BEFORE THE COMMISSIONERS APPOINTED BY THE WAIKATO REGIONAL COUNCIL

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of the First Schedule to the Act

AND

IN THE MATTER of Waikato Regional Plan Change 1- Waikato and Waipā River Catchments and Variation 1 to Plan Change

AND

IN THE MATTER of submissions under clause 6 First Schedule

BY **BEEF + LAMB NEW ZEALAND LIMITED**
Submitter

EXECUTIVE SUMMARY OF DR JANE MARIE CHRYSTAL
27 JUNE 2019

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BACKGROUND

1. My full name is Dr Jane Marie Chrystal.

2. I am a soil scientist specialising in farm systems and environmental impact modelling. I am employed by Beef and Lamb New Zealand as their Senior Environment Data Analyst.

3. Prior to working for Beef and Lamb New Zealand I was employed by AgResearch for 11 years. There my work focused mainly on the dairy industry, specifically modelling nutrient losses from dairy farms using Overseer and also generating base farm files using Farmax DairyPro. The topic of my PhD was Dairy wintering systems in Southern New Zealand – quantification and modelling of nutrient transfers and losses from contrasting wintering systems.

4. I provided a Statement of Evidence in Chief on behalf of Beef + Lamb New Zealand dated 15 February 2019 and 9 May 2019.

5. I confirm the qualifications and experience set out in my Statement of Evidence in Chief.

6. I have read the Code of Conduct for Expert Witnesses in the Environment Court's 2014 Practice Note and I have complied and continue to comply with it.

SCOPE OF EVIDENCE

7. I have been engaged by Beef + Lamb New Zealand to provide evidence based on case studies of the nutrient losses of sheep and beef farms in Waikato. In particular for HS2 I consider the application of the Nitrogen Reference Point (NRP) and its effects on extensive farming systems.

CORRECTIONS TO EVIDENCE IN CHIEF

8. Commissioners, can I please draw your attention to two sections of my evidence in chief that require corrections.

9. First if you could please turn to paragraph 127. Please strike out, in its entirety the second sentence beginning 'indeed' (Indeed, anecdotal

comment suggests that over half of New Zealand is not). Please also strike out the end of the first sentence after the brackets where I said, “is that not all land is mapped on S-Map”. At the end of the paragraph please add the sentence “However, I understand why the Waikato Regional Council has used Soil Order rather than S-Map as S-Map classification does not cover the whole of the Waikato region.” Please also circle the third sentence beginning ‘Appendix 21’ and move that to the end of the paragraph. Then please add the sentence, “I suggest that a complete coverage of S-Map of the region is a priority and once that is available then the use of Soil Order should be replaced by the use of S-Map.”

10. The paragraph should now read; “ I disagree strongly with the use of Soil Order instead of S-Map (an online soils database provided by Manaaki Whenua-Landcare Research; https://smap.landcareresearch.co.nz/). My view is that using Soil Order rather than the more detailed S-Map Soil Series may result in large variations in nitrogen leaching loss values calculated by OVERSEER® for some soil types. However, I understand the reasoning for using Soil Order rather than S-Map as S-Map classification does not cover the whole of the Waikato region. Appendix 21 shows the areas of Waikato in the Waikato-Waipā catchment that are not on S-Map. I suggest that a complete coverage of S-Map of the region is a priority and once that is available then the use of Soil Order should be replaced by the use of S-Map.”

11. Can I also please draw your attention to Appendix 8. That is the incorrect table for that farm. That owner has two farms a dairy and a sheep and beef farm. The correct LUC table is attached to this document. Please note, however, that the analysis I conducted used the correct sheep and beef farm LUC details.

12. I have also reproduced appendices 6 and 10 in this statement for ease of reading.

EXECUTIVE SUMMARY

13. A significant component of my brief was to conduct computer simulation modelling work to assess the implications of the application of a Nitrogen Reference Point (NRP) and the effects on extensive farming systems.

14. For this reason, and because I covered the main drivers of nitrogen, phosphorus and sediment loss in my HS1 evidence, I focus primarily on nitrogen in relation to allocation in this hearing stream 2 evidence.

15. I used three case study farms to look at the financial implications of constraining farms to a nitrogen reference point.

16. The three farms selected were chosen because these farmers have the comprehensive and reliable data sets required to conduct the modelling analysis. These farms are also covered by S-Map, they cover 2 of the three Farm Class classifications in Waikato; the more intensive Farm Class 5 farms (Case Study 1, 12.4 SU/ha), and less intensive Farm class 4 farms (case study 2 and 3 at stocking rates of 10.6 and 9.6 SU/ha, respectively). There were no Farm Class 3 farms that met the data requirements plus being covered by S-Map.

