Gully is a snow and spring feed creek that is fully contained within Killermont Station, forming an ephemeral tributary of Manuka Stream. Currently all flow in the creek is collected in a dam located at the downstream end at or about map reference H39:559-248, from which the applicant is proposing to abstract water. Below the dam the creek bed is dry, except for some minor seepage from the base of the dam. During higher flows, or when abstraction from the dam does not occur, some water flows over the crest of the dam and down the existing creek channel towards Manuka Creek, however it only reaches it during periods of extremely high flow; otherwise any flow disappears underground approximately 250 m downstream of the dam (Aqualinc, 2009). The Frosty Gully was flowing at the time of my site visit.

116. Small brown trout have been found in Frosty Gully upstream of the dam (Ryder Consulting, 2009a).

Killermont Station – WQS thresholds

117. A table showing the proposed whole farm losses from WQS, the WQS thresholds and the OVERSEER modelling outputs (modelling the proposed system with mitigations) are shown below. For this farm, the Ahuriri Arm of Lake Benmore mitigation requirements are the most stringent. These mitigation requirements set Killermont Station's nutrient discharge allowance at 9,440[8] kg N per annum and 179 kg P per annum. A full table showing the mitigation requirements for each receiving environment and the original predicted losses are given in each FEMP attached to this evidence.

Table 11 Total N and P losses modelled by OVERSEER for the proposed farming system on Killermont Station WQS thresholds and original WQS proposed farm losses

	WQS whole farm proposed losses	**WQS threshold kg/year**	**OVERSEER modelling outputs kg/year**
Total N leaching/runoff	14,264	9,440	9,284 (alternative system 8,838)
Total P leaching/runoff	829	179	172 (alternative system 177)

118. On a per hectare basis over the entire farm, this gives an N loss of < 4 kg/ha and a P loss of < 0.1 kg/ha. The N loss is less than the typical reference range for New Zealand farms reported in OVERSEER of 5-20 kg N/ha.

119. At a highly developed setting, the modelled N losses increase to > 12,000 kg N for both systems. This station is already proposing to undertake significant farm management measures to meet their threshold under developed settings and have received some reallocated N from WHL Killermont. Without a shift in farm system, it may be that acquiring of additional N is the most effective way forward in the future. However, if this is not possible, the threshold or NDA can be met under the highly developed setting through reducing stock numbers and fertiliser inputs[9].

[8] This includes 1500 kg N 'gift' from WHL Killermont
[9] This system has not been assessed for economic feasibility.

120. Where stations' modelled proposed system do not meet their threshold using the highly developed setting, it is imperative that they monitor soil organic matter development and rate of accumulation to assess soil development.

Killermont Station – Proposed farming system with mitigations

Farming operation

121. The proposed farm system on the main block is a partially irrigated beef, deer and sheep unit. On the main block would be high performance pasture (irrigated and fertilised), hill country, dryland pasture, along with limited forage cropping for pasture renewal. On the Pebbly block, a cut and carry system is proposed on approximately half of the block, to provide dry matter to local dairy farms. Solid manure from the neighbouring dairy unit will be imported and dry matter exported. No stock will be grazed on this block.

122. An alternative farm system is for the Pebbly Block to remain in its current condition and all the proposed irrigation to be conducted on the Home Block. In this alternative system, solid manure will be brought on to the Home Block and all irrigated blocks would be grazed and have supplements removed to be exported from the farm.

123. An annotated map of the key mitigations can be found in Appendix T.

Soils

124. The FERA highlighted potential soil issues arising from the vulnerable nature of the soils to erosion, the susceptibility of exposed soils to capping and the possibility of trafficking soils when wet. The proposed management option or mitigations are:

(a) Proposed irrigation and consequent full ground cover to protect the soil from erosion.

(b) Ground cover, either green or trash, to be maintained through pasture to pasture renewals on Pebbly Block and by spraying and direct drilling of fodder crops and pasture reseeds.

(c) No trafficking of soils when wet, and as this is not always possible, the annual monitoring and identification of soil compaction in hydrologically connected areas and documented remedial actions taken.

