Consents Hearing
3 February 2020

T J & J A Driscoll for the T & J Driscoll Family Trust – APP 20181765

Appendices

Updated Assessment of Environmental Effects

T J & J A Driscoll as trustees of the T & J Driscoll Family Trust

Resource Consent Application to
Environment Southland
To Use Land for Dairy Farming
and Associated Permits

Updated with additional mitigation post notification: 13 September 2019

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QUALITY INFORMATION

Reference:	L:\17423 - Tim Driscoll - Discharge Consent Variation\Docs\Drafts\20181008_1	
Date:	13 September 2019	
Prepared by:	Tanya Copeland	Update by Mike Freeman
Reviewed by:	Hilary Lennox	Update reviewed by Matilda Ballinger
Client Review:	Tim Driscoll	
Version Number:	**Final update**	

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LIST OF ATTACHMENTS

1. INTRODUCTION

1.1 Overview of Proposal

T J and J A Driscoll on behalf of the T & J Driscoll Family Trust (the applicant) own a 599-cow dairy farm located approximately 5 km south of Winton. Discharge Permit AUTH-301043 authorises the discharge of farm dairy effluent (FDE) and Water Permit AUTH-301044 authorises the taking of groundwater at this farm. These consents do not expire until 2021 but the applicant wishes to expand the dairy platform onto a neighbouring block of land, known as the "East Block", which was purchased in 2016. The applicant would also like to milk up to 680 cows across the extended dairy platform. Consent is sought for the following:

- To use land for a farming activity where the land area of the dairy platform would be greater than at 3 June 2016;
- To replace Discharge Consent AUTH-301043 with a new discharge consent to discharge FDE from the seasonal milking of up to 680 cows; and
- To replace Water Permit AUTH-301044 with a new water permit that allows for enough water to be taken to support the proposed farming operation.

1.2 The Applicant

Applicant Address: T J and J A Driscoll
266 Thomsons Crossing Road East
Winton

Address for Service: C/- Landpro Limited
PO Box 302
Cromwell 9342

1.3 Purpose of Documentation

Under Section 88 of the Resource Management Act 1991 (the RMA), this report provides an assessment of the activities effects on the environment as required by Schedule 4 of the RMA.

2. DETAILS OF PROPOSAL

2.1 Location

The figure below shows the location of the farm in relation to Winton as well as the proposed farm boundary.

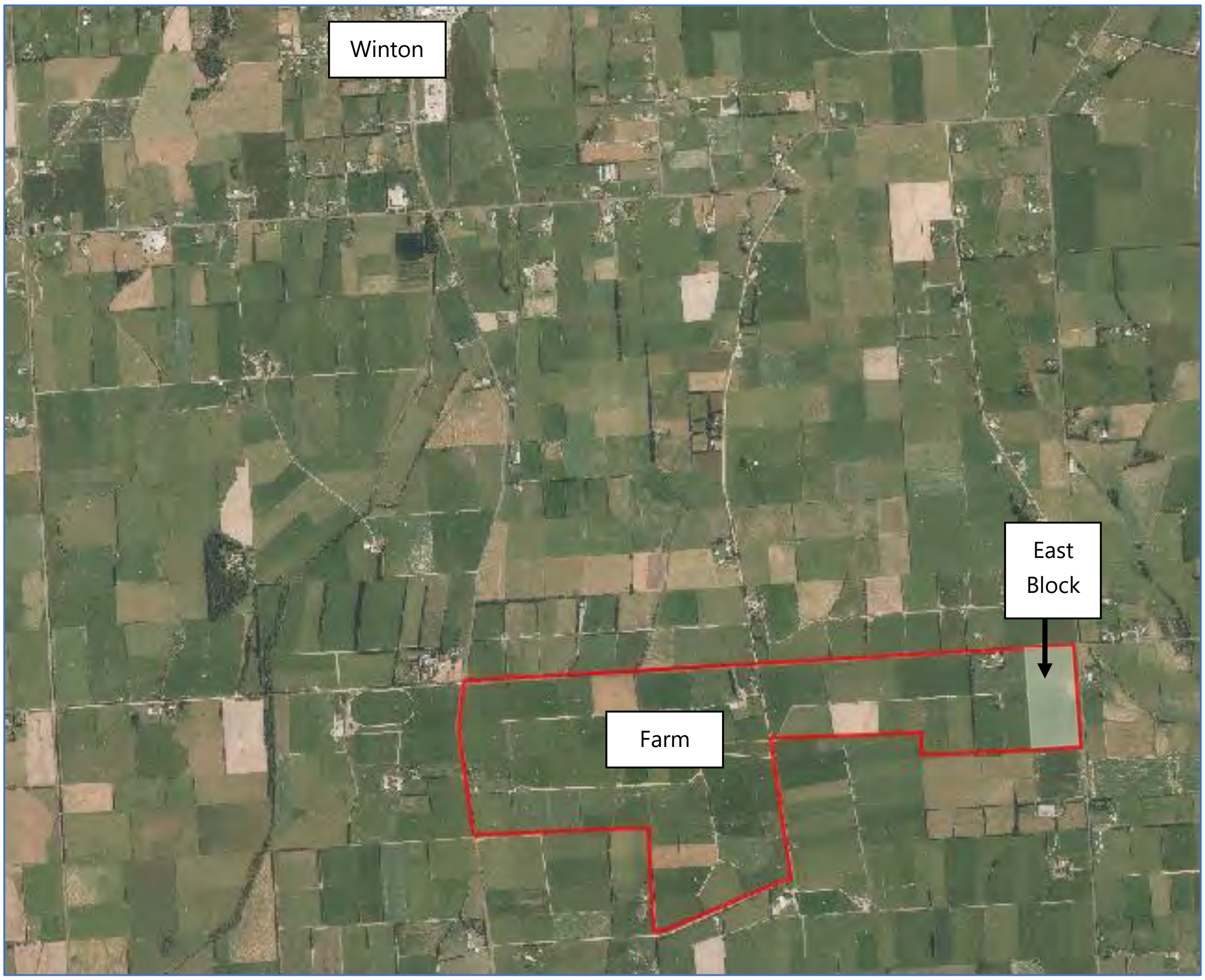

Figure 1: Proposed Farm Boundary, with the new East Block shaded

2.2 Details of Dairy Farm

The following provides further details of the farming system proposed.

Table 1: Details of the Dairy Farm

Property Details	
Property address	266 O'Shannessy Road, RD1, Winton
Property owner(s)	T J, J A, J P and C A Driscoll
Legal Description	Pt Sec 30 Blk I Winton Hundred
	Pt Sec 29 Blk I Winton Hundred
	Sec 43 Blk I Winton Hundred
	Sec 44 Blk I Winton Hundred
	Sec 45 Blk I Winton Hundred
	Sec 54 Blk I Winton Hundred
	Lot 1 DP 449518
	Lot 2 DP 449518 (new block)
Property area (ha)	224.5 ha (previously 210.6 ha)
Change in scale/intensity/farm boundary?	Increase in farm area and cow numbers
Discharge Permit Details:	
Replacement of permit no.	AUTH-301043
Number of dairy cows	680
Stocking rate (cows/ha)	3.0
Winter milking?	No milking between 20 June and 20 July other than slipped cows
Wintering barn?	No
Feed pad/standoff pad?	Two impervious pads that don't drain into the effluent pond
Other sources of effluent?	Vat stand, tanker apron
Type of shed	50 bale rotary (only 6 yrs old – recent conversion)
Effluent treatment	Stirrer in the pond (no need for weeping wall)
Storage available (m^3)	3,261 m^3 lined pond
Storage required (m^3)	2,670 m^3 (as per attached dairy effluent storage calculator[1])
Disposal area (ha)	93.3
Irrigator proposed	RX Plastics Maxi Pods. Slurry tanker may be used rarely, such as when desludging the pond.
Application rate and depth	10 mm/hr rate and 25 mm depth per application 5mm depth for the slurry tanker
Monitoring proposed	None other than that which will be provided for in CAEMP/FEMP
Water Permit Details:	
Replacement of permit no.	AUTH-301044
Freshwater Management Unit	Lower Oreti and Makarewa
Groundwater Zone	Bore is located in the Lower Oreti groundwater management zone
Average rate of take over 24 hrs (L/s)	1

[1] DESC has not been updated - required storage will decrease slightly.

Daily volume (L)	81,600
Allocation per cow (L/cow/day)	120
Location of point of take	Well Number E46/1067, which is located at the house, is currently used for the shed and troughs. There is another well, E46/1089, which is located at the dairy shed but is not currently used.
Freshwater storage onsite?	4 x 30,000 L tanks
Yearly volume (m^3/year)	25,173 (120 L/cow/day for 680 cows over summer, 70 L/cow/day for 86 cows over winter)
Discretionary allocation limit for groundwater zone (m^3/year)	20,700,000
Amount currently allocated from groundwater zone, including current permit (m^3/year)	4,106,038 (20% of allocation limit)
Land Use Consent (use land for dairying)	
Area of new block (ha)	13.9 ha
Use of land pre-May 2016	Sheep grazing
When was it converted to dairying?	Yet to happen – need to wait until consent is granted
Proposed use of land	Incorporation into the dairy platform

Effluent Management

Effluent generated in the dairy shed flows under gravity to the effluent pond via a stone trap. A weeping wall is not necessary at this property because a mechanical stirrer has been fitted on the pond. This is mounted on a concrete pontoon extending into the pond to ensure that the effluent is stirred well. The pond, which was built 6 years ago when the farm was converted, is lined with an HDPE liner and has had no performance issues. All of the farm's effluent infrastructure has been maintained in excellent condition. Given the age, condition and construction of the pond, a pond drop test is superfluous for this consent application. The image below shows that the leak detection system was recently inspected and running clear.

Figure 2: Infrastructure layout

Figure 3: Large stone trap adjacent the effluent pond

Figure 4: Effluent pond

Figure 5: Leak detection port with no trace of effluent

The Dairy Effluent Storage Calculator (DESC) attached shows that the pond is adequately sized to allow for effective deferred irrigation.

This proposal seeks to increase the size of the area to which effluent is actually discharged. Appendix I of Discharge Permit AUTH-301043-01 shows a disposal area of 107.7 ha but this has not been fully utilised and effluent is rarely applied to the east of O'Shannessy Road. Effluent can be applied over a larger area if the effluent disposal field is extended to the south instead. This is an effective way of ensuring that nutrients are distributed over a larger area, thus reducing the intensity of loading in any particular paddock. The current and proposed effluent discharge areas are shown in the figure below, which has been taken from the attached nutrient budget report.

Figure 6: Effluent disposal area

Land Use Consent to Use Land for Dairying

The attached plans from the applicant's Farm Activity Focus Plan confirm what the dairy farm boundary was pre-May 2016. The applicant purchased the East Block in April 2017. This 13.9 ha section has previously been used as a sheep grazing block, but it is proposed that it now be incorporated into the dairy platform.

Inclusion of the new block into the dairy platform will allow for an increase in the number of cows milked at the farm from 599 to 700. To offset the potential increase in N losses from the increased cow numbers, the applicant is proposing to undertake mitigation measures such as:

- reducing the winter crop area on the dairy platform and utilizing 4ha of grass/baleage over winter
- increasing the effluent discharge area so that the concentration is effluent in any one area is reduced; and
- reduced N fertiliser use on the effluent discharge area.
- maintaining the same level of off-platform wintering as the current scenario

These mitigation measures are discussed in further detail in Section 6 of this report. The proposed farming system is essentially one where the majority of the milking herd is wintered offsite, however, the modelling undertaken as part of this application has allowed for some cows of these cows to be on-farm during June and July. This is to allow for delays in removing all of the herd at the start of June, and to allow for early calvers to be brought home early.

Compliance

The compliance history for Discharge Permit AUTH-301043 shows that the consent holder has been fully compliant, with all scores being "1: Fully Compliant". The compliance staff have often commended the consent holder for their performance.

Regarding Water Permit AUTH-301044, this permit requires monthly reporting and the consent holder has sometimes been late in submitting this information. However, there is no record to indicate that there has ever been any over-abstraction.

3. DESCRIPTION OF EXISTING ENVIRONMENT

3.1 Land Use, Topography & Climate

The property, located at approximately 40 m above mean sea level, is an existing dairy farm and conventional farming practices are undertaken. Surrounding land use comprises other dairy farms, sheep and beef farms and some rural dwellings. Based on 30 years of rainfall records of Middle Creek at Otahuti (being the nearest rainfall station to the property) the property is likely to receive an average of 996 mm of rainfall per year.

There are tile drains across the property but most of these were installed before the applicant took possession of the property and so their exact location is not known.

3.2 Water Resources

3.2.1 Surface waterways

According to Beacon, the majority of the property is contained within the Lower Oreti Surface Water Management Zone, and the eastern-most portion is contained within the Tussock Creek catchment/Makarewa Surface Water Management Zone. The Makarewa River is a tributary of the Oreti River. In reality, the sub-catchments identified in the Beacon GIS system are simplifications of actual surface water catchments (see Figure 7b) with the likelihood that little surface runoff enters Tussock Creek.

There are a number of tributaries of the Oreti River on the property, most of which have been modified and all are fenced from stock. The tributaries discharge to the Oreti River approximately 3.6 km downstream of the property boundary. As shown on the plan below (taken from the applicant's Farm Activity Focus Plan), there are no tributaries of Tussock Creek/the Makarewa River on the subject property. Effluent disposal does not occur within 20 m of any surface water body.

Figure 7a: Surface waterways (blue lines) and CSAs (dotted orange lines)

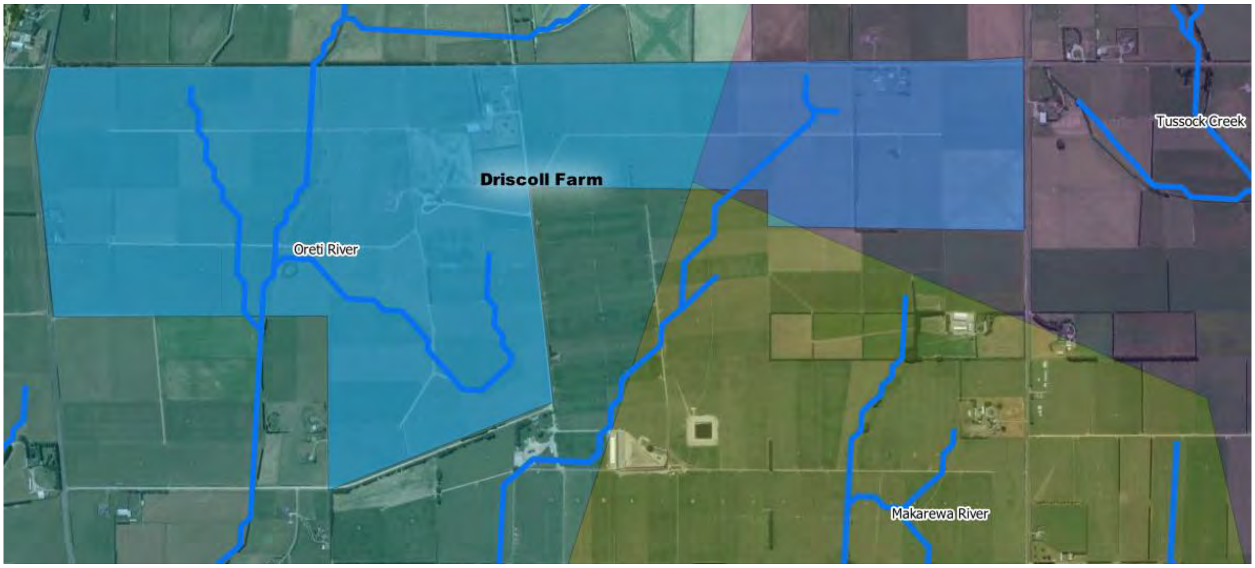

Figure 7(b) Farm location relative to actual surface water catchments and Beacon sub-catchment estimates

3.3 Soils and Physiographic Zones

Soil types and physiographic zones present will guide the choice of which Good Management Practices (GMPs) the applicant will adopt to ensure that potential adverse effects associated with the proposed activities are managed as far as reasonably practicable.

The following provides a description of the soils, FDE classifications and physiographic zone(s) present as well as the associated risks. The farm has been assessed as a whole, following the addition of the new block.