17. I used a computer model called APSIM (agricultural production simulator) to model pasture growth rates using Waikato climate data over a 12-year period. The 12-year period was used because the AgInform® model that these were produced for runs the simulation for 10 years and I generated pasture growth rates for the 10 years prior to and including to the NRP year of 15/16 and I stretched the data collection out to include the 2 following years. Those results showed a wide range in total production and monthly growth rates. The greatest between-year variation occurs during summer/autumn.

18. Looking at this graph and where the nitrogen reference point years sit in relation to the average, the likely impact of the NRP being set using these years is that it would be lower than the average. The 2015/16 season has very low pasture growth rates in autumn. Autumn deposited urine patches are high risk as the nitrogen is deposited when there is less pasture growth and where it receives all the winter rainfall and it

therefore has a much higher potential to be lost in drainage. Lower pasture growth rates than average in autumn will result in less feed available and quite likely result in farmers selling more animals than average during autumn. Less animals on the land results in less urine patches and a lower predicted N leaching which will be a lower than average NRP.

19. I then used these pasture growth rates, adjusted for the carrying capacity of the different land management units on each farm, to financially optimise each farm using an AgResearch modelling tool called AgInform®.

20. This model is used to answer questions at the strategic level. It is used to financially optimise a farm over multiple years (up to 10 years) given the fixed farm resources. Where this model differs from other agricultural production simulation models is that it looks at the impacts over time rather than looking at a snapshot in time. In addition, the model uses the information provided of the different pasture growth curves for different areas of the farm over the multiple years. The pasture growth rates are a proxy for; soil type differences, slope and topography differences and climatic differences.

21. The development team of the AgInform® model have shown a difference in the financial and production output of the model when using the multi-year version compared to the single-year steady-state version. They have subsequently found that stocking density is over-estimated by approximately 30%, and NPV by 20%, when using a steady-state, single-year model compared to looking at the farm over a 10-year period.

22. One key attribute of the model is that it has the ability for the user to define constraints for the property, such as constraining the farm to particular systems (e.g. remain sheep and beef finishing). When used in conjunction with Overseer it can maximise a farming system within environmental limits (losses of N; by imposing limits on Urinary N at different times of the year, and P; by excluding classes of animals from LMUs at times of the year).

23. I ran the model initially with no constraints then added the constraints of:

    (a) No winter applied N fertiliser

    (b) No nitrogen fertiliser applied

    (c) Restricted urinary N

24. These graphs show the Overseer predicted N leaching from the three case study farms over a 10-year period. The grey line is the NRP for the actual farm, the red line is the average N loss for the scenario (in this case it was optimised with no N fertiliser) and the red dots are the individual N loss values for each year.

25. Optimisation of case study farms using these PGR curves results in an OVERSEER®-predicted average nitrogen leaching loss values that vary widely between scenarios. One scenario resulted in an average loss of 14 kg N/ha/yr over 10 years with a range of 12 to 21 kg N/ha/yr, which was a response to altering the farming system to maximise production as pasture production varied between years.

26. An important factor to note is that these N loss values are Overseer predicted using the standard 30-year average climate data thus the climate data for each of the years modelled in Overseer is the same. Therefore, the fluctuation you see between years is not caused by rain-induced leaching.

27. Farming to the pasture growth curve results in annual fluctuations in livestock numbers and thus nitrogen leaching losses. Constraining farms that farm to the pasture growth curve to a single nitrogen leaching loss figure significantly constrains their ability to farm and reduces their profitability.

28. For a case study farm to financially optimise its operation (without applying nitrogen fertiliser or buying in supplementary feed), livestock numbers are varied according to the pasture production within a season, which varies. Thus, farmers need to have flexibility around a nitrogen leaching loss limit or a SU reference value to optimise their operations.

29. The key point I want to get across is that extensive farmers with low inputs of supplementary feed and/or nitrogen fertiliser who farm to the grass curve and have fluctuating stock numbers require a Nitrogen Reference Range rather than a Nitrogen Reference Point. They require headroom to allow them to survive into the future. Their stock numbers will fluctuate year-by-year in response to the climate and they will be disadvantaged by having their system constrained to an, already low, N leaching value.