Stock

125. 4,200 Merino breeding ewes and 800 ewe hoggets will be reared for ewe flock replacements. The balance of 3,400 surplus lambs will be wintered, shorn in September and sold prime in October to December. 250 steer and heifer yearling cattle will be purchased and finished. 300 breeding hinds with fawns weaned and retained to be sold in the following spring.

126. The FERA highlighted potential stock issues arising from the non-exclusion of beef stock from the watercourses when they are flowing, and the grazing of stock over winter with no provision for reducing these losses. In addition higher losses of P are associated with deer due to wallowing behaviour and fence-line running. The proposed management options or mitigations are;

(a) The exclusion of stock from watercourses by temporary fencing when the watercourses are flowing.

(b) The use of a nitrification inhibitor on the irrigated land will reduce winter stock nutrient losses.

(c) No runoff from deer wallows or fence-line runs allowed to enter a watercourse.

Production

127. The irrigated areas will be under ryegrass/white clover and medium clover levels are expected. Pasture production is expected to be approximately 13.5 tonnes/ha on fertilised and irrigated land. A pasture utilisation of 70% is assumed on the irrigated area and easy dryland. On the hill slopes, a lower utilisation of 50% is used. On Pebbly Block (intended as a cut and carry block) an 85% pasture utilisation rate has been assumed as the mechanical harvesting and feeding of silage on neighbouring dairy farms will result in greater utilisation rates, and the lack of pasture damage from stock will enhance pasture production (Engelbrecht, 2009). For the alternative system, a pasture utilisation rate of 73% on irrigated land that is both grazed and is cut for silage. The hill country and Pebbly Block have utilisation rates of 50%.

Silage storage

128. Unless impermeability can be illustrated on the existing clay lined silage pit, silage should be made and stored on a concrete[10] pad with an impermeable cover, and effluent collected. Silage effluent production can be greatly reduced by ensuring that the dry matter of the grass is > 35%. A visual inspection should be made of the clay lined pit and any effluent lost from the front of the pit should be immediately attenuated e.g. with straw or sawdust/ shavings.

Effluent

129. No effluent will be stored or used on the property, but solid manure will be imported from the neighbouring farm; therefore no provisions are required for effluent/manure storage. Effluent will be applied using a calibrate spreader. Manure application will not exceed 200 kg N/ha/year. No manure will be applied within 20 m of a watercourse and all applications will be recorded and accounted for when determining fertiliser recommendations. These conditions will also apply under the alternative system.

130. The proposed additional management measure is:

(a) A farm map showing no spread areas should be clearly displayed in the farm office and in the tractor cab.

Fertiliser

131. Specific fertiliser recommendations will be produced on an annual basis using a recommended system. Plant nutrient supply will be estimated from both organic and inorganic fertilisers as well as N fixation using a nutrient budgeting system. The manure imported onto Pebbly Block will provide an important part of the nutrient requirement for that block. Or in the alternative system, the manure will provide an organic input onto the Home Block

132. The FERA highlighted potential fertiliser issues arising from N applications occurring in autumn and winter, elevation of Olsen P levels and no suitable storage and filling area having been identified. The proposed management or mitigation options are:

(a) No N fertiliser to be applied in autumn and winter.

(b) N fertiliser applications to be split to less than 50 kg N/ application.

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[10] The concrete will need to be an appropriate specification for containing silage as the effluent is highly corrosive.

(c) Soil Olsen P levels to be maintained below 25.

(d) Fertiliser will be stored in a covered area.

(e) The identified fertiliser filling area will be at least 50 m from a watercourse of spring or bore and will have no drains that discharge to clean water or that can discharge straight to ground.

(f) If liquid fertiliser is used, fertiliser will be stored in a bunded tank and also protected from vehicle movements.

Cultivation

133. Direct drilling is expected to be the principal method of establishing crops and reseeding pastures. The FERA highlighted potential soil risks arising from inversion tillage. The proposed management or mitigation option is:

(a) Direct drilling is expected to be the principal method of establishing crops and reseeding pastures.

Water and Runoff

134. 619 ha of the farm is planned to be irrigated at a rate of 600 mm/year. Final design has avoided water crossings.