Table 2: Summary of Soils, Physiographic Zone(s) and Risks

Soil Type	Vulnerability Factors			FDE Classification	*Physiographic Zones*
	Structural Compaction	N leaching	Waterlogging		
Pukemutu	Severe	Slight	Severe	Category A	Gleyed (no variant)
Edendale	Slight	Moderate	Slight	Category A	Oxidising (no variant)

3.3.1 Soils

Pukemutu soils have heavy silt loam, grading with depth to silty clay, textures and are poorly drained, with a dense frangipan between 60 and 90 cm depth, which restricts water drainage. They respond well to mole and tile drainage. These soils are poorly drained, with very slow permeability in the subsoil and limited aeration during sustained wet periods.

Edendale soils are well-drained and have a deep rooting depth, high water-holding capacity, and silt-loam textures. Whilst these soils are well-drained, the compact subsoil is slowly permeable and may cause short-term waterlogging after heavy rainfall.

The proposed expansion in the effluent disposal area and expansion of the dairy platform will not impact on any soil types that aren't already included in the effluent disposal area or dairy platform.

3.3.2 Farm Dairy Effluent Classification

All of the soils across the property are categorised as Category A – artificial drainage or coarse soil structure. The average FDE application rate needs to be less than the soil infiltration rate and FDE must only be applied when a soil water deficit exists.

The proposed expansion in the effluent disposal area and expansion of the dairy platform will not impact on FDE categories that aren't already included in the effluent disposal area or dairy platform.

3.3.3 Physiographic Zones

The western part of the property is within the Oxidising physiographic zone, which coincides with the presence of the Edendale soils. The rest of the property, which is underlain by Pukemutu soils, is within the Gleyed physiographic zone.

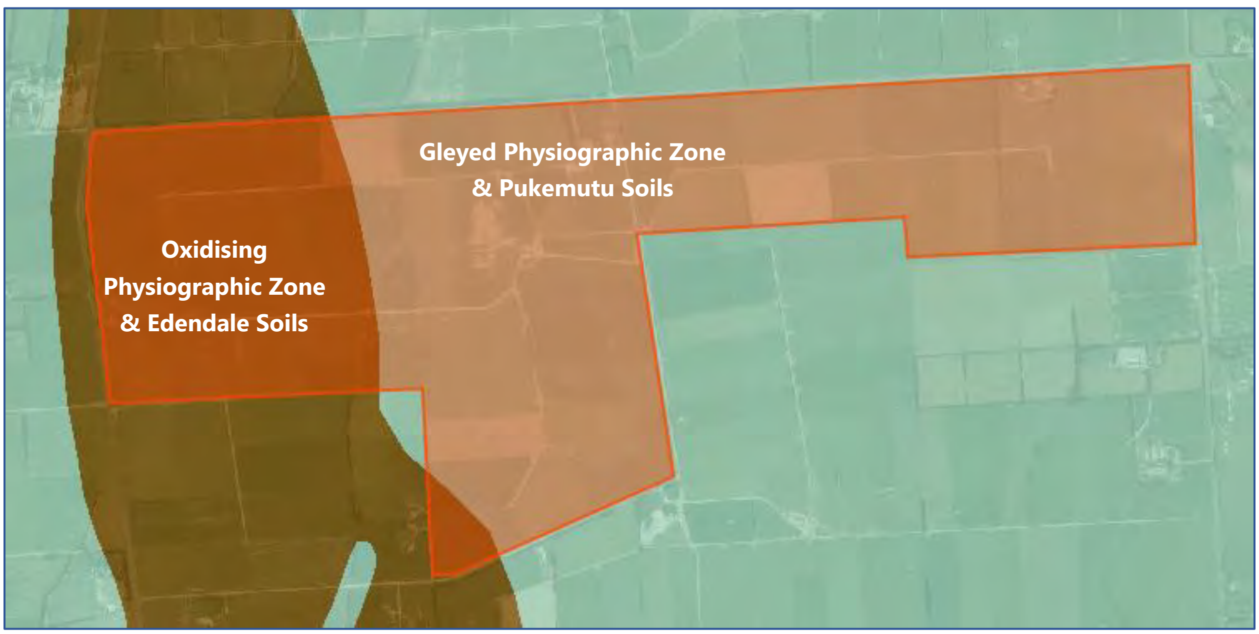

Figure 8: Physiographic zones present across the subject property

The Gleyed physiographic zone comprises predominately flat to undulating land that occurs between major river systems where soils are fine textured and poorly drained. This zone is characterised by soils which have distinctive redoxomphoric features such as mottling and gleying (resulting from extending periods of soil waterlogging). Soils in this zone have some ability to remove nitrogen from water to the atmosphere via denitrification. However this process can be bypassed when contaminants are flushed to nearby surface water bodies via artificial drains and overland flow following heavy or sustained rainfall event.

The Oxidising zone is well aerated with plenty of oxygen. High levels of oxygen allow nitrate nitrogen to develop, and therefore this setting has little to no ability to remove nitrogen (i.e. denitrification). When soils are wet, any nitrogen not used by plants has the potential to drain down into the underlying groundwater. Soils in Oxidising zone generally have good permeability although some soils in this zone have low subsoil permeability making them susceptible to waterlogging and therefore artificial drainage is used. However, Edendale soils are not prone to waterlogging.

The proposed expansion in the effluent disposal area and expansion of the dairy platform will not impact on any physiographic zones that aren't already included in the effluent disposal area or dairy platform.

3.3.4 Summary

The depth of nearby bores (6 – 13 m) indicates that there is a relatively shallow groundwater resource available locally and ES's factsheets for the Lower Oreti and Makarewa groundwater zones suggest that this groundwater resource is recharged predominantly by rainfall. Nutrients, such as N, do leach from the upper soil profiles and enter this groundwater resource. This is particularly true in the western portion of the property that is in the Oxidising physiographic zone, although a significant local groundwater quality issue has not been detected.

The key contaminant pathway on the western-most portion of the property is deep drainage and the key contaminant pathway for the rest of the farm is artificial drainage. In either area, soil moisture deficit FDE application is required to avoid the accumulation of contaminants in the topsoil and subsequent leaching through to tile drains and/or groundwater.

3.4 Water quality

Receiving water bodies

According to the Environment Southland (ES) Beacon GIS mapping system the Driscoll property is spread across upper catchment of the Oreti River and Tussock Creek that subsequently feeds into the Makarewa River and then the Oreti River. The NIWA/MfE River Environment Mapping layer indicates that the vast majority of the property lies within the primary Oreti River catchment with a very small proportion of the property potentially within the Tussock Creek/Makarewa River catchments. There is a long-term water quality monitoring site for the Oreti River at Wallacetown, for Tussock Creek at Cooper Road and for the Makarewa River at Wallacetown. The focus of this report in terms of surface water quality is the Oreti River because the most definitive evidence strongly indicates that the vast majority of surface runoff and likely direction of shallow groundwater recharging surface water will be to the Oreti River and those tributaries south of the property that feed directly into the Oreti River.

Figure 9: **Location of Driscoll property and catchment above the two key long-term water quality monitoring sites**

The NIWA REC information shows that surface water bodies arise on the eastern side of the property and drain directly towards the Oreti River rather than via the Tussock Creek or the Makarewa River. ES staff have acknowledged that these sub-catchment maps are not that accurate and in any regard, this is not critical except to focus downstream water quality attention on the Oreti River water quality monitoring site at Wallacetown.

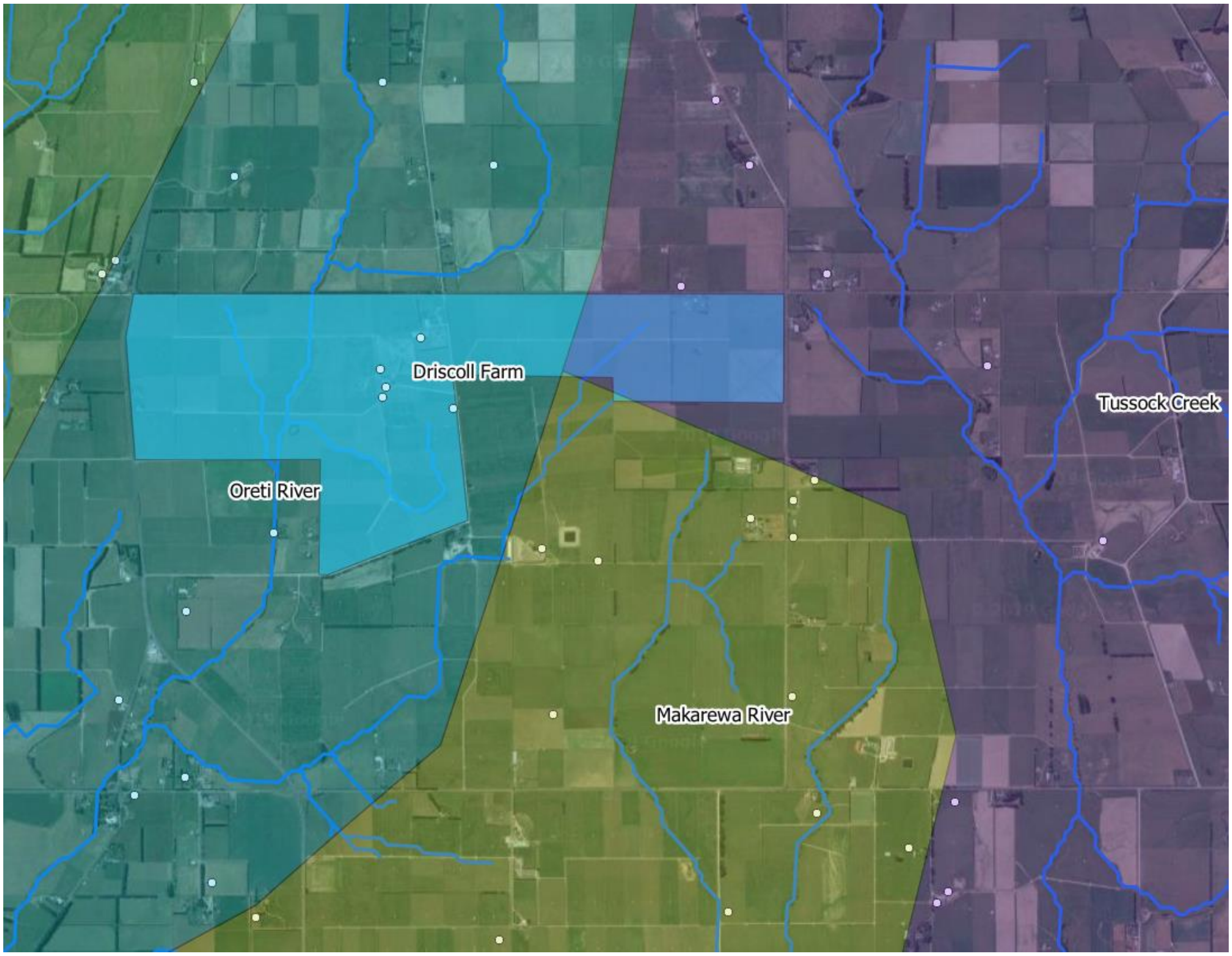

Figure 10: **Location of the property relative to NIWA mapped surface water bodies and ES sub-catchment areas.**

The property is primarily underlain by groundwater that is part of the Lower Oreti groundwater management zone (as specified in the PSWLP), with a small part of the property within the Makarewa groundwater management zone. This is illustrated in the following figure.

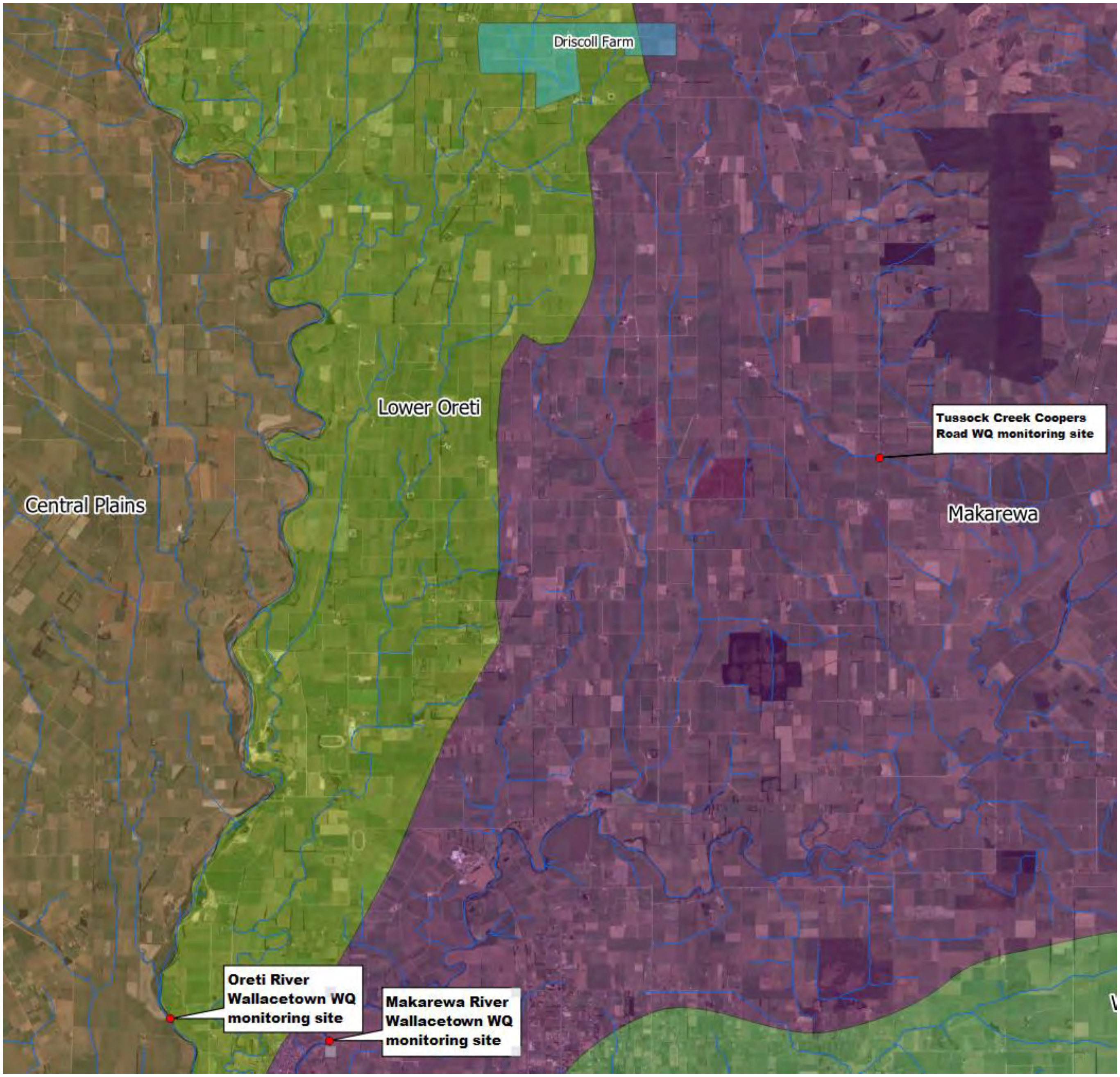

Figure 11: Location of Driscoll property relative to the PSWLP groundwater management zones

There does not appear to be any specific technical reports on groundwater hydrogeology in this area. However, information used to inform the PSWLP process (LWP 2017[2]) strongly indicates that the groundwater in this area is primarily recharged via rainfall, groundwater discharge is primarily to drains and streams in the area, and the general direction of groundwater flow is south south-west.

[2] Landwaterpeople (2017) Groundwater Provisions of the Proposed Southland Water and Land Plan, Technical Background, Report for Environment Southland

Statutory water quality objectives and standards relevant to assessing existing water quality

The most directly relevant planning documents are the Southland Regional Water Plan (SRWP) and the Proposed Southland Water and Land Plan (PSWLP). These describe the values, objectives, policies and 'standards' for water in the Southland region.

Under the PSWLP, surface water bodies on the property are primarily classified as lowland hard and spring-fed streams and the Oreti River at the Wallacetown water quality monitoring site is classified as lowland hard. Table 1 summarises the values associated with these water body types as specified in the SRWP. The PSWLP does not use a classification system to establish values for rivers and streams. However, the relevant regional objectives in the PSWLP are also provided in Table 1.

The relevant numerical water quality standards and guidelines are included in section 5 along with the results from water quality monitoring.