DATED this 27th day of June 2019

Dr Jane Chrystal

APPENDIX 6: CASE STUDY 1 LUC TABLE (pages 68 and 69)

Cambridge Sheep and Beef Farm Land Use Capability Table

Farm resource information	Luc unit	Total area (ha)	Parent material Dominant soil type and characteristics	Slope degree	Land Cover	Erosion degree & severity		Strengths	Limitations	Landuse suitability	Stock carrying capacity (su/ha)	Conditions of use
						Actual	Potential					
4e 1 Strong rolling slopes on yellow-brown loams with a moderate to severe erosion hazard when cultivated. 		78.9	**Parent:** Tephra – Mairoa ash **Soil:** Mairoa clay soil • Well drained • Stoneless • No significant rooting barrier within 1m • Moderate permeability • High P retention (83%) • Low N leaching vulnerability • Very low structural vulnerability (0.2) • Very low water logging vulnerability	8-20°	Pasture	Nil	Slight gully. Moderate to severe sheet and rill and moderate gully when cultivated	• Contour • Accessibility • Free draining soil • Supports high producing pasture	• Moderate to severe erosion limitation under cultivation	Intensive grazing Occasional cropping. Forestry	Average: 14 Top: 18 Potential: 20	• Avoid structural degradation of soils under intensive, regular cropping • Contour cultivation required and minimum tillage practices required

4w 1 Narrow stream terraces and valley bottoms with moderately highwater table and subject to runoff from adjacent hills, dissected by meandering streams. 	13.2	**Parent:** Alluvium and peat **Soil:** Peat soil • Poorly drained/high water tables • Low pH • High carbon:nitrogen ratio • Low mineral content and therefore deficient in all major elements required for plant growth	0-7^0		Nil	Moderate to severe streambank and deposition	• Contour • Accessibility • Greater pasture water availability under drought conditions	• Streambank erosion potential • Seasonal wetness limitation • Seasonal pugging risk	Grazing	Data not available	• Keep heavy stock off when soils are wet • Possible streambank erosion control planting needed
6e 1 Moderately steep to strong rolling slopes on yellow-brown loams over various lithologies. 	132.1	**Parent:** Tephra – Mairoa ash **Soil:** Mairoa clay soil	16-25^0	Pasture	Negligible.	Slight sheet and soil slip	• Free draining soil • Stable, high producing hill country	• Steep gradient precludes cropping • Gradient gives slight erosion risk	Intensive grazing Forestry	Average: 13 Top: 18 Potential: 21	• Maintain good pasture cover. • Carefully plan all earthworks and minimize exposure of bare ground. • When harvesting plantation trees follow industry best practice guidelines.

Farm resource information	Luc unit	Total area (ha)	Parent material Dominant soil type and characteristics	Slope degree	Land Cover	Erosion degree & severity		Strengths	Limitations	Landuse suitability	Stock carrying capacity (su/ha)	Conditions of use
						Actual	Potential					
6e 6 Moderately steep to steep greywacke slopes where rainfall is less than 1500mm p.a. 		161.5	**Parent:** Patchy Mairoa ash over Greywacke **Soil:** Mairoa clay	21-35^0	Pasture Indigenous vegetation	Slight to moderate sheet, soil slip and gully	Moderate sheet, soil slip and gully	• Good natural fertility • Indigenous vegetation adds biodiversity value and shade and shelter for stock	• Steep gradient precludes cropping • Gradient gives a moderate erosion risk • Difficult to revegetate erosion scars • Prone to reversion	Intensive grazing Forestry	Average: 11 Top: 14 Potential: 16	• Maintain good pasture cover. • Carefully plan all earthworks and minimize exposure of bare ground. • When harvesting plantation trees follow industry best practice guidelines. • Open plant poplar poles on steep slopes to help control/prevent erosion • Pair plant willow poles in gullies to help prevent gully erosion
6e10 Strong rolling to steep slopes on Mairoa ash and andesite. 		29.1	**Parent:** Patchy Mairoa ash over andesite **Soil:** Mahoenui loam • Well drained • Moderately stony topsoil • Potential rooting depth 60-80cm, massive rock barrier	16-35^0	Pasture Indigenous vegetation	Negligible	Moderate sheet and soil slip	• Free draining soil • Stable hill country	• Steep gradient precludes cropping • Gradient gives a slight to moderate erosion risk	Intensive grazing Forestry	Average: 10 Top: 11 Potential: 12	• Maintain good pasture cover. • Carefully plan all earthworks and minimize exposure of bare ground. • When harvesting plantation trees follow industry best practice guidelines. • Open plant poplar poles to help prevent/control erosion