135. The FERA highlighted potential water and runoff risks arising from beef stock having access to watercourses (Manuka Creek and Frosty Gully), the access into a top paddock above Frosty Gully dam is through the waterway and vehicular access through Manuka Creek. In addition, elevated P losses are associated with runoff from deer wallowing and fence-line running. The proposed mitigation or management options is:

(a) When watercourses are flowing, temporary fencing to prevent stock encroachment of Manuka Creek and Frosty Gully.

(b) Water gates to prevent beef stock encroachment of Manuka Creek and Frosty Gully via vehicular crossing when watercourses are flowing.

(c) No runoff from deer wallows or fence-line runs permitted to reach a watercourse.

Killermont Station – Monitoring and auditing

Table 12 Location, frequency and parameters for monitoring on Killermont Station

		Location	**Frequency**	**Measured parameters to include**	**Triggers**	**Contingency plan if triggers are exceeded**
Soil	Soil nutrient testing	All blocks in rotation	1 in 3 years	Standard suite of soil nutrients, C, N and organic matter	Olsen P of 25	Reduce or stop addition of P fertiliser to area and monitor
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/Manure	Manure nutrient testing	All blocks receiving manure	Regularly throughout spreading season	Total N, Total P	NA	
Effluent/Manure	Cumulative manure application	All blocks receiving manure	Record each time manure is applied	Application depth	200 kg organic N	Import no more manure
Water	Groundwater quality	On Farm bore H39/0045	Annually at mid depth of aquifer	Total Nitrogen, nitrate, ammonia, total kjeldahl nitrogen, total phosphorus, dissolved reactive phosphorus.	> 1 mg/l nitrate-N	If comparative groundwater analysis from existing concentrations indicates an excedence of 1 mg/l due to on farm activities, the N application to land should be reduced or stock numbers reduced until a root cause analysis can be conducted
Water	Surface water quality	Entry and exit (share with WHL Killermont) of Tara Hills race on property boundaries. Exit of Manuka Creek on property boundary when flow permit (share with WHL Killermont)	Monthly for first couple of years to establish patterns	Total Nitrogen, nitrate, ammonia, total kjeldahl nitrogen, total phosphorus, 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 manure, then manure application should cease on the implicated pivots. If the analyses indicate stock encroachment, the stock should be withheld from the connected paddocks.

		Location	Frequency	Measured parameters to include	Triggers	Contingency plan if triggers are exceeded
Water	Irrigation application		Annually in house 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 in house and 1 in 5 years by an independent	Application uniformity		Optimisation of the spreader performance will be performed at the time of testing

136. An auditing plan has been proposed form Killermont Station. The audit plan examines both the compliance with the WQS thresholds and the management options implemented to address identified site-specific environmental issues. The audit table also includes the action to be taken in the case of non-compliance.

Table 13 Table showing proposed contents of an annual audit report for Killermont Station

Audit measures	Action in the case of non-compliance
Additional auditing that must be done externally	
Check riparian planting and fencing is present when and where it should be and that it is intact, plus photographs (when stream is flowing and stock are grazing)	Any failure in the integrity of the temporary fencing should be repaired immediately or a barrier placed around gap to prevent stock access until repair is made
Check watergates are intact and functioning and that there is no signs of encroachment up and downstream of the gates when streams are flowing..	Any failure of the integrity of the gates should be repaired immediately or a temporary structure put in place to prevent stock encroachment.
Check the storage of silage for visible signs of discharge and destination of silage liquor	All liquid should drain into in effluent storage vessel. Any discharge to ground must be stopped immediately. Temporary barriers such as straw bales may be used to take up any discharges until permanent structures are in place
Check fertiliser storage and filling area.	There should be no possibility of loss of fertiliser to drains or direct discharge to ground. Any drains should be covered, or the filling area moved to where no discharges will occur.
Annual audit of OVERSEER nutrient budget and report based on previous 3 years. Submission of compliance with thresholds	Should the OVERSEER report show losses exceeding the threshold, further mitigations should be adopted to effect a reduction in nutrient loss to below thresholds.
Fertiliser spreader/Muck spreader and irrigation testing and calibration 1 in 5 years by independent auditor	Spreaders and irrigators not performing should be recalibrated
Additional auditing that can be done either externally or internally	
Reconciliation of fertiliser, effluent and soil records with nutrient budget and fertiliser recommendations	Where reconciliation is not possible and an over application has occurred, this should be rectified in the following year