The Southland Regional Coastal Plan also contains a diverse suite of objectives and values that apply to the New River Estuary. Those are not repeated here but it is important to appreciate that there is a relationship between regional plans, the regional coastal plan and the overarching Southland Regional Policy Statement.

Table 3: Summary of key regional plan surface water values & objectives relevant for water quality

Regional Plan	Classification	Values/objectives specified in the relevant plan
Southland Regional Water Plan 2010 Objective 3	Lowland soft & hard bed	- Bathing in those sites where bathing is popular; - Trout where present, otherwise native fish; - Stock drinking water; - Ngāi Tahu cultural values, including mahinga kai; - Natural character including aesthetics.
Proposed Southland Water and Land Plan Objectives 3, 6, 7, & 8		3 The mauri (inherent health) of waterbodies provide for te hauora o te tangta (health of the people), te hauora o te taiao (health of the environment) and te hauora o te wai (health of the waterbody) 6 There is no reduction in the quality of freshwater and water in estuaries and coastal lagoons by, (a) maintaining the quality of water in waterbodies, estuaries and coastal lagoons, where the water quality is not degraded; and (b) improving the quality of water in waterbodies, estuaries and coastal lagoons, that have been degraded by human activities. 7 Any further over-allocation of freshwater (water quality and quantity) is avoided and any existing over-allocation is phased out in accordance with freshwater objectives, freshwater quality limits and timeframes established under Freshwater Management Unit processes. 8 (a) The quality of groundwater that meets both the Drinking Water Standards for New Zealand 2005 (revised 2008) and any freshwater objectives, including for connected surface waterbodies,

		established under Freshwater Management Unit processes is maintained; and (b) The quality of groundwater that does not meet Objective 8(a) because of the effects of land use or discharge activities is progressively improved so that: (1) groundwater (excluding aquifers where the ambient water quality is naturally less than the Drinking Water Standards for New Zealand 2005 (revised 2008)) meets the Drinking Water Standards for New Zealand 2005 (revised 2008); and (2) groundwater meets any freshwater objectives and freshwater quality limits established under Freshwater Management Unit processes

These values and objectives are relevant reference points to understand the implications of existing water quality particularly where that quality is not consistent with relevant objective and values specified in relevant regional plans.

Surface water quality

The following tables and figures provide summary information on the quality of surface water and groundwater in the vicinity of the proposed dairy expansion. This water quality information is compared to the most relevant guidelines, standards and thresholds, specifically the National Objective Framework (NOF) attributes (e.g., *E. coli*, clarity (black disc), dissolved reactive phosphorus, ammonia, etc.) contained within the National Policy Statement Freshwater Management (2017), the PSWLP Appendix E Water Quality 'Standards' (referenced primarily via Policy 16 of the PSWLP), and the Australia New Zealand Environment and Conservation Council (ANZECC) water quality trigger values.

The vast majority of the property is classed as Lowland Hard Bed under the PSWLP with a very small proportion of the property of the far west in the Spring-fed water quality category. The Oreti River at the Wallacetown water quality monitoring site is classed as Lowland Hard Bed.

Table 4: Summary of state and trend at the Oreti River Wallacetown water quality monitoring site

Primary WQ indicators	State	LAWA National Objective Framework (NOF) Band, Annual Median (2008 – 2017) PSWLP Maximum (2009 -18)	Trend	PSWLP water quality standard (Lowland Hard Bed) & ANZECC[∞] trigger values
E. Coli	In the worst 50% of all lowland rural sites	**D** – 20-30% of the time, the estimated risk is >=50 in 1000 (>5% risk). The predicted average infection risk is >3%*. 5-year median = **130 n/100ml** Maximum = **10,000 cfu/100ml**	Likely Improving	≤1,000/100ml Faecal coliforms[#] Highly unlikely to meet standard
Clarity (Black Disc)	In the best 50% of all lowland rural sites	No NOF attribute band set 5-year median = **1.815 metres** Seven results during 2009 – 2018 did not comply with PSWLP WQ standard	Indetermi nate	≥ 1.6 m when flow below median flow (27.4 m3/s), Does not meet standard
Total Oxidised N	In the worst 25% of all lowland rural sites	**B** – Some growth effect on up to 5% of species. 5-year median = **0.94 g/m³** Maximum = **2.5 g/m³**	Not assessed	≤0.444 g/m³ (ANZECC, 2000)* Greater than this trigger value
Ammoniacal N	In the best 25% of all lowland rural sites	**A** – 99% species protection level. No observed effect on any species tested. 5-year median = **0.005 g/m³** Maximum = **0.04 g/m³**	Not assessed	<2.5-0.9 (pH 6.0-8.0) Meets standard
Dissolved Reactive P	In the best 50% of all lowland rural sites	No NOF attribute set 5-year median = **0.006 g/m³** Maximum = **0.04 g/m³**	Not assessed	≤0.01 g/m³ (ANZECC, 2000)* Greater than this trigger value
Macroinvertebrate Community Index	Poor	MCI 5-year median = 95. Fair ecological condition. Indicative of only fair water quality and/or habitat condition.	Likely degrading	>90 Meets standard
Additional PSWLP Water Quality Stds		**Observed WQ range Jan 2009 – Dec 2018**		**PSWLP water quality standard (Lowland Hard Bed)**
Temperature		4.2 – 21 °C		≤23°C Meets standard
pH		7.0 – 7.8		6.5 – 9.0 Meets standard
Sediment cover		Not assessed by ES		
Dissolved oxygen		82 – 132% (7.4 – 14.2 g/m³) NOF Attribute **B** band		> 80 % sat. Meets standard
Bacterial/fungal slime		Not assessed by ES		
Periphyton		4.5 – 361 mg chl *a*/m² (annual sampling, 2004 - 2018) NOF Attribute possibly **C** band (92%ile = 158)		<120 mg chl *a* /m² filam. algae < 200 mg/m² diatom/cyanob. Does not meet standard
Fish		Not assessed by ES		

∞Australian and New Zealand Environment and Conservation Council, 2000, Australian and New Zealand guidelines for fresh and marine water quality.
\# PSWLP standard is ≤1,000 faecal coliforms/100 ml. However, *E. coli* is monitored. *E coli* are a subset of faecal coliforms.
* ANZECC trigger values for investigation. These have no legal status in NZ and are included as a reference point only.

The data indicate that water quality in the Oreti River at Wallacetown is not suitable for the all of the uses, values and objectives identified in relevant regional plans and does not meet all the relevant numerical standards or guidelines.

The most significant water quality-related issues in the Oreti River at this location appear to be:

1. Poor microbiological water quality,
2. Infrequent poor water clarity, and
3. Raised nutrient concentrations leading to plant growth in the stream and further downstream.

The relatively frequent high concentrations of faecal indicator microorganisms mean that this location would not be suitable for swimming or other similar water contact recreation (as specified in the LAWA guidance, i.e., a significant risk of infection) and would also generally have implications for microbiological quality further downstream.

The infrequent poor water clarity is likely to be indicative of raised suspended solids in the water column that could impact the macroinvertebrate community. However, the MCI is relatively high and meets the PSWLP water quality standard, strongly indicating that even if suspended solids concentrations are high at times that is not causing any significant adverse effects on the macroinvertebrate community.

While nitrate-nitrogen concentrations in the Oreti River have been rated as 'B' under the NOF attribute, this value has been set on the basis of nitrate toxicity rather than for nitrogen (N) as a nutrient. In the context of nitrate-nitrogen as a nutrient both it and DRP concentrations are relatively high (using ANZECC triggers as a guide). This has the potential to accelerate the growth of macrophytes, periphyton and, lower down in the catchment, in the New River Estuary, phytoplankton and macroalgae.

Periphyton coverage has been monitored annually at this site since 2003 and the results are summarised in the following figure.

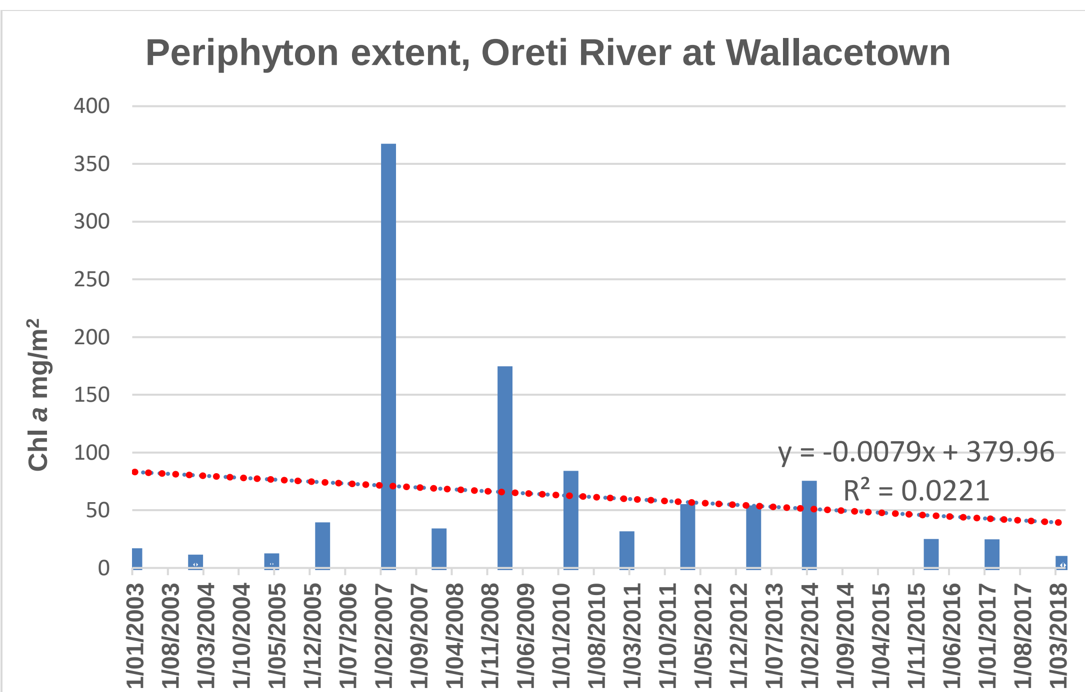

Figure 12: Periphyton extent at the Oreti River water quality monitoring site, 2003 - 2018

The significance of the periphyton results is challenging to interpret. The data from 2003 – 2018 indicate an apparent small trend of improvement. However, the R^2 value (0.0221) is extremely low so the trend is not statistically significant and is likely to be significantly influenced by the two high values.

The NPSFM states that the periphyton attribute applies to the results of monthly, not annual sampling, so this means that definitive conclusions can't be made about the NOF band. Hence the indication in Table 1 that the periphyton attribute band could be C is only indicative, not conclusive.

It is also important to appreciate that there are significant limitations involved in comparing annual results because the sampling was not limited to comparable situations in potential periphyton development. For example, the sampling was not timed to coincide with similar periods of stable flow or linked to flushing events/accrual periods. This means that one sample could have been taken shortly after a significant 'fresh' that may have removed periphyton while another sample may have been taken after a prolonged period of stable flow that would allow periphyton to build up. Therefore, the annual periphyton sampling results can only be taken as a potential indicator of periphyton coverage.

The PSWLP periphyton standards are relatively simple maxima and the results over the monitoring period show at least one significant exceedance with the other high result probably indicating exceedance of the standards but because the standard is written in terms of filamentous algae and diatoms/cyanobacteria and the sampling is just total chlorophyll-*a* it is not possible to be definitive.

Both the property location and the Oreti River water quality monitoring site are classified as the Default Class for the periphyton attribute and therefore leaving aside the fact that monthly sampling has not been undertaken, the Attribute State could potentially be 'C' on the basis of the 2003 – 2018 periphyton data (92%ile value of 158 mg/m^2 based on the fourteen results). The narrative for this state is described in the NPSFM[3] as "Periodic short-duration nuisance blooms reflecting moderate nutrient enrichment and/or alteration of the natural flow regime or habitat."

River nutrient concentrations have not been monitored over as long a period of time as periphyton has been. However, monitoring since 2013 does not indicate a significant trend of increasing nitrate N in the river at this location. There is a small apparent increase but the R^2 value is extremely small and strongly indicates that the apparent increase is not statistically significant. There appears to be a regular annual winter/autumn increase of nitrate N concentrations seen in the Oreti River (this has not been statistically assessed).

[3] National Policy Statement Freshwater Management (2014) Updated 2017.

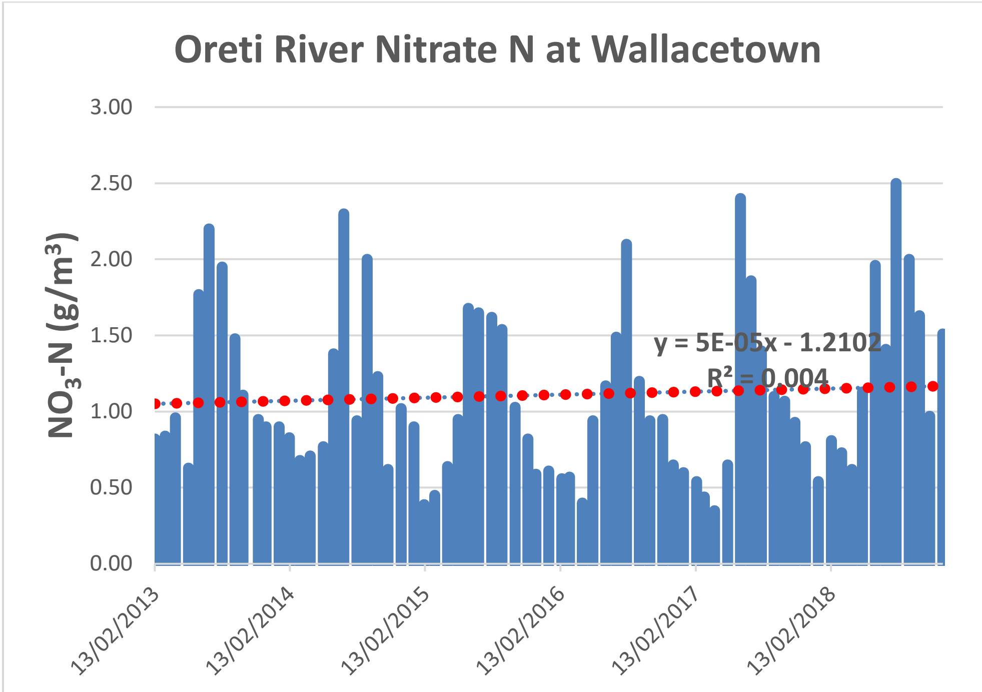

Figure 13: Nitrate N concentrations in the Oreti River at Wallacetown, 2013 - 2018

Similarly, the concentrations of dissolved reactive phosphorus in the Oreti River at Wallacetown have been monitored and while the data shows an apparent trend of decreasing DRP it is not statistically significant (R^2 = 0.01).

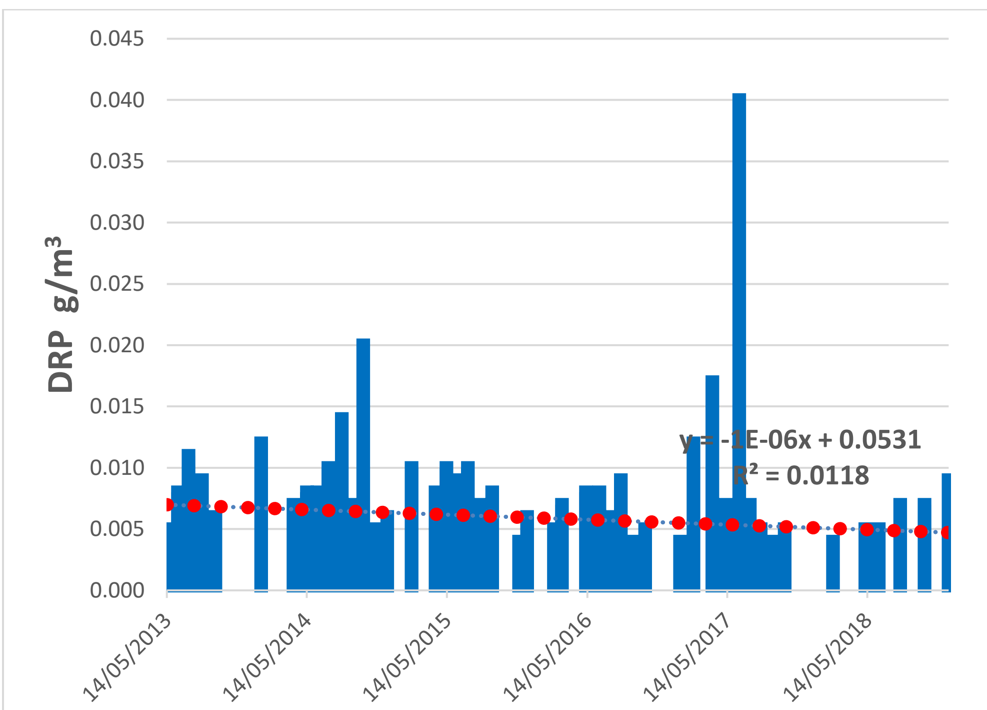

Figure 14: Dissolved reactive phosphorus concentrations in the Oreti River at Wallacetown, 2013 - 2018

The LAWA water quality monitoring information only goes up to December 2017. Additional information was provided separately from Environment Southland in an Excel file. A comprehensive statistical comparison of this dataset with the LAWA statistical summaries has not been undertaken but a review of median values for the 2018 monitoring period indicated that it is unlikely that there are significant changes from the summary data reported in Table 1. It is understood that the LAWA data and analyses will be updated with 2018 data in September this year.