		• Slightly limited aeration in the root zone • Moderate over slow permeability • Low P retention (22%) • High structural vulnerability (0.67) • Low water logging vulnerability • Medium N leaching vulnerability									

LUC Unit	Area (Ha)
4e 1	78.9
4w 1	13.2
6e 1	132.1
6e 6	161.5
6e10	29.1
Pond	0.1
Total Area	**414.9**

APPENDIX 8: CASE STUDY 2 LUC TABLE (pages 71 and 72)

Otorohanga Sheep and Beef Farm Land Use Capability Table

Loomans' farm resource information	Luc unit	Total area (ha)	Parent material Dominant soil type and characteristics	Slope degree	Land Cover	Erosion degree & severity		Strengths	Limitations	Landuse suitability	Stock carrying capacity (su/ha)	Conditions of use
						Actual	Potential					
2s 2 Flat to undulating slopes on yellow-brown loams formed on Mairoa ash. 		3.1	**Parent:** Tephra – Mairoa ash **Soil:** Mairoa clay soil • Well drained • Stoneless • No significant rooting barrier within 1m • Moderate permeability • High P retention (83%) • Low N leaching vulnerability • Very low structural vulnerability (0.2) • Very low water logging vulnerability	0-7^0	Pasture	Nil	Nil.	• Contour • Accessibility • Free draining soil • Supports high producing pasture and cropping	• Slight soil limitation for cropping use .	Intensive grazing Intensive cropping Forestry	Average: 14 Top: 17 Potential: 24	• Avoid structural degradation of soils under intensive, regular cropping

2w 1 Low river terraces with a continuing slight wetness limitatio after drainage. 	0.7	**Parent:** Alluvium **Soil:** Awatere sandy loam • Well drained • Slightly stony • No significant rooting barrier within 1m • Rapid permeability • Low P retention (19%) • Low N leaching vulnerability • High structural vulnerability (0.61) • Very low water logging vulnerability	0-3^0	Pasture	Nil	Nil.	• Contour • Accessibility • Supports high producing pasture and cropping	• Slight soil limitation for cropping use • .	Intensive grazing Intensive cropping Forestry	Average: 17 Top: 25 Potential: 28	• Avoid structural degradation of soils under intensive, regular cropping • Careful control of ground water tables necessary
3e 1 Rolling slopes on yellow-brown loams with slight to moderate erosion hazard when cultivated. 	16.7	**Parent:** Tephra – Mairoa ash **Soil:** Mairoa clay soil	8-15^0	Pasture	Nil	Slight to moderate sheet and rill when cultivated.	• Contour • Accessibility • Free draining soil • Supports high producing pasture and cropping	• Moderate erosion limitation under cultivation	Intensive grazing Cropping Forestry	Average: 14 Top: 18 Potential: 21	• Avoid structural degradation of soils under intensive, regular cropping • Contour cultivation required

3w 1 Narrow river terraces with a moderately high water table and subject to runoff from adjacent hills. 	0.4	**Parent:** Colluvium, alluvium **Soil:** Sandy loam over sandy alluvial soils over lying poorly drained colluvium from surrounding hills. Fine textured • No significant rooting barrier within 1m • Low N leaching vulnerability • Low P retention • Imperfectly drained	0-3^0	Pasture	Nil	Moderate streambank	• Contour • Accessibility • Supports high producing pasture and cropping	• Wetness limitation	Intensive grazing Cropping	Average: 9 Top: 12 Potential: 14	• Drainage and streambank protection maybe needed in some places

Loomans' farm resource information	Luc unit	Total area (ha)	Parent material Dominant soil type and characteristics	Slope degree	Land Cover	Erosion degree & severity		Strengths	Limitations	Landuse suitability	Stock carrying capacity (su/ha)	Conditions of use
						Actual	Potential					
4e 1 Strong rolling slopes on yellow-brown loams with a moderate to severe erosion hazard when cultivated. 		39.9	**Parent:** Tephra – Mairoa ash **Soil:** Mairoa clay soil	8-20°	Pasture	Nil	Slight gully. Moderate to severe sheet and rill and moderate gully when cultivated	• Contour • Accessibility • Free draining soil • Supports high producing pasture	• Moderate to severe erosion limitation under cultivation	Intensive grazing Occasional cropping. Forestry	Average: 14 Top: 18 Potential: 20	• Avoid structural degradation of soils under intensive, regular cropping • Contour cultivation required and minimum tillage practices required
4w 1 Narrow stream terraces and valley bottoms with moderately highwater table and subject to runoff from adjacent hills, dissected by meandering streams. 		1.4	**Parent:** Colluvium **Soil:** Porchester clay • Imperfectly drained • No significant rooting barrier within 1m • Moderate over slow permeability • Medium P retention (36%) • Low N leaching vulnerability • Moderate structural vulnerability (0.54)	0-7°	Pasture	Nil	Moderate to severe streambank and deposition	• Contour • Accessibility • Greater pasture water availability under drought conditions	• Streambank erosion potential • Seasonal wetness limitation • Seasonal pugging risk	Grazing	Data not available	• Keep heavy stock off when soils are wet • Possible streambank erosion control planting needed