Audit measures	Action in the case of non-compliance
Submission and brief interpretation of soil, manure water quality and machinery calibration tests	Where triggers have been exceeded, immediate contingency plans should have been put in place and a root cause analysis conducted. The results of which should be presented here.
Submission of field records demonstrating fertiliser and manure practice	Where field records show variation from proposed system, changes must be justified and the farm shown to remain within threshold limits, or the practice must revert to the proposed system
Submission of example irrigation schedules and calculated water use efficiency	Where calculated water use efficiency is such that the trigger is exceeded, remedial action of how the system is to be optimised should be submitted, and followed up in the next audit
Annual quadrat testing for % ground cover, submission broad findings	Where poor groundcover is found and cause assessed, the remedials should be implemented and followed up in the next audit
Annual soil compaction survey, submission of broad findings and remedial actions	Where poor soil structure is found in hydrologically connected areas, the remedials should be implemented and followed up in the next audit
Annual fertiliser spreader and irrigation testing and calibration	Spreaders and irrigators not performing should be recalibrated
Auditing that must be done internally	
Self certification for application of fertiliser according to code of practice	Any failures in observing the code of practice for applying fertiliser should be rectified and followed up in the next audit
Submission of proof of 'approved handler' status	Handling of chemicals should cease until an approved handler is in place

Modelling limitations

137. The OVERSEER model in its current format is not able to model a complete cut and carry system as the model will only allow up to 50 % of the dry matter grown on a paddock to be cut, with the remainder having to be grazed. This limits the extent to which a restricted grazing model can be modelled, and in the case of Killermont Station, a more restrictive system is proposed on Pebbly Block than that which can be modelled. The implications of this are that the nutrient losses modelled in OVERSEER on this block are likely to be an overestimate.

SECTION 42A RESPONSES

138. A number of the concerns raised in the Section 42A Officers' reports related to the cumulative impacts on water quality and more specifically that either the WQS thresholds did not in themselves confer adequate protection or that insufficient evidence had been supplied that the requirements set out in the WQS would be met (including concerns over local impacts on water quality). These concerns have been fully addressed in the MWRL case. However, I wish to comment on the ability to meet the WQS thresholds for these properties..

139. The FEMPs submitted for each property clearly demonstrate how the requirements set out in the WQS for the wider environment have been complied with through meeting the farm thresholds or NDAs. In addition, the FEMPs view features such as watercourses, lagoons, wetlands as local receiving environments to the farm and put in place mitigation and management strategies such that these features are protected. To ensure that the measures recommended are implemented on farm, the FEMPs have both a monitoring plan and an auditing plan. These plans allow the farmer to demonstrate compliance, and the regulatory authority and other interested parties to have confidence in the plan doing what it sets out to do. Where the measures in the plan are not working, there is a clear mechanism for these to be identified and new measures put in place.

140. Set out below are my responses to the site specific issues raised in the s42A report

Ohau Downs Station

141. The Section 42A report states in paragraph 63 that Ohau Downs Station will only be used for intensive beef and sheep. The applicant is proposing a housed dairying system using cubicle stables which will reduce the nutrient losses below that of an equivalent intensity beef and sheep operation. With regard to both local and wider receiving environments, considerably less nutrients than the farm NDA permits are modelled to be released (11597 kg N and 2463 kg P below the threshold) under the proposed system.

Glen Eyrie Downs Station

142. With regard to Glen Eyrie Downs Station, it is stated in paragraph 11 of the s42A report that there is currently border dyke irrigation in Glen Eyrie Downs. This is incorrect, as there is currently no irrigation in place on the station. In

paragraph 35(a) it is stated that the property is currently in low intensity beef and sheep. Currently the property is under a cropping programme for biofuel production.

143. Concerns raised in the Section 42A Officer's report are:

(a) That significant waterbodies pass through the station.

(b) That the QEII covenanted area is next door and the station plans to dairy farm.