Groundwater Quality

The results of Environment Southland's survey of regional nitrate-nitrogen concentrations are provided as a layer within the Beacon public GIS system and indicates that the property is in an area where the underlying unconfined groundwater nitrate N concentrations were likely to have been primarily between 0.4 – 3.5 mg/L between 2007 – 2012, or indicative of minor to moderate land use impacts. The downgradient area appears to have had slightly higher nitrate N concentrations, between 3.5 – 8.5 mg/L indicative of moderate to high land use impacts. This is illustrated in the following figure.

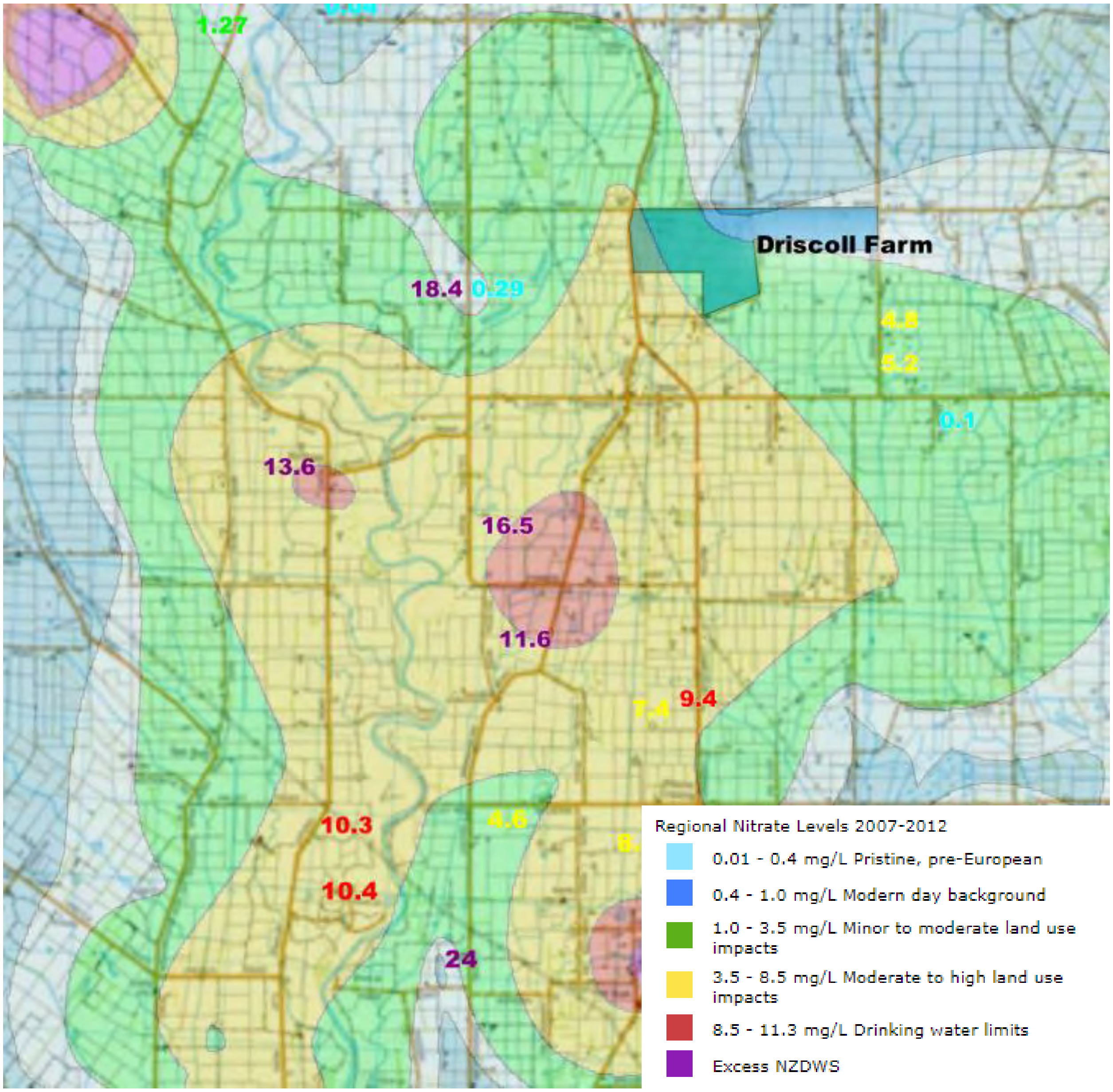

Figure 15: Peak nitrate N concentrations for groundwater from bores in the general area, post-2012 overlaid onto the 2007-2012 nitrate N concentration contour estimates

Interpretation of this data should be done with great care because there are a limited number of results that have been used as the basis for developing these groundwater quality contours, and the source data includes results from a wide range of bores. Some of these bores are very shallow (<5 m depth) and most likely represent a significant proportion of drainage water quality rather than being representative of unconfined groundwater in the area (majority of water supply bores in the area are between 5 – 25 m depth). There is also anecdotal evidence and from old and recent reports that a proportion of bores in Southland have inadequate well head protection that can at times allow contaminated surface water quality to enter groundwater[4]. For example, the 18.4 g NO_3-N/m^3 result from a bore to the west of the Driscoll farm has been acknowledged by Environment Southland as likely caused by a "direct or semi-direct contamination"[5]. Neither Environment Southland nor Landpro has checked the well head protection status of the bore which is about 15 m from a dairy farm laneway close to a relatively new dairy shed. Uncertainties about well head protection make interpretation of the relationship between land use and groundwater results challenging.

Some more recent groundwater quality data has been obtained from Environment Southland and while very limited recent reliable groundwater quality data is available for this general area, what is available indicates that the general pattern of nitrate-nitrogen concentrations in the area does not appear to have changed significantly.

Groundwater from two bores (peak values 8.7 (14.5 km west) and 10.3 g NO_3-N/m^3 (8.5 km south south-west)) appear to indicate higher groundwater nitrate N concentrations than existed during the 2007 – 2012 survey. The data from these bores are illustrated below.

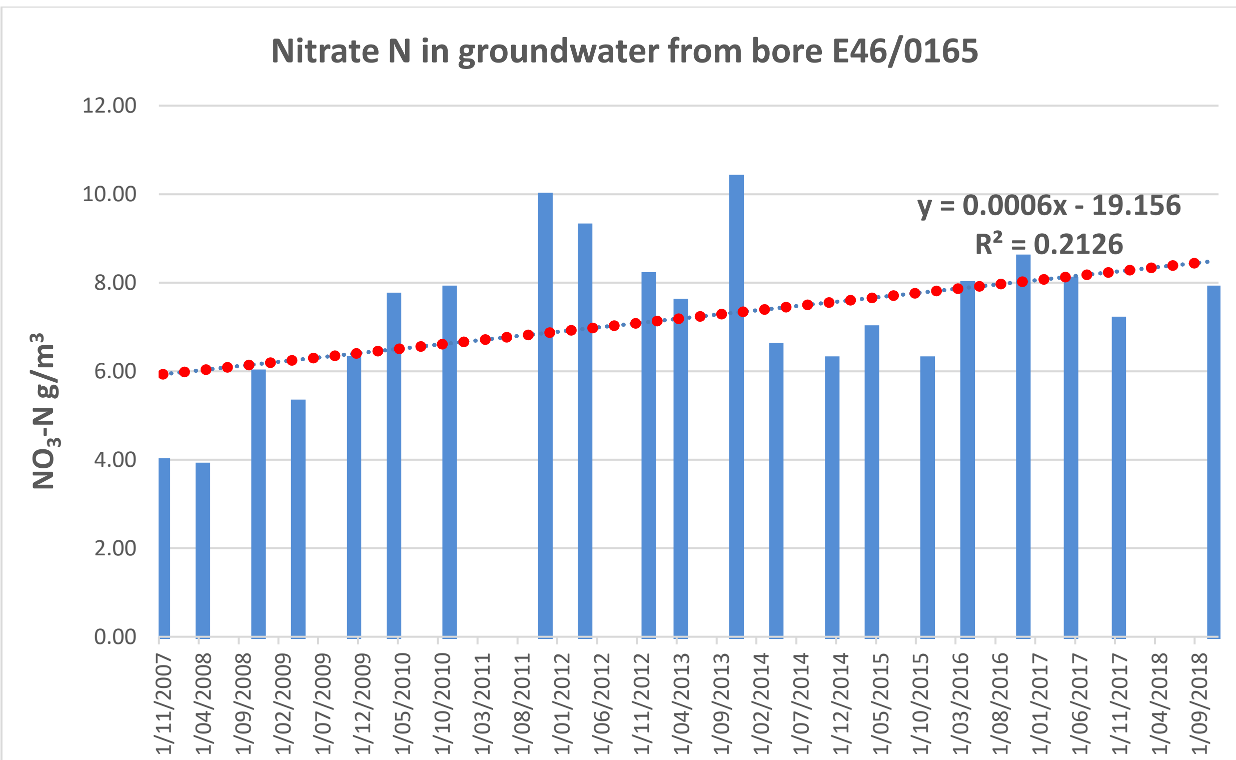

Figure 16: Nitrate N concentrations from bore E46/0165, ~8.5 km south south west of Driscoll property (red 10.3 in Figure 16)

[4] Dairy Green Limited (2019) Groundwater Well and/or Bore Assessment - Heddon Bush; Central Southland

[5] Email from Fiona Smith, Environment Southland, relaying feedback from a "scientist", dated 23 May 2019.

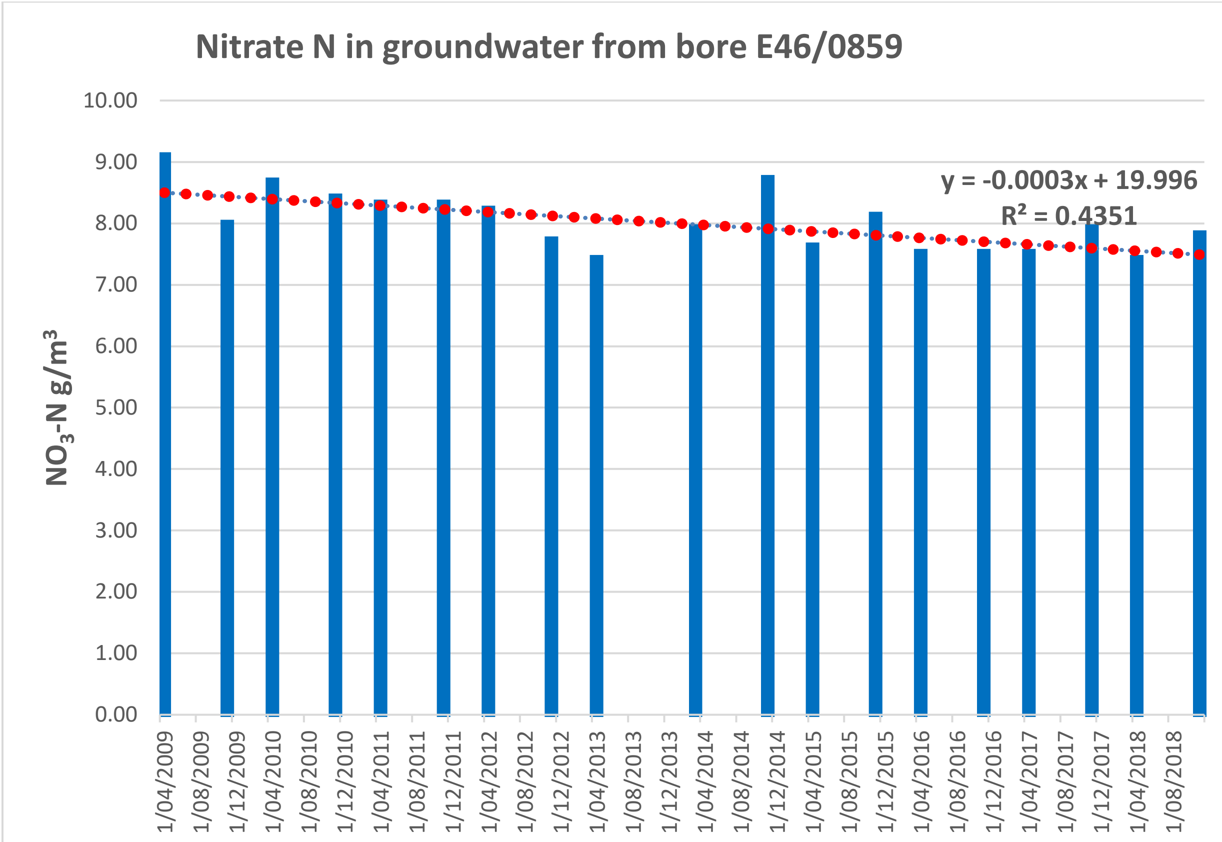

Figure 17: Nitrate N concentrations from bore E46/0859, ~14.5 km west of Driscoll property (red 8.7 in Figure 16)

The information illustrated in figures 20 and 21 indicate some of the difficulties in interpreting groundwater quality. The bore down-gradient of the Driscoll property is quite some distance away, approximately 8.5 km south south-west, and therefore there will be many land use activities occurring in this area that could be influencing groundwater quality. The apparent trend of increasing concentration has a relatively low R^2 value of 0.21. This indicates that while the trend may well be real there may be other factors behind the trend line and the large variability of results over the period will contribute to this relatively low R^2 value.

There is a potential inconsistency between the 2007-2012 survey results reported in the ES contour layer that should have included a nitrate N result in 2009 of 9.1 g/m^3 for this bore. However, this is not apparent from the contour (3.5 – 8.5) given for the area. Therefore, the apparent increase to a peak of 8.7 post 2012 is unlikely to be real in that the earlier result of 9.1 g/m^3 should have been reflected in the 2007 – 2012 survey contour. The apparent downward trend of nitrate N concentration illustrated in Figure 21 still has a relatively low R^2 value (0.43) but is significantly higher than that for the trendline in Figure 20. This indicates that there is a higher level of confidence about the downward trend indicated in Figure 21 compared to the upwards trend indicated in Figure 20.

In general, the groundwater quality data reflects the predominant rural land use in the catchment contributing to nitrate N leaching through to groundwater. There are two key issues in the wider area with some apparent 'hotspots' with elevated nitrate N concentrations, close to or greater than the NZ drinking water standard of 11.3 g nitrate-N/m^3. Each of the bores that have had groundwater sample results greater than the drinking water standard have been checked and all of them are relatively shallow bores (7.5m deep or shallower).

In addition, the discharge of groundwater with elevated nitrate N will result in that groundwater recharging connected surface waters, specifically the Oreti River. However, the nitrate nitrogen concentrations in the Oreti River appear to reflect "minor to moderate land use impacts".

New River Estuary water quality

The key water quality issue in the New River Estuary is eutrophication and sediment deposition that appears to be driven by N, P and sediment loads to the estuary from the main surface water inputs. Nutrients enter the estuary primarily via the major source of the Oreti River, to a lesser extent the Waihopai River and a number of relatively small creeks. Broad-scale macroalgal mapping undertaken by Wriggle Coastal Management in 2018[6] shows that there has been a significant increase in macroalgal growth, and an associated decline in estuary quality, in the upper estuary, since 2016. However, large sections of the lower estuary, which is well flushed in comparison to the upper estuary, remain in good condition. Table 4 below summarises macroalgal cover within the New River Estuary. Macroalgal growth was assessed by mapping the spatial spread and density of macroalgae in the Available Intertidal Habitat.