		• Moderate water logging vulnerability									
6e 1 Moderately steep to strong rolling slopes on yellow-brown loams over various lithologies. 	61.8	**Parent:** Tephra – Mairoa ash **Soil:** Mairoa clay soil	16-25^0	Pasture Indigenous vegetation	Negligible.	Slight sheet and soil slip	• Free draining soil • Stable, high producing hill country	• Steep gradient precludes cropping • Gradient gives slight erosion risk	Intensive grazing Forestry	Average: 13 Top: 18 Potential: 21	• Maintain good pasture cover. • Carefully plan all earthworks and minimize exposure of bare ground. • When harvesting plantation trees follow industry best practice guidelines.
6e 8 Moderately steep to steep slopes om Mairoa ash over Tertiary sedimentary lithologies. 	59.2	**Parent:** Tephra – Mairoa ash **Soil:** Mairoa clay soil	21-35^0	Pasture Indigenous vegetation	Slight soil slip	Moderate sheet and soil slip	• Free draining soil • Stable, high producing hill country	• Steep gradient precludes cropping • Gradient gives a moderate erosion risk	Intensive grazing Forestry	Average: 9 Top: 12 Potential: 14	• Maintain good pasture cover. • Carefully plan all earthworks and minimize exposure of bare ground. • When harvesting plantation trees follow industry best practice guidelines. • Open plant poplar poles on

												steepest slopes to control/prevent erosion
Loomans' farm resource information	**Luc unit**	**Total area (ha)**	**Parent material** **Dominant soil type and characteristics**	**Slope degree**	**Land Cover**	**Erosion degree & severity**		**Strengths**	**Limitations**	**Landuse suitability**	**Stock carrying capacity (su/ha)**	**Conditions of use**
						Actual	**Potential**					
6w 2* Hillside springs and narrow seeps with a severe wetness limitation. Surface water present during the winter with high water tables through the rest of the year. 		0.6	**Parent:** Colluvium and swamp material **Soil:** Unnamed soil Material located at the bottom of narrow gullies fed by hillside springs and runoff. Material to wet and undeveloped to be called a soil.	0-7^0	Rushes, pasture	Severe debris flow	Moderate to severe streambank and debris flow	• If retired water quality and biodiversity benefits	• Severe wetness limitation • Erosion potential	Retirement Light sheep grazing in summer	Data not available	• Pair plant willow poles at the edges of seeps to help stabilize slopes above and prevent slumping and to stabilize seep soil material and vegetation during high rainfall events. • Willow poles will help to dry out the seeps and minimize pugging damage. • Areas can be fenced and retired for water quality and

											biodiversity benefits
7e 1 Steep slopes on Tertiary sedimentary lithologies with a "Mairoa ash" cover in places and a severe soil slip potential. 	86.4	**Parent:** Sandstone, mudstone **Soil:** Sandy clay loam and clay hill soils • Well drained • No significant rooting barrier within 1m • Soil susceptible to trading damage during wet months	26-35^0	Pasture Indigenous vegetation	Slight to moderate soil slip. Negligible to slight tunnel gully	Severe soil slip. Moderate sheet and gully	• Some areas of ash soil • Contour assisted drainage	• Clay soils have poor internal drainage • Clay soils prone to pugging and compaction • Moderate erosion risk • Contour	Grazing Erosion control forestry	Average: 8 Top: 10 Potential: 12	• Space plant poplar pole to prevent/control erosion • Pair plant willow poles in gullies. • Consider erosion control forestry • Take care during wet months to avoid pugging damage from heavy stock

LUC Unit	Area (Ha)
2s 2	3.1
2w 1	0.7
3e 1	16.7
3w1	0.4

4e 1	39.9
4w 1	1.4
6e 1	61.8
6e 8	59.2
6w 2	0.6
7e 1	86.4
Total Area	**270.2**

APPENDIX 10: CASE STUDY 3 LUC TABLE (pages 74 and 75)