144. Significant surface water bodies pass through the property. Within the FEMP, the Six Mile Creek, Wairepo Creek and Serpentine Creek plus tributaries are all subject to riparian protection through fencing and planting. In addition a 20 m layback of fertiliser and effluent will be observed. Any crossings will be over bridges and any tracks will have structures such as cross drains to prevent runoff direct to the watercourses. These actions will confer more protection to the watercourse than exists currently.

145. The QEII covenant area is adjacent and dairying in proposed. The QEII area is recognised in the FEMP as a local receiving environment for Glen Eyrie Downs Station. The nil and restricted grazing system proposed will minimise N leaching due to the complete absence of stock on the paddocks for 8 months of the year and will confer greater protection in terms of N and P loss than the current system.

WHL Killermont

146. It is stated in paragraph 78 of the Section 42A report that the property is currently in low intensity beef and sheep. Currently the property is capable of extremely limited dry matter growth and therefore capable of supporting virtually no stock.

147. With regard to WHL Killermont, considerably less nitrogen than the threshold permits are modelled to be released (16,905 kg N below the threshold) under the proposed system.

Killermont Station

The report related to the recommended thresholds in the WQS and the absence of mitigations put forward to meet them.

RESPONSE TO SUBMITTERS

Waitaki First Incororated

148. Waitaki First Incorporated express concerns based on provisions around the take and use of water, adverse impacts on water quality and monitoring. The first concern related to efficient and appropriate use of water. Mandatory good agricultural practices, that are committed to, stipulate that the irrigation system must be appropriate to the soils, capable of delivering water to at least 80 % uniformity and must be subject to robust irrigation scheduling which includes the use of technology such as Aquaflex to determine soil moisture deficit. While monthly reports to ECan on SMD are not envisaged, annual ones are proposed.

149. The second concern raised by Waitaki First Incorporated is that proactive steps need to be taken to decrease the potential risk of adverse impacts of agricultural intensification on water quality. The FEMP process sets out to address the specific environmental issues associated with farming a particular enterprise in each specific location. Concerns are raised about the flushing of bacteria to groundwater through over irrigating. The effluent management provisions highlighted in the FEMP for mitigating effluent nutrient losses will also be effective for bacteria.

150. Thirdly, Waitaki First Incorporated proposed that monitoring should be in place to monitor the cumulative effects on water quality. A three tier monitoring programme has been proposed combining on farm monitoring and auditing and sub-catchment and catchment scale monitoring to maintain an on-going assessment of the cumulative impacts of the development.

Stephen Carswell

151. Stephen Carswell expresses concerns that the more intensive farming and runoff will lead to irreversible degradation in water quality. The nutrient concentrations in the principle watercourse will increase with more intensive land use, however, the thresholds recommended by the WQS maintain the water quality in the principle watercourse below ANZECC trigger guidelines. In addition, the degraded physical nature of the watercourses that traverse Ohau Downs and Glen Eyrie Downs will be improved through the mitigation measures laid out in the FEMP.

DoC

152. DoC express concern that no mitigation of any significance is proposed or that mitigation is insufficient. For example, the mitigation measures being proposed on Ohau Downs, Glen Eyrie Downs and SHL Killermont of cubicle stable dairy farming where stock are housed completely for 6-8 months of the year and partially for the remaining of the year, and with approximately 30 mitigation and management measures to adhere to are extremely significant as a mitigation that will be highly effective in limiting the nutrient losses from the farming system. On Killermont Station, approximately 25 mitigation and management measures are proposed and are modelled to maintain losses below the typical New Zealand range for sheep and beef farms

Meridian Energy Limited

153. Meridian Energy Limited express concern in submissions over the potential cumulative effects on water quality of these applications along with other concurrent applications. Of particular relevance in MEL's submitted evidence is concern expressed over the Wairepo Arm/Kelland pond. MWRL have found the water body to be typically in a mesotrophic state, however the concern raised by MEL was that a higher TLI than that found in the WQS should be used for current conditions. Further sampling should be conducted to verify the current state. However, it should be noted that the proposed farming systems on Ohau Downs and Glen Eyrie Downs are modelled to release substantially lower N and P than their farm NDA, and consequently less N and P will be lost to the environment and into the Wairepo Arm (a combined total of over 18500 kg N and over 2400 kg P below farm thresholds).

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