Table 5: Summary of intertidal opportunistic macroalgal cover, New River Estuary, February 2018[7]

Metric	Face Value	Final Equidistant Score (FEDS)	Quality Status
AIH - Available Intertidal Habitat (ha)	2944		
Percentage cover of AIH (%) = (Total % Cover / AIH) x 100 *where Total % cover = Sum of {(patch size) / 100} x average % cover for patch*	17.9	0.543	Moderate
Biomass of AIH (g.m^{-2}) = Total biomass / AIH *where Total biomass = Sum of (patch size x average patch biomass)*	1205	0.252	Poor
Biomass of Affected Area (g.m^{-2}) = Total biomass / AA *where Total biomass = Sum of (>5% cover patch size x average patch biomass)*	3160	0.191	Bad
Presence of Entrained Algae = (No. quadrats or area (ha) with entrained algae / total no. of quadrats or area (ha)) x 100	35.3	0.298	Poor
Affected Area (use the lowest of the following two metrics)		0.137	Bad
Affected Area, AA (ha) = Sum of all patch sizes (with macroalgal cover >5%)	1123	0.137	Bad
Size of AA in relation to AIH (%) = (AA / AIH) x 100	38.1	0.468	Moderate
OVERALL MACROALGAL ECOLOGICAL QUALITY RATING - EQR (AVERAGE OF FEDS)		**0.284**	**POOR**

The above table indicates that the New River Estuary has been experiencing significant eutrophication with a macroalgal Ecological Quality Rating (EQR) of 'poor' for the 2018 period. The trend for this ecological rating over the 2001-2018 period strongly indicates a significant decline from a 'good' state to a 'poor'

[6] Stevens, L.M. 2018. New River Estuary: 2018 Macroalgal Monitoring. Report prepared by Wriggle Coastal Management for Environment Southland.

state. The upper estuary has been particularly adversely affected by eutrophication. The Wriggle report concluded that "Ecological condition has consistently declined since monitoring commenced in 2001, and particularly since 2007", and the estuary is "…exhibiting significant problems associated with excessive nutrient fuelled macroalgal growth…".

Nutrient loads to the New River Estuary have been estimated by Aqualinc[8]. These are outlined in the following table.

Table 6: Summary of estimated N and P loads to eight Southland catchments

Catchment	Current catchment agricultural source loads (t/year)		Total catchment source nitrogen load (t/yr)	Estimated realised nitrogen loads (t/yr)	Estimated attenuation (%)
	Nitrogen	Phosphorus			
Bluff_Harbour	19	1	36	29	20
Haldane_Estuary	23	0	39	26	33
Jacobs_River_Estuary	1958	53	2133	1300	39
Lake_Brunton	20	0	20	14	30
New_River_Estuary	4969	139	5513	3718	33
Toetoes_Harbour	6256	142	6617	4392	34
Waiau_River	2714	35	4970	1864	62
Waikawa_Harbour	144	4	176	180	-2
Total/average	16,102	374	19, 404	11,524	31 (average)

The Aqualinc report further identified the potential nutrient load reductions that could result from various levels of mitigation. These are summarised in the following two tables.

Table 7: Estimated reductions in the agricultural source loads under three levels of mitigation for all dairy farms in each Southland catchment

Catchment	M1			M2			M3		
	Nitrogen	Phosphorus	Overall[1]	N	P	Overall[1]	N	P	Overall[1]
Bluff_Harbour	4	26	2	4	29	2	12	29	6
Haldane_Estuary	0	0	0	0	0	0	0	0	0
Jacobs_River_Estuary	6	28	5	8	31	6	18	31	15
Lake_Brunton	0	0	0	0	0	0	0	0	0
New_River_Estuary	6	29	5	8	32	7	18	32	15
Toetoes_Harbour	3	17	3	4	19	4	10	18	9
Waiau_River	1	9	0	1	9	1	4	9	2
Waikawa_Harbour	1	4	1	1	5	1	2	5	2

The full suite of mitigations assessed by Aqualinc includes the following measures.

Table 8: Description of mitigations assumed to apply under each mitigation level

[8] Aqualinc, Assessment of farm mitigation options and land use change on catchment nutrient contamination loads in the Southland region, 2014

Mitigation level	Name	Sheep & Beef	Dairy
Mitigation level 1	M1	• Optimised nutrient inputs • Low solubility P • Wetlands	• Stock exclusion from streams • Improved nutrient management • Improved farm dairy effluent (FDE) management
Mitigation level 2	M2	• Stock exclusion from streams • Reduced stocking rates, improved productivity	• Wetlands • Improved FDE management • Reduced stocking rates, improved per animal productivity.
Mitigation level 3	M3	• Grass buffer strips • Feed pad for beef cattle	• Restricted grazing strategies • Grass buffer strips • Improved FDE management

The proposal would provide for many of the relevant mitigation measures suggested by the Aqualinc report. It has not been possible to determine exactly what stocking rate was envisaged in the Aqualinc report or the NZIER report that it was partly based. However, our experience of modelling nutrient loss management is that stocking rate by itself is not generally accepted as the major driver of nutrient loss. Instead, a broader approach is needed that incorporates a full understanding of the whole farm system and all nutrient loss mitigation measures.

Implications of water quality for targeting of mitigation

The water quality results indicate that priorities for contaminant loss mitigation should be faecal indicator organisms, nitrogen, phosphorus (P) and sediment. This is largely reflected in the assessment of the physiographic zones that indicate risks from both artificial drainage and surface runoff because of the generally heavy soils in both areas. Therefore, with mitigation that targets a reduction in sediment loss (and associated P and faecal indicator organisms), N and P loss will be consistent with the identified water quality issues.

The primary contribution to the observed water quality issues will be the wider land use activities in the catchment, with only a tiny contribution from this individual property.

4. ACTIVITY CLASSIFICATION

4.1 Consents Required

The following resource consents are required under Regional Water Plan for Southland, 2010 (RWPS) and Proposed Southland Water and Land Plan, 2018 (PSWLP).

Table 9: Applicable Rules

Consent	Plan	Rule	Activity Status
Discharge Permit to discharge agricultural effluent to land	RWPS	50(d)	*Restricted Discretionary*
	PSWLP	35(c)	*Discretionary*
Water Permit to abstract groundwater for dairy shed wash down and stock drinking	RWPS	23(d)	*Discretionary*
	PSWLP	54(a)	*Permitted*
Land Use Consent to use land for dairy farming	PSWLP	20(e)	*Discretionary*

Overall, the proposal is for ***discretionary*** activity.

4.2 Consents Not Required

In accordance with Schedule 4 of the RMA, an application must describe and demonstrate compliance with any permitted activity that is part of the proposal to which the application relates.

Table 10: Activities for which Consent is Not Required

Activity	Compliance with the relevant permitted rules of the RWPS and PSWLP
Use of land for the maintenance and use of an existing agricultural effluent storage facility (Rule 32D of the pSWLP)	The use of land for the maintenance and use of an existing agricultural storage facility (includes ponds, weeping walls, sumps and stone traps etc) that was authorised before 4 April 2018 is a permitted activity providing the construction of the facility was authorised by a resource consent.
Incidental discharges from farming (Rule 24 pSWLP)	The land use associated with this discharge is authorised under Rules 20, 25 or 70.
Fertiliser (Rule 10 RWPS & Rule 14 pSWLP)	All practicable measures will be taken to minimise fertiliser drift beyond the target areas. Fertiliser will be applied to selected areas of the farms in accordance with nutrient budget recommendations, and soil tests to avoid excess leaching of nutrients to groundwater. Fertiliser will be applied when a soil water deficit exists, and all waterways will have riparian margins with stock excluded.
Silage storage and silage leachate (Rule 51 of the RWPS, and Rules 40 & 41 of the pSWLP.)	All silage storage facilities are located away from sensitive receiving environments, in accordance with permitted rule setbacks and no direct discharge of silage leachate to any waterbody is proposed. The silage pad is not hooked up to the effluent system, and therefore silage leachate is discharged to land in accordance with the rules listed in the column to the left.
Sludge (Rule 38 of the PSWLP)	Solid sludge effluent collected from the stone traps and effluent pond will be laid out to dry before applying to land when conditions are suitable, observing appropriate separation distances, and there will be no disposal of solids to any waterway.
Cleanfill, Farm Landfills and Offal Holes (Rules 53, 54 & 55 of the RWPS, and Rules 42 & 43 of the pSWLP)	No more than 500 m^3 of material will be discharged within cleanfill sites. Stormwater will be directed away from fill areas and no unauthorised material will be placed into proposed fill areas. No naturally formed limestone rock is known to reside within the property. Excavation of fill holes do not intercept springs and are not below the seasonal mean groundwater level in that location. Sensitive areas can be easily avoided when undertaking these associated activities. Offal sites are to be covered and the surfaces to be restored to a similar state as surrounding land upon closing.
Drainage of Land (Rule 9 RWPS & Rule 13 pSWLP)	It is not anticipated that any discharge from subsurface drains would result in a conspicuous change to the colour and/or clarity of the receiving waters at a distance of 20 metres from the point of discharge. The proposed good management practices will significantly reduce the likelihood of any contaminants reaching the subsurface drains.

5. NOTIFICATION AND CONSULATION

A consent authority has the discretion whether to publicly notify an application unless a rule or National Environmental Standard (NES) precludes public notification or section 95A(2) applies.

The effects of the activity will be no more than minor, the applicant does not request public notification and there are no rules or NES' which require the public notification of the application. In addition, there are no special circumstances relating to the application. As such, notification of the application is not necessary.

Clause 6(1)(f) of Schedule 4 of the RMA requires the identification of, and any consultation undertaken with, persons affected by the activity. The assessment of environmental effects below demonstrates that no persons will be adversely affected by the proposal to a degree that is minor or greater. Overall, it is considered that this application can be processed non-notified and without the need for written approvals.

6. ASSESSMENT OF ENVIRONMENTAL EFFECTS

In addition to the application being made in the prescribed forms and manner, Section 88 of the RMA also requires that every application for consent includes an assessment of the effects of the activity on the environment as set out in Schedule 4 of the RMA.

6.1 Effluent Disposal

6.1.1 Application Rate/Depth

The proposed application rate and depth are 10 mm/hr and 25 mm respectively. This is appropriate for Category A soils and will be achieved using a low rate pod system. The slurry tanker will apply effluent at a maximum depth of 5mm.

In Southland, regular soil water deficits greater than 10 mm mainly occur between the months of October to May, which makes it difficult to accurately schedule the application of effluent to coincide with soil moisture deficits over the entire milking season, which usually begins in August. The applicant checks weather forecasts, checks the nearest soil moisture site on the ES website and checks paddocks before application to ensure that effluent is only applied when a soil water deficit exists.

The applicant also plans to install his own soil moisture probe/tapes on the property to ensure a higher level of effluent management that is targeted at site-specific soil conditions. It is appropriate for the discharge consent sought to require that this is installed within 6 months of the consent being exercised.

Careful irrigation scheduling will maintain nutrients within the top 200 mm of soil[9], enabling the assimilation of nutrients into a form which can be used by plants whilst avoiding ponding, odour, overland flow and or/nutrient leaching and microbial leaching to groundwater and surface water. Ensuring that effluent is not

[9] Houlbrooke, D J, Monaghan R M, *The influence of soil drainage characteristics on contaminant leakage risk associated with the land application of farm dairy effluent*, 2009, AgResearch Ltd

applied at depths greater than those specified above will ensure that when there is a soil water deficit, the nutrients should remain in the top 200 mm of soil.

Effluent discharge will observe a 28-day return period. Effluent will be discharged to land year-round, on days when conditions are suitable. Furthermore, "proof of placement" of irrigators provides a record of effluent application and the required information to make informed decisions daily and seasonally regarding the forecasting of FDE disposal.

With regards to the typical tile drain located at least 1 m beneath ground level, the proposed depth of application and assimilation in the topsoil will ensure that an appropriate separation distance to subsurface drains (should they occur in the disposal area) is maintained.

Provided that FDE is applied to land in the manner described, then any potential adverse effects associated with ponding, odour, overland flow and or/nutrient leaching and microbial leaching to groundwater and surface water should be avoided as far as reasonably practicable.

6.1.2 Storage

Currently, effluent storage at the farm consists of a relatively new 3,261m^3 lined pond with a mechanical stirrer, which was designed by RDAgritech Ltd. There are no signs to suggest that the pond is leaking. The attached Dairy Effluent Storage Calculator (DESC) report shows the pond is adequately sized as the total volume exceeds the minimum of 2,670m^3 suggested by the DESC. Adequate storage will enable irrigation of effluent to be deferred when conditions are not suitable.

6.1.3 Nutrient Loading

Calculations using the DESC attached indicates that the farm will produce around 10,200 m^3 of FDE per year[10]. This equates to 148 m^3/ha/yr based on an irrigation area of 69 ha. Using DairyNZ (2010) guideline N concentration of FDE of 0.45 kg/m^3, this equates to an annual loading rate of 67 kg N/ha/yr (assuming all areas receive an equal amount of effluent. An areal loading of 67 kg N/ha/yr equates to 44% of ES's recommended maximum areal rate of 150 kg N/ha/yr for all N inputs, and is less than the limit imposed by current consent conditions.

ES's recommended maximum areal rate of 150 kg N/ha/yr is supported by the 2009 report for ES by AgResearch[11] that recommended the maximum N load as a management criterion to avoid direct losses of land-applied FDE. Given that the proposed areal loading is a fraction of the limit recommended by AgResearch, land-applied FDE nitrogen leaching will be within acceptable limits.

FDE can be used as an organic fertiliser, which means that it relies on soil organisms to break down the organic matter. Nutrients are released more slowly than they are from inorganic fertilisers and this slow-release method reduces the risk of nutrient leaching. Inorganic fertilisers, such as urea, provide the same nutrition in a plant-ready form immediately, but the rapid release of nutrients creates a higher risk of leaching past the root zone.

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[10] This figure was calculated using 700 cows. The application has been scaled back to 680 cows. The effluent production figures have not been updated. This provides an additional margin of safety for effluent management.

[11] Houlbrooke, D J, Monaghan R M, *The influence of soil drainage characteristics on contaminant leakage risk associated with the land application of farm dairy effluent*, 2009, AgResearch Ltd

Overall, the effluent disposal system described above allows the effluent to be used as both a fertiliser and soil conditioner with a lower risk of nutrient leaching than inorganic fertilisers.

6.1.4 Disposal Area

A total discharge area is to be extended to 69.3 ha which provides a discharge area to stock ratio of approximately 10 ha per 100 cows, which is greater than the recommendation of 4 ha/100 cows. The available disposal area is also greater than the minimum required in ES's Best Practice Guidelines, which is 8 ha/100 cows. This limit is derived as a further method for ensuring that ES's recommended 150 kg N/ha/yr areal loading limit for N (discussed above) is not exceeded.

Effluent will not be applied within the following buffer zones:

- 20 m of any surface watercourse
- 100 m of any potable water abstraction point
- 20 m to any landholding boundary; and
- 200 m of any residential dwelling on a neighbouring property

There are no other sensitive receptors that require separation measures to be implemented. Provided that these buffers zones are maintained, there should be no significant adverse effects resulting from the siting of the disposal area.

6.1.5 Effects on Water Quality from FDE Disposal

A desktop assessment of the potential effects of the potential loss of N from the disposal of FDE to land has been undertaken.

Using a 304-day milking season, potential effects associated with N leaching have been calculated. It has been assumed that:

- Attenuation (e.g. plant uptake etc) can account for up to 97% of total N input[12] but for this estimation we consider that an attenuation of 50% is more appropriately conservative and realistic and
- Drainage equates to 368 mm/yr (based on land surface recharge for the Lower Oreti Groundwater Management Zone[13]); and
- An average of 50 L/cow/day of FDE will be produced and that FDE has an average TN loading of 0.45 kg/m^3.

Based on these assumptions, the average TN concentration in drainage water as a result of FDE application is likely to be in the order of 9 g/m^3. This is generally consistent with the more robust estimate of drainage N concentrations identified in the Overseer modelling (Attachment C).

This application seeks to increase the size of the disposal area over soils with the same characteristics and within the same physiographic zones as the existing disposal area.

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[12]Houlbrooke D, Longhurst B, Laurenson S and Wilson T, 2014, *Benchmarking N and P loss from dairy effluent derived nutrient sources*

[13]Chanut P, 2014, *Estimating time lags for nitrate response in shallow Southland groundwater*, Environment Southland publication number 2014-03, Invercargill.

There is a registered drinking water site at Lochiel School (LOC001), which is located approximately 1.5 km down-gradient of the subject property. An assessment of the potential adverse effects on this water supply is detailed later in this report.

Other contaminants of concern include sediment and micro-organisms. Contaminant transportation towards sensitive receiving environments is dependent on many factors, including soil type, climate and anthropogenic influences such as the presence of drains. All of these factors have been considered when determining an appropriate irrigation location and method (including rate and depth), and in ensuring that there is adequate storage to allow for deferred irrigation. By restricting effluent irrigation to periods where drainage events are less likely to occur, there is less risk of leaching, overland flow and losses via artificial drains occurring. The proposed application depths will enable nutrients to be assimilated in the root zone in the top 200 mm of soil (tile drains are located beneath this) and avoid direct contamination of waterbodies via discharges.

Provided that effluent is applied at the proposed rate/depths and effluent irrigation is avoided when conditions are not suitable, then any significant adverse effects on water quality will be appropriately avoided or mitigated.

6.1.6 Odour

The effects of odour are most likely to occur from the discharge of FDE or from the storage of effluent where it may be encountered beyond the boundary of the site. The effluent pond is located at a suitable distance from the property boundaries and nearest dwellings. The physical location of the effluent infrastructure coupled with the proposed low application rate irrigation and effluent discharge buffers means there is little risk of adverse effects from odour and spray drift on surrounding land owners and occupiers. As such, the effects of odour are avoided.

6.1.7 Contingency Plans

An alarm and automatic switch-off system is installed and this acts as a contingency measure in the event of an effluent system failure such as sudden pressure drop, irrigator stoppage or breakdown.

A slurry tanker may be used at certain times if the usual methods of effluent discharge are under repair or if conditions allow for more effluent to be applied than the usual system is capable of conveying. Any discharges from the slurry tanker must adhere to the rate and depth limits imposed on the consent.

6.2 Groundwater Abstraction

6.2.1 Allocation

The applicant's proposed abstraction represents a negligible portion of the allocation of the respective groundwater management zone. This application seeks to replace existing groundwater permits with no increase in the volume of water sought, therefore there will be no effect on current allocation volumes.

6.2.2 Stream Depletion and Interference Effects

Policy 29 in the RWPS and Policy 23 of the pSWLP requires a stream depletion assessment when the daily average rate of take is more than 2 L/s because takes less than this are expected to have a minor effect on stream flows. Over 24 hours of pumping, the rate of take is less than 2 L/s and therefore does not require a stream depletion assessment.

Significant interference effects on neighbouring bores are not expected. Given that the average rate of take is relatively low, it is unlikely that the radius of interference would affect any of these bores.

6.2.3 Effects on Groundwater Quality

The low rate of take is highly unlikely to result in the drawdown of contaminants from the upper soil profiles and so the proposed abstraction is highly unlikely to have any adverse effects in terms of groundwater quality. The applicant will need to ensure that the bore head casing is adequately sealed to prevent the ingress of contaminants.

6.2.4 Efficiency of Use

The proposed rate of take is estimated at 120 L/cow/day, which is consistent with Council's recommendations. The applicant is not opposed to the continued monitoring of water abstraction on the property to ensure that use is not excessive.

6.2.5 Monitoring

The proposed abstraction will continue to be metered with records kept on a monthly basis, consistent with the existing conditions of consent. These records will be provided to Council annually at the end of the "water year" and upon request.

6.3 Expansion of the Dairy Platform and the Addition of Cows

Conservative Assessment

The modelling of the "existing environment" has taken into consideration the activities that have been occurring on-site for the past three years, rather than just last year, and also uses actual cow numbers on the dairy platform rather than consented cow numbers. Modelling *actual* cow numbers provides Council with more certainty about how future losses compare with recent historic losses.

The applicant took over ownership of the east block in October 2016 it has since been gradually transitioned into a dairy support block. Before that is was used for sheep grazing only. To create a meaningful assessment of estimated losses for the past three years, three separate budgets were created for the Eastern Block and these are discussed in the attached Overseer modelling report. The modelling undertaken represents a meaningful, conservative estimate of nutrient losses for the past 3 years. The detailed modelling information is contained in Attachment C.

Results from Overseer Modelling

CURRENT SCENARIO

Overseer was used to model losses from the existing sheep farm (east block) and existing dairy farm for the last three years to formulate a current scenario model. Three separate budgets were modelled for the east block to account for the transition that this block has undertaken from a sheep grazing block in the 2015/2016 season to a dairy support block in the 2017/2018 season.

The existing dairy farm has maintained a consistent farm system for the preceding three years and accordingly one nutrient budget was prepared which used actual inputs from farm records which has been averaged for the three years. The applicant peak milked 573 cows producing 473 kg MS/cow. A total of 516 cows were wintered off the platform at a grazier with the remaining average of 83 cows wintered at home on fodder beet.

The cows on fodder beet are averages across the month to allow for some of the herd to stay on farm at the start of June, and to allow for early calvers to be brought home early at the end of July. The numbers used in the model (20 in June and 86 in July) are an average across those months. So, if there were 300 cows on-site for the first two days in June and none for the rest of the month, or 20 cows on-site for every day in June, the effect would be the same.

Combining the two current scenarios for the east block and dairy platform gives a representation of the level of predicted nutrient losses occurring from the whole landholding currently, prior to any proposed land use change.

PROPOSED SCENARIO

Overseer was then used to model the proposed scenario, which sees 680 cows being milked over the expanded dairy platform onto east block. Under the proposed scenario, the same number of cows are wintered at a grazier (516 cows in June and 459 cows in July) with the remainder of the herd being wintered on farm on grass/baleage over the winter period. Supplement usage and fertiliser inputs have been adapted to suit the proposed farm system with the only major changes being the expansion of the effluent discharge area and the concurrent partial substitution of the nutrients in applied fertilizer with effluent to facilitate pasture growth.

COMPARISONS – CURRENT vs PROPOSED SCENARIOS

The results of this modelling are summarised in the following table.

Table 11: Summary of Overseer (6.3.1) and additional nutrient loss modelling for the whole dairy platform

	Current Total Farm System	Proposed Total Farm system	Reduction
N (kg/yr)	11,513	10,507	-~9%
P (kg/yr)	230	212	-~8%

OFF-SITE EFFECTS

The offsite effects have not been included in the above modelling. As detailed in Attachment C the number of mixed age cows and R2 heifers wintered off-site is the same for both the current and proposed scenarios. Young stock numbers grazed with a third party grazier will increase and the modelling undertaken in Attachment C has estimated that the additional nutrient losses associated with this could be approximately 473 kg N/year and 7.8 kg P/year.

The modelling has shown that authorising the expansion of the dairy farm as proposed will result in a significant net reduction in the quantity of N and P lost from the landholding. This is because of the following changes in the way that the land will be used:

- Removing winter crop area from the dairy platform and replacing it with grass/baleage wintering to enable the wintering of 216 cows on farm.
- Increasing the effluent discharge area so that the concentration of effluent in any one area is reduced; and
- Reduced N fertiliser use on the effluent discharge area and overall.
- Increased use of barley.
- Increased in the area utilised for baleage grass wintering.
- A reduction in Olsen P to 30 on the dairy platform (but with the level increasing to 30 on the East Block)

The East Block is flat, there are no waterways on this block and only one new lane will need to be constructed. The photos below show existing ways in which the applicant mitigates against direct P losses to waterways. The installation of bargeboards and sandbags on crossings prevent sediment and effluent runoff from the lane into the waterway and direct drainage to the adjacent pasture.

Figure 18: Laneway crossing with kickboard to prevent direct runoff into creek

Figure 19: Laneway crossing with kickboard to prevent direct runoff into creek

Figure 20: Laneway crossing with sandbags to prevent direct runoff into creek

Artificial drainage is the key contaminant pathway for much of the existing dairy farm and the new east block, but the risk of P infiltrating the topsoil and being transported to surface water via tile drains is low because P adsorbs to soil articles and so it is not prone to leaching in the same way that N is. Overland flow is the more common mechanism for P loss to water and this is not a key contaminant pathway on this property, although the applicant adequately mitigates against the risk of contaminant loss via this pathway in accordance with the measures in the FEMP.

The applicant will operate the farm in accordance with this FEMP to ensure that any potential effects associated with the proposed farming operation will be managed appropriately.

Based on the above, the risk of adverse environmental effects occurring because of an increase in P loss to water as a result of the proposed expansion is negligible.

Microbial Contamination

With respect to microbiological contamination from pastoral farms, research by AgResearch[14] strongly indicates that late autumn until mid-spring is the high-risk period as this is when surface runoff and mole-pipe drainage is most likely to occur. They also note that *"not all areas of the landscape contribute to flow pathways of loss. Those that do are termed critical source areas and are characterised as being directly "connected" to water bodies"*. AgResearch research indicates that improved effluent management, stock exclusion and the elimination of stock crossings will have the greatest impact in reducing microbiological contamination from pastoral farms. These GMPs will be adopted on farm through the implementation of the FEMP, which will ensure that adverse effects resulting from microbial contamination will be reduced as far as reasonably practicable and will be less than occurring prior to the implementation of the FEMP.

6.4 Effects of the proposal on water quality

Contaminant loss mitigation proposals & Overseer modelling

The attached report (Attachment C) prepared by Mo Topham summarises the pre and post-development farm systems and the primary contaminant loss mitigation measures proposed.

The uncertainties involved in Overseer modelling are not currently able to be quantified. They are probably greater than 30% for both N and P modelling[15]. However, this concept of uncertainty applies to the absolute estimate of nutrient loss, i.e., what is the uncertainty relating to a specific numeric estimate.

There are two significant conclusions from this:

- The estimated differences between the current and proposed farm system nutrient loss estimates are significantly less than the likely uncertainties involved in Overseer modelling undertaken to estimate an absolute number.
- Overseer modelling should be considered in conjunction with the specific farm systems and mitigation measures that are proposed to provide a reasonable level of certainty about nutrient loss estimates. This provides a high level of certainty that the actual loss of N and P will be significant and actual.

Local and cumulative surface water quality

The information outlined above on the quality of surface water downstream of this property combined with the estimates of the current and likely futures losses of sediment, faecal indicator organisms, N and P from the properties provide strong evidence for a real but extremely small overall improvement in local

[14] Monaghan, R. M., Semadeni-Davies, A., Muirhead, R. W., Elliott, S and Shankar, U., 2010. *Land use and land management risks to water quality in Southland.* Prepared for Environment Southland, April 2010.

[15] Wheeler D & Shepherd M (2013) Overseer: Answers to commonly asked questions, RE500/2012/027

surface water quality. This improvement would not be measurable with the current Environment Southland surface water quality monitoring programmes. However, if other properties in the wider catchment implemented equivalent good management practices it is highly likely that there would be significant and measurable improvements particularly for the water quality variables that currently do not comply with the relevant guidelines, standards or trigger values. The nature of the water quality issues in the Oreti River such as deposition of sediment in slow-flowing reaches (which may take many years to move downstream) means that some water quality improvements would take a long time to be realised.

The vast majority of surface runoff from the property will be into drains and creeks that discharge into the Oreti River. There is a chance that the most eastern side of the east block has run-off at times that moves to the tributaries of Tussock Creek that in turn drains into the Oreti River. It is acknowledged that the east block will have a slightly higher P loss compared to the current average. This has been estimated by Ms Mo Topham as follows (refer to Attachment C for background supporting information):

> *"losses of P from the East Block are a total of those attributed to the block itself (10kg) plus a proportion of the other losses (farm total of 106). Of this 106 kgP, 13. 9ha/224.5 ha or 6.2% can be attributed to the East Block (6.6 kgP). This takes the total attributable loss of P from the East Block to 16.6 kgP. However, other losses includes losses from laneways, but there will be no laneways on the East Block, so we can take this impact out. Using the same assumptions as I have for my P loss mitigation file note, of the 106 kgP other losses, 104kgP is attributed to laneway losses. Therefore, of the 2kg remaining, 0. 1kgP can be attributed to the East Block. So, P loss from the East Block is predicted to be 10.1 kgP. This is compared to 9.7 kgP for the current (average of 9, 10 and 10)[16]."*

Therefore we have an estimate of an increase of 0.4 kg P/yr (10.1-9.7) or approximately a 4% increase, for the proposed use of the East Block compared to the average for the last three years. This is in the context of a total property reduction of 18 kg P/yr as outlined in the above table.

There is some uncertainty about whether any surface run-off from the East Block would fall towards the drains leading to the Oreti River or Tussock Creek. The location of the property and the East Block relative to drains/creeks on the property and immediately down-gradient is illustrated in the following figure.

[16] Email dated 29 August 2019.

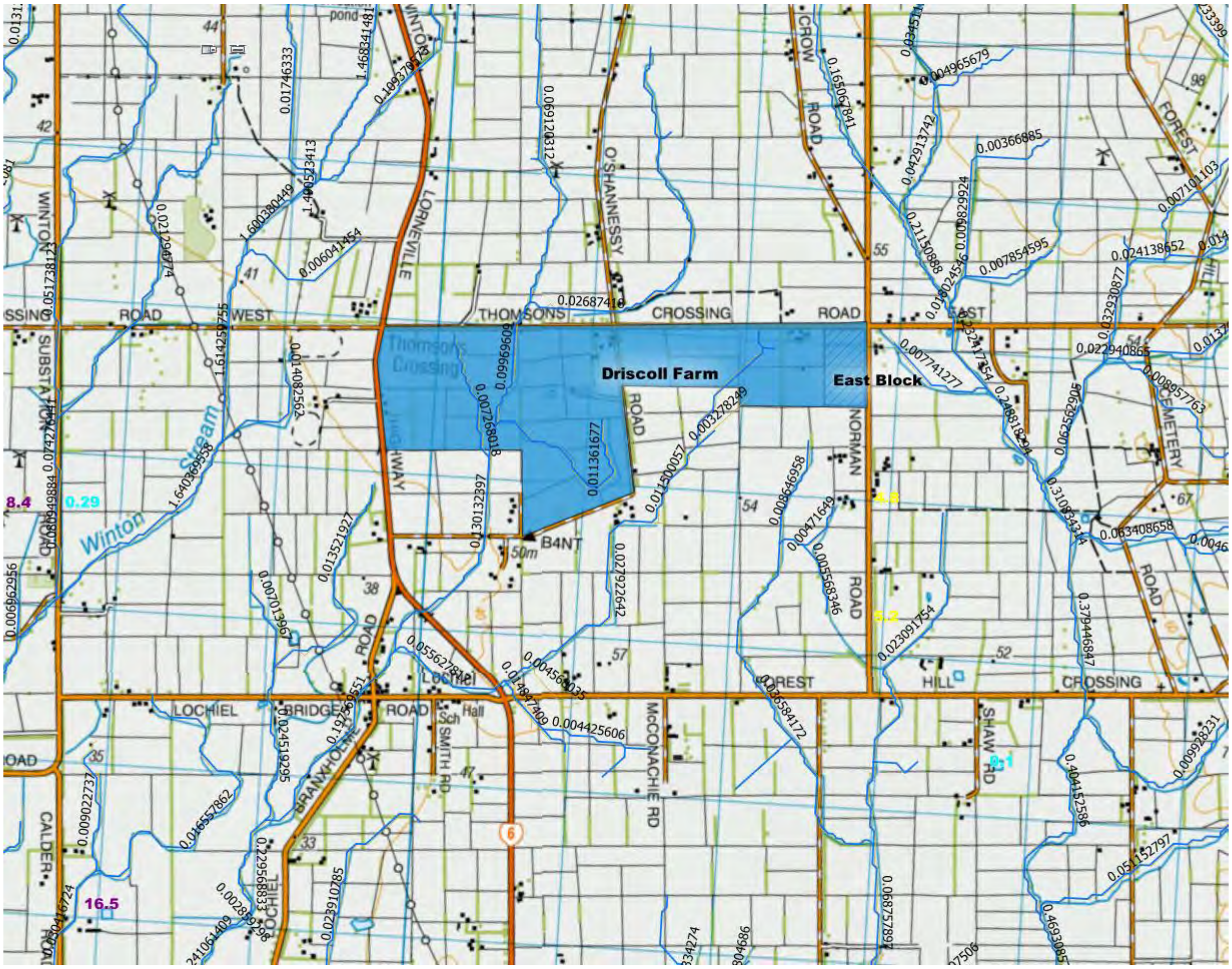


Figure 21: Location of the property, the East Block (hatched area) and creeks/drains in the area.

On the basis of the overall surface topography as indicated by the 20 m contours showing a gentle fall to the south west, and with information from the applicant on what they have observed during major rainfall events it clear that the vast majority, ≥~90%, of runoff from the East Block moves towards the creek directly south west of the block with only a very small amount of the block, ≤~10%, draining west towards Tussock Creek. So, it is likely that any negilible increase going into the creek to the south west of the block would be countered by a negligible decrease coming from the adjacent block. This would just leave say very roughly 10% of 0.4 kg of P potentially moving towards a creek in the headwaters of Tussock Creek. We consider that the effects of this are highly likely to be *de minimus*.

The above figure also includes NIWA modelling estimates of mean annual flows of each surface water reach[17]. This assists to understand the relative amounts of water flowing in each tributary.

The above assessment while relatively crude in nature does strongly indicate that particularly in the context of the overall reduction in nutrient losses and the trivial increase in potential P loss from the East Block

[17] https://shiny.niwa.co.nz/nzrivermaps/ (data imported into QGIS)

mean that it is highly unlikely that there would be any significant adverse effects in any surface water drain/creek.

Local and cumulative groundwater quality

The information from the Overseer modelling combined with the specific good management practices provide strong evidence for a real reduction in the N loading to groundwater and if this occurs across enough properties in this general area there will be an improvement in both the underlying groundwater nitrate N concentrations and eventually the concentrations in drainage water discharging to streams. Because of the complexity of groundwater systems including the inherent heterogeneity of alluvial aquifers, and travel times for drainage water and groundwater it may be many years before reductions in N loads are observed in bores used to monitor groundwater quality and in surface water recharged by that groundwater.

Effects of the proposal on the Lochiel School water supply

The Lochiel School water supply appears to be from bore E46/1473 (unknown depth, unknown diameter, but likely to be between 5 – 20 m depth but there is a small possibility that it could be as deep as 40 m, based on bore depths in this general area).

The Driscoll dairy farm is spread over two main soil types that differ significantly in terms of the predominant contaminant pathways. The predominant Pukemutu soils are poorly drained and the predominant pathway is via runoff and artificial drainage. Conversely, the Edendale soils are well-drained providing a transport route to groundwater. The greatest risk to shallow bores used to supply drinking water is in areas with well-drained soils in locations with activities that can result in contaminants leaching through soils into groundwater.

The location of the Lochiel School water supply is illustrated in the following figure together with the 2007-2012 nitrate nitrogen survey and more recent nitrate nitrogen results.

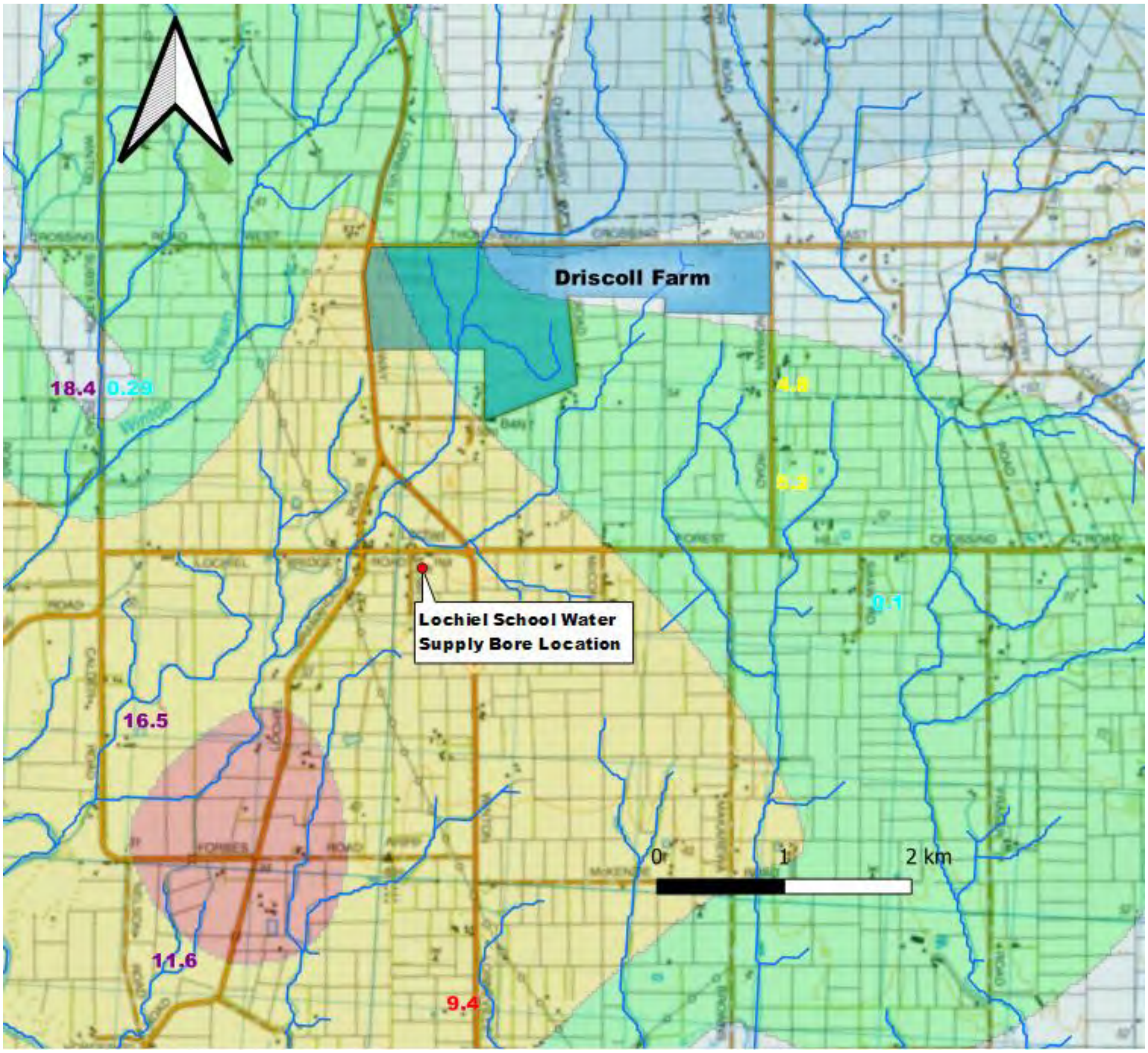


Figure 22: Location of the Lochiel School Water supply bore relative to the Driscoll Farm

The two primary issues for groundwater-sourced drinking water supplies in areas are nitrate nitrogen and faecal indicator organisms (indicators of pathogens, disease-causing organisms). The AEE provided with the application explains in some detail how nitrogen losses from the property will be reduced and consequently reduce the risk. The background concentrations of nitrate nitrogen as indicated by the 2007 – 2012 survey indicate that nitrate nitrogen concentrations in this area are between 3.5 – 8.5 g/m3.

The factors involved in influencing the transport of faecal indicator organisms have the added complexity of a range of complex attenuation factors apply to microorganisms that do not apply to dissolved nitrate nitrogen.

It has been recognised for many decades that shallow groundwater in those parts of Southland (and other parts of New Zealand) with pastoral catchment land use is vulnerable to microbiological contamination[18].

[18] Hamil K (1998) Groundwater Quality in Southland" A Regional Overview, Southland Regional Council Publication No 96, 51p.

This 1998 study showed that 75% of the wells sampled and 25% of the bores samples had faecal coliforms detected. This and other studies around New Zealand have demonstrated that shallow bores/well in areas with well-drained soils and pastoral agriculture are vulnerable to microbiological contamination.

The good management practices and mitigation measures that are proposed will result in a significant reduction in N loss to groundwater and in P loss to surface water. It has been generally accepted that a significant reduction in P loss to surface water will also result in a reduction in the risk of microbiological loss to surface water. While we are not aware of any specific research into the consequences for microbiological groundwater quality of mitigation measures designed to reduce N loss to groundwater and P/sediment/microbiological loss to surface water. We consider that it is conceivably possible that some of these mitigation measures could theoretically result in a very small increased risk of microorganisms entering soils and eventually potentially entering the underlying groundwater. For example, recontouring laneways and installing culvert cut-offs to ensure that contaminated surface water doesn't enter surface water means that that surface water runoff is redirected onto soils to allow it to slowly drain into soils.

However, it would be a complex process to then assess the extent to which a small potential occasional increase in microorganism loss to soils could then eventually move into groundwater and then migrate through an aquifer towards drinking water supplies. The scope of this assessment does not allow a quantitative assessment of the potential risks. In the context of the existing relatively high risk of microbiological contamination of shallow groundwater supplies it is highly likely that the increased risk posed by these mitigation measures would be insignificant.

We also note the recent Government Enquiry Report[19] into the outbreak of campylobacteriosis in Havelock North has made some strong recommendations regarding the risks of untreated drinking water and recommended that all drinking water supplies (including those delivered by self-suppliers) should be appropriately and effectively treated.

We understand that the Lochiel School water supply is disinfected. However, we have not yet had that corroborated by the Ministry of Education's representative.

Finally, we note that in the s42A report for a since granted, expansion of South Dairy 1 application in Feb 2018, the Consents officer, Emily Allan, concluded that:

> "*Any potential effects on the water supply are likely to be negligible. The discharge of effluent is not directly to water and the maintenance of buffer zones, along with other mitigation methods, will be required by consent conditions. Provided the conditions are adhered to, then the discharge is not likely to introduce or increase the concentrations of contaminants at the drinking water abstraction point that would cause a breach of standards.*"

Estimates of faecal indicator organisms and sediment losses before and after development

[19] Havelock North Drinking Water Inquiry (2017) Government Inquiry into Havelock North Drinking Water Stage 2 Report, 286p.

It is very difficult to develop quantitative estimates of the loss of faecal indicator organisms or sediment loss. There are no equivalent readily available farm-scale models that can be used. However, one common approach[20] is to use Overseer modelled P loss as a surrogate for both. This is because a key component of Overseer P loss modelling is based on an assessment of soil loss which will include faecal indicator organisms as well as sediment. Therefore, a combination of the Overseer modelled P loss indicating a very small reduction in P loss and the broader good management practices being proposed and outlined in the AEE, provide a very strong indication that there is highly likely to be at least equivalent small reductions in both sediment and faecal indicator loss to water from the development.

Although Overseer phosphorus loss modelling can be used as an approximate proxy for sediment and microbiological contaminants, as indicated above Overseer does not currently model many of the possible farm management techniques that can be employed to manage P loss partly because the model is not spatially explicit.

The FEMP includes a list of proposed management tools which will result in less phosphorus, and generally less sediment and microbiological contaminant loss to water. The table also summarises whether or not they are modelled in Overseer and which management practices the applicant will undertake to further minimise P and generally sediment and faecal indicator organism loss on farm under the proposed dairy expansion. With the adoption of these management measures, losses of these three contaminants will be further reduced.

The applicant is willing to have these measures imposed as appropriate resource consent conditions, which will provide the consent authority sufficient certainty about the likely effects of the proposal.

Effects on the New River Estuary

As a proportion of the estimated catchment loads, the overall load from this property is understandably extremely small. On a modelled catchment source load basis, the overall load would amount to approximately 0.2% (9,908/4,969,000 or 9.908/5,513,000) of the modelled catchment N load. While this calculation is useful to get a broad appreciation of the potential scale of the overall contributions to N and P catchment loads, it can't be used in any meaningful way to estimate contributions to concentrations in either the Oreti River or the New River Estuary because of the complex hydrogeological, physical, chemical and biological processes that operate in the catchments. However, it does highlight the importance of targeted catchment-wide implementation of contaminant loss measures to address water quality issues.

The new good management practices that will be implemented will reduce this contribution by an almost insignificant amount. By itself this would be virtually insignificant but combined with similar initiatives across the whole New River Estuary catchment would result in significant reductions in the nutrient and sediment loadings to the estuary which has the potential to contribute to a significant improvement in a broad range of water quality indicators.

[20] It was accepted at a 2018 ES consultant meeting that phosphorus loss modelling can be used as an approximate proxy for sediment and microbiological contaminant losses.

6.5 Good Management Practices

The applicant already has a Farm Activity Focus Plan, and this has been incorporated into the attached draft FEMP. The FAFP doesn't cover the East Block but there is no waterways or CSAs on the East Block that require specific management.

Plans showing the areas to be cultivated and the areas to be intensively winter grazed over the following season need to be provided before the FEMP can be completed, however, there is no sense in doing this until the applicant knows if/when the new land use consent might be granted. For example, the cultivation and winter grazing areas could be mapped now, but if consent is not granted soon then these maps may not longer be applicable.

The subject site covers two different physiographic units therefore it requires a range of GMPs to be adopted, with the key contaminants pathways being deep drainage and artificial drainage (see earlier in this report report). Rule 20(d)(ii)(2) of the PSWLP requires a detailed mitigation plan for any mitigations proposed, that identifies the mitigation or actions to be undertaken including any physical works to be completed, their timing, operation and their potential effectiveness. Although this application is made under Rule 20(e), the applicant has included a mitigation plan for completeness. This mitigation plan has been incorporated into the FEMP to ensure that there is one comprehensive document that can be incorporated into consent conditions and be used as an operational guide.

The property includes Oxidising and Gleyed physiographic zones, so requires a range of GMPs to be adopted, with the key contaminant pathways being deep drainage, artificial drainage and a risk of surface runoff. The table below describes the mitigation measures which will be adopted. The GMPs will ensure that the farm is operated in accordance with industry accepted and promoted good practice.

Table 12: Mitigation Plan Outline – refer to FEMP for detail

Mitigation	Timing	Operation	Level of effectiveness
Effluent mitigations (increased area and targeted applications)	Only apply effluent when there is a sufficient soil deficit.	Ensure effluent only applied to appropriate areas and spread as widely as possible, with Nitrogen applications taking into account the additional effluent nutrients. Avoid sensitive areas as detailed in FEMP.	High level of effectiveness for reducing contaminant losses via, artificial drainage and deep drainage contaminant pathways when applied at a depth less than soil water deficit which allows nutrients to be utilised in pasture production. Effluent spread little and often reduces the risk of losses.

Mitigation	Timing	Operation	Level of effectiveness
Calving Pad	Autumn and Spring period (shoulder seasons)	With additional milking cows, an ability to reduce risk of pugging to pastures over spring and at autumn is required.	The risk of pugging reduces infiltration of soils and increases overland flow of nutrients. Also, nutrients are held and spread onto soil by effluent applications when pastures are more able to receive the nutrients and thus lowers risk of losses.
Best practice pasture/baleage grazing techniques	Winter period	All pasture/baleage grazing will be undertaken using good management practices to reduce risks of overland flow and loss of nutrients via artificial drainage and profile leaching pathways. (See table 3 in FEMP)	Grazing on a flat block reduces risk of overland flow of contaminants and reduces the width of buffer zones required. Losses via artificial drainage and leaching represent the greatest risk but are mitigated with GMPs.
Fertiliser usage based on soil tests	Soil testing to be undertaken on regualar (at least every 3 years) basis, preferably at the same time each year.	Soil tests are used to guide fertiliser recommendations, particularly to guide the decision whether to apply capital or maintenance fertiliser. Maintain Olsen P levels at optimum levels (30).	High level of effectiveness as using soil testing can significantly reduce nutrient inputs and avoid the excess accumulation of nutrients in the soils – especially P. Higher than optimum Olsen P levels in the soil increases the risk of P losses from the farm system.
Little and often N fertiliser applications timed to avoid high risk periods.	Throughout the growing season	Reduced split application for effluent blocks. Fertiliser is not applied during the winter period.	High level of effectiveness for reducing potential nutrient losses via all three contaminant pathways. Fertiliser application is designed to meet pasture demand and reduce the likelihood of excess nutrients applied.
Control of runoff risk from lanes, gateways	Prior to the start of the season	Bridges and culverts to be updated to reduce runoff.	High level of effectiveness for reducing P losses via "other sources" as modelled in Overseer.

The table below outlines which GMPs will be adopted and which physiographic zones they provide most benefit in.

Table 13: Site Specific Good Management Practices and mitigation measures

Good Management Practices to be adopted	Most effective in these zones
Protect soil structure • Wintering the majority of the herd off the milking platform • Wintering a small portion of the herd on grass/baleage • Re-sow bare soils as soon as possible • Use of calving pad when ground conditions are saturated (not for a fixed period)	Gleyed
Manage CSAa • Avoid working CSAs and their margins • Leave grassed areas (or native vegetation) around CSAs • All riparian margins to be fenced and planted • Increase buffer width along laneway • Direct water way through vegetated areas for filtering • Riparian planing	CSAs (Gleyed and Oxidising)
Reduce P loss • Reduce use of P fertiliser where Olsen P values are above agronomic optimum • Reduce the risk of run-off to water from laneways and other sources • Changer fertiliser type on Eastern Block to a less water-soluble fertiliser. • Improve kickboards on bridges and culverts.	Gleyed
Reduce N accumulation in soil • Control the intensity of grazing of pasture by opening up breaks during adverse weather conditions • Wintering the majority of the herd off the milking platform • Optimise timing and amounts of FDE application to avoid high risk drainage periods and saturated soils • Time N fertilizer application to meet pasture and crop demand using split applications • Re-sow bare soils as soon as possible	Gleyed, Oxidising
Avoid preferential flow of FDE through drains • Defer effluent application when soil conditions unsuitable • Apply effluent at low rates • Utilize the full effluent discharge area to reduce N loading	Gleyed

6.6 Other Assessment Matters

In accordance with Clause 7 of Schedule 4 of the RMA the following provides an assessment of the activity's effects on the environment:

a) any effect on those in the neighbourhood and, where relevant, the wider community, including any social, economic, or cultural effects

The effects of the proposal to abstract ground water and discharge dairy shed effluent already form part of the existing environment. Throughout the duration of the existing consents, there have been no known complaints from neighbours, which indicates that the potential adverse effects on the neighbourhood are less than minor.

The proposed activities will result in net positive benefits to the neighbourhood as there will be capacity to provide for the social and economic benefits with the employment of staff, as well as contractors and consultants, and the farm is serviced by local schools and many businesses that would not benefit if the activities were unable to occur. More generally, the dairy sector continues to contribute greatly to the New Zealand economy in many ways including gross domestic productivity, employment, community growth and resilience and reinvestment capacity via tax revenues. The ability for the applicant to continue to operate their dairying operation will enable them to provide for their own social, economic and cultural wellbeing.

In terms of the potential effects on cultural values, an assessment of the proposal against the Te Tangi a Tairua is the Iwi Environmental Management Plan (applicable to the Southland Region), is made below. The proposal is considered to be wholly consistent with the relevant policies of the Iwi Management Plan.

b) any physical effect on the locality, including any landscape and visual effects

In terms of landscape and visual effects, the presence of effluent irrigation, other farming equipment and cows is expected within the rural locality. It is expected that the proposal will not have any significant physical effects on the locality over and above that currently experienced.

c) any effect on ecosystems, including effects on plants or animals and any physical disturbance of habitats in the vicinity

The dairy farm is located within a highly modified ecological landscape and it is anticipated that the proposal will not have any significant adverse effects on ecosystems above that which has been occurring for many decades.

d) any effect on natural and physical resources having aesthetic, recreational, scientific, historical, spiritual, or cultural value, or other special value, for present or future generations

It is not considered that the activities will have any effect on aesthetic values, as the existing dairy platform is established and in keeping with the general rural nature of the area. The land in this area is historically known for farming activity, and the presence of a dairy operation on this property does not result in any effect contrary to the historical values associated with the natural and physical resources in the vicinity.

The waterways within the proposed dairy platform are non-navigable and public access would be by permission of the applicant only. There is no evidence to suggest popular recreation fishing spots nearby which may be affected by the proposal. The effects on any cultural values are assessed below.

> e) *any discharge of contaminants into the environment, including any unreasonable emission of noise, and options for the treatment and disposal of contaminants*

Effluent is proposed to continue to be treated and discharged to land as described earlier in this report. The assessment of alternatives provided in this report has concluded that this is the preferred solution for managing FDE generated at the property. The activity is in keeping with the rural nature of the area, therefore it is not considered there will be any unreasonable emission of noise or odour.

> f) *any risk to the neighbourhood, the wider community, or the environment through natural hazards or the use of hazardous substances or hazardous installations*

All hazardous materials carried and used onsite will comply with the relevant rules of the Part operative Southland District Plan 2012, and the Hazardous Substances and New Organisms Act 1996. As such, there will be no risk to the neighbourhood, wider community or the environment due to natural hazards or the use of hazardous substances or hazardous installations.

6.7 Assessment of Alternatives

Clause 6(1) of the Resource Management Act requires that an assessment of environmental effects must include a description of any viable alternative locations or methods for undertaking the activity if it is likely that the activity will result in any significant adverse effect on the environment and/or if the activity includes the discharge of contaminants. None of the activities described in this report are expected to result in significant adverse effects on the environment and so this assessment of alternatives considers the proposed discharge of FDE only.

Method of Discharge

Deferred irrigation methods will be utilised on the property to ensure that effluent is only applied when conditions are suitable. Detention in the effluent pond also provides some level of treatment to the effluent before it is applied to land. Alternative methods may include direct discharge of the effluent to land on an as-required basis, regardless of the conditions. This would likely result in over-saturation of soils, ponding, overland flow and/or excessive leaching of contaminants, all of which can lead to significant adverse environmental effects. There are no other practicable environmentally acceptable alternatives to applying FDE to land.

Receiving Environment

Discharging effluent to land, if conducted appropriately, enables the reuse of a waste product as a soil conditioner and provides nutrients for plant growth. Attenuation of contaminants cannot occur if effluent is discharged directly to water and is therefore considered unsuitable. Direct discharge to water would almost certainly be more detrimental to the receiving environment than discharging to land.

Overall, the proposed discharge methods and receiving environment are the most suitable for managing the FDE generated at the farm.

6.8 Summary

This proposal seeks to expand the footprint of an existing dairy farm and increase the number of cows milked. Modelling indicates that the proposal with a suite of farm system changes and mitigations will significantly reduce the amount of N, P sediment and faecal indicator organisms lost to water.

The effluent collection, treatment and disposal methods proposed are appropriate given on-site conditions and will ensure that any potential effects associated with effluent disposal are managed appropriately. No adverse effects are anticipated from the continued abstraction of groundwater.

Potential adverse effects associated with the operation of the dairy farm will be managed through the FEMP, which contains site-specific GMPs and mitigation measures that have been identified as being the most effective for managing the risks associated the soil types and physiographic zones present.

The proposed activities will enable the applicant to provide for their economic and social wellbeing while providing environmental benefits in the form of significantly reduced contaminant losses to the environment and no cultural values will be compromised.

7. STATUTORY CONSIDERATIONS

Schedule 4 of the RMA requires that an assessment of the activity against the matters set out in Part 2 and any relevant provisions of a document referred to in Section 104 of the RMA is provided when applying for a resource consent for any activity. These matters are assessed as follows.

7.1 Part 2 of the RMA

The proposal is consistent with the purpose and principles of the RMA, as outlined in Section 5. The proposal will have less than minor effect on the environment's ability to meet the reasonably foreseeable needs of future generations, or on the life-supporting capacity of the environment and any ecosystems associated with it. The proposal ensures that adverse effects on the environment are avoided or appropriately mitigated.

There are no matters of national importance under Section 6 of the RMA that will be affected by the proposal. In regard to Section 7, particular regard has been given to the efficient use and development of natural resources, and the maintenance and enhancement of the quality of the environment. Regarding Section 8, the proposed activity is not inconsistent with the principles of the Treaty of Waitangi.

Overall, the activity is considered to be consistent with Part 2 of the RMA, given the minor nature of the activity and the proposed mitigations.

7.2 Section 104(1)(b) of the RMA

In accordance with Schedule 4 of the RMA, an assessment of the activity against the relevant provisions of a document referred to in 104(1)(b) of the RMA must be included in an application for resource consent. Relevant documentation covered by this section are:

- National Environmental Standard for Sources of Human Drinking Water, 2007
- National Policy Statement for Freshwater Management, 2014

- Te Tangi a Tauira - The Cry of the People, Ngai Tahu Ki Murihiku, Natural Resource and Environmental Iwi Management Plan, 2008
- Regional Policy Statement for Southland, 2017
- Regional Water Plan for Southland, 2010
- Proposed Southland Water and Land Plan, 2018

Under the RMA, regional plans need to give effect to NPSs, NESs and RPSs. For an application of this scale, an assessment of the application against the regional plans is adequate as these plans ultimately give effect to the higher order statutory instruments.

Regional Water Plan for Southland, 2010

The following policies, which give effect to the plan's objectives, are relevant to this application for resource consent.

Table 14: Applicable policies from the RWPS 2010

Policy	Wording	Comment
1A	Any assessment of an activity covered by this plan must take into account any relevant Iwi Management Plan.	Te Tangi a Tauira is considered below.
7	Prefer discharges to land over discharges to water where this is practicable, and the effects are less adverse.	The proposed discharge is to land, not water.
14A	To determine the term of a water permit consideration will be given, but not limited, to: (a) the degree of certainty regarding the nature, scale, duration and frequency of adverse effects from the activity; (b) the level of knowledge of the resource; (c) relevant tangata whenua values (d) the allocation sought, particularly the proportion of the resource sought; (e) the duration sought by the applicant, plus material to support the duration sought; (f) the permanence and economic life of the activity; (g) capital investment in the activity; (h) monitoring and review requirement in permit conditions; (i) the desirability of applying a common expiry date for water permits that allocate water from the same resource; and (j) the applicant's compliance with the conditions of the previous permit (where a new water permit is sought for a previously authorised activity).	The consent term sought is discussed later in this report.
21	To ensure that the rate of abstraction and abstraction volumes specified on water permits to take and use water are no more than reasonable for the intended end use.	The rate and volume sought are reasonable for the intended use.

22	Require, where appropriate, the installation of water measuring devices on all new permits to take and use water.	The water take will be metered.
25	To avoid, remedy or mitigate the adverse effects arising from point source and non-point source discharges so that there is no deterioration in groundwater quality after reasonable mixing, unless it is consistent with the promotion of the sustainable management of natural and physical resources, as set out in Part 2 of the Resource Management Act 1991, to do so.	Adverse effects on groundwater from the discharge of FDE will be appropriately avoided and mitigated as discussed earlier in this report.
28	To manage groundwater abstraction to avoid significant adverse effects on: • long-term aquifer storage volumes • existing water users • surface water flows and aquatic ecosystems and habitats • groundwater quality	There will be no adverse effects on any of the matters listed from the proposed groundwater abstraction.
29	Manage the stream depletion effect of any groundwater abstraction with a rate of take exceeding 2 L/s.	The average rate of abstraction over 24 hrs is less than 2 L/s.
31	Limit the cumulative interference effect of any new groundwater abstraction (in conjunction with other lawfully established groundwater takes) to no more than 20 percent of the available drawdown in any unconfined aquifer or up to 50 percent of the potentiometric head in any confined aquifer. The effects on any neighbouring bore will be considered where that bore is lawfully established and an assumption will be made that the bore fully penetrates the aquifer.	This application is for a replacement consent and so this policy is not applicable.
31A	Matching discharges to land to the level of risk posed by the following risk factors: (a) Nature and quantity of contaminants; (b) Sloping land; (c) Soil drainage characteristics; (d) Climate; (e) Proximity to surface water; (f) Natural hazards	As discussed earlier in this report, the proposed discharge method, rate and depth are appropriate for the subject property.
31C	Manage discharges to land to avoid, remedy or mitigate adverse effects on: (a) soil quality; (b) amenity values; (c) ecological factors; (d) historic, cultural and traditional values; (e) natural character; (f) outstanding natural features.	As discussed earlier in this report, the proposed discharge will not have any significant adverse effects on any of the matters listed.
31D	Encourage the beneficial reuse of materials, to promote discharges of these materials onto land to maximise potential reuse of nutrients	As discussed earlier in this report, the proposed discharge allows for the beneficial reuse of FDE.

42	Avoid adverse effects on water quality and other adverse environmental effects associated with the application of farm dairy effluent to land by matching farm dairy effluent management to receiving environment risk.	As discussed earlier in this report, the proposed discharge method, rate and depth are appropriate for the subject property.
43	Match consent duration and inspection and audit requirements on resource consents to apply farm dairy effluent to land to the level of risk of adverse environmental effects.	The consent term sought is discussed later in this report.

Proposed Southland Water and Land Plan, 2018

The following policies, which give effect to the plan's objectives, are relevant to this application for resource consent.

Table 15: Applicable policies from the pSWLP 2018

Policy	Wording	Comment
1	Enable papatipu rūnanga to effectively undertake their kaitiaki (guardian/steward) responsibilities in freshwater and land management through the Southland Regional Council: 1. providing copies of all applications that may affect a Statutory Acknowledgement area, tōpuni (landscape features of special importance or value), nohoanga, mātaitai or taiāpure to Te Rūnanga o Ngāi Tahu and the relevant papatipu rūnanga; 2. identifying Ngāi Tahu interests in freshwater and associated ecosystems in Murihiku (includes the Southland Region); and 3. reflecting Ngāi Tahu values and interests in the management of and decision-making on freshwater and freshwater ecosystems in Murihiku (includes the Southland Region), consistent with the Charter of Understanding.	Te Tangi a Tauira is considered below.
2	Any assessment of an activity covered by this Plan must: 1. take into account any relevant iwi management plan; and 2. assess water quality and quantity, taking into account Ngāi Tahu indicators of health.	Te Tangi a Tauira is considered below.
6	In the Gleyed, Bedrock/Hill Country and Lignite-Marine Terraces physiographic zone, avoid, remedy, or mitigate adverse effects on water quality from contaminants, by: 1. requiring implementation of good management practices to manage adverse effects on water quality from contaminants transported via artificial drainage, and overland flow where relevant; and 2. having particular regard to adverse effects on water quality from contaminants transported via artificial drainage, and overland flow where relevant when assessing resource consent	Potential contaminant transportation pathways in the Gleyed physiographic zone and appropriate GMPs/mitigation measures are discussed elsewhere in this report. The addition of the East Block requires the expansion of the dairy platform further into the Gleyed physiographic zone. Appropriate mitigation

	applications and preparing or considering Farm Environmental Management Plans.	measures have been applied across the Gleyed zone to ensure that there is an overall decrease in contaminant losses. The very small potential increase in P loss from the East Block will be effectively offset by significant decreases of P loss elsewhere on the property.
10	In the Oxidising physiographic zone, avoid, remedy, or mitigate adverse effects on water quality from contaminants, by: 1. requiring implementation of good management practices to manage adverse effects on water quality from contaminants transported via deep drainage, and overland flow and artificial drainage where relevant; 2. having particular regard to adverse effects on water quality from contaminants transported via deep drainage, and overland flow and artificial drainage where relevant when assessing resource consent applications and preparing or considering Farm Environmental Management Plans; and 3. decision makers generally not granting resource consents for additional dairy farming of cows or additional intensive winter grazing where contaminant losses will increase as a result of the proposed activity.	Potential contaminant transportation pathways in the Oxidising zone and appropriate GMPs/mitigation measures are discussed elsewhere in this report. Contaminant losses will decrease as a result of the proposed activities. The addition of the East Block into the milking platform doesn't extend into the Oxidising physiographic zone.
13	1. Recognise that the use and development of Southland's land and water resources, including for primary production, enables people and communities to provide for their social, economic and cultural wellbeing. 2. Manage land use activities and discharges (point source and non-point source) to enable the achievement of Policies 15A, 15B and 15C.	Granting of the consents sought will enables people and communities to provide for their social, economic and cultural wellbeing. The proposed discharge will be managed appropriately.
14	Prefer discharges of contaminants to land over discharges of contaminants to water, unless adverse effects associated with a discharge to land are greater than a discharge to water. Particular regard shall be given to any adverse effects on cultural values associated with a discharge to water.	The proposed discharge is to land, not water.
15B	Where existing water quality does not meet the Appendix E Water Quality Standards or bed sediments do not meet the Appendix C ANZECC sediment guidelines, improve water quality including by: 1. avoiding where practicable and otherwise remedying or mitigating any adverse effects of new discharges on water quality or sediment quality that would exacerbate the exceedance