Te Awamutu Sheep and Beef Farm Land Use Capability Table

Farm resource information	Luc unit	Total area (ha)	Parent material Dominant soil type and characteristics	Slope degree	Land Cover	Erosion degree & severity		Strengths	Limitations	Landuse suitability	Stock carrying capacity (su/ha)	Conditions of use
						Actual	Potential					
3e 1 Rolling slopes on yellow-brown loams with slight to moderate erosion hazard when cultivated. 		23.2	**Parent:** Tephra – Mairoa ash **Soil:** Mairoa clay soil • Well drained • Stoneless • No significant rooting barrier within 1m • Moderate permeability • High P retention (83%) • Low N leaching vulnerability • Very low structural vulnerability (0.2) • Very low water logging vulnerability	8-15^0	Pasture	Nil	Slight to moderate sheet and rill when cultivated.	• Contour • Accessibility • Free draining soil • Supports high producing pasture and cropping	•Moderate erosion limitation under cultivation	Intensive grazing Cropping Forestry	Average: 14 Top: 18 Potential: 21	• Avoid structural degradation of soils under intensive, regular cropping • Contour cultivation required

4e 1 Strong rolling slopes on yellow-brown loams with a moderate to severe erosion hazard when cultivated. 	39.1	**Parent:** Tephra – Mairoa ash **Soil:** Mairoa clay soil	8-20°	Pasture	Nil	Slight gully. Moderate to severe sheet and rill and moderate gully when cultivated	• Contour • Accessibility • Free draining soil • Supports high producing pasture	•Moderate to severe erosion limitation under cultivation	Intensive grazing Occasional cropping. Forestry	Average: 14 Top: 18 Potential: 20	• Avoid structural degradation of soils under intensive, regular cropping • Contour cultivation required and minimum tillage practices required
6e 1 Moderately steep to strong rolling slopes on yellow-brown loams over various lithologies. 	27.1	**Parent:** Tephra – Mairoa ash **Soil:** Mairoa clay soil	16-25^{0}	Pasture Indigenous vegetation	Negligible.	Slight sheet and soil slip	• Free draining soil • Stable, high producing hill country	• Steep gradient precludes cropping • Gradient gives slight erosion risk	Intensive grazing Forestry	Average: 13 Top: 18 Potential: 21	• Maintain good pasture cover. • Carefully plan all earthworks and minimize exposure of bare ground. • When harvesting plantation trees follow industry best practice guidelines.

Farm resource information	Luc unit	Total area (ha)	Parent material Dominant soil type and characteristics	Slope degree	Land Cover	Erosion degree & severity		Strengths	Limitations	Landuse suitability	Stock carrying capacity (su/ha)	Conditions of use
						Actual	Potential					
6e10 Strong rolling to steep slopes on Mairoa ash and andesite. 		132.7	Andesite **Parent:** Tephra – Mairoa ash **Soil:** Mairoa clay soil	16-35^0	Pasture Indigenous vegetation	Negligible	Moderate sheet and soil slip	• Free draining soil • Stable hill country	• Steep gradient precludes cropping • Gradient gives a slight to moderate erosion risk	Intensive grazing Forestry	Average: 10 Top: 11 Potential: 12	• Maintain good pasture cover. • Carefully plan all earthworks and minimize exposure of bare ground. • When harvesting plantation trees follow industry best practice guidelines. • Open plant poplar poles to help prevent/control erosion
6w 2* Hillside springs and narrow seeps with a severe wetness limitation. Surface water present during the winter with high water tables through the rest of the year. 		0.3	**Parent:** Colluvium and swamp material **Soil:** Unnamed soil Material located at the bottom of narrow gullies fed by hillside springs and runoff. Material to wet and undeveloped to be called a soil.	0-7^0	Rushes, pasture	Severe debris flow	Moderate to severe streambank and debris flow	• If retired water quality and biodiversity benefits	• Severe wetness limitation • Erosion potential	Retirement Light sheep grazing in summer	Data not available	• Pair plant willow poles at the edges of seeps to help stabilize slopes above and prevent slumping and to stabilize seep soil material and vegetation during high rainfall events. • Willow poles will help to dry out the seeps and minimize pugging damage.

LUC Unit	Area (Ha)
3e 1	23.2
4e 1	39.1
6e 1	27.1
6e10	132.7
6w 2	0.3
Total Area	**222.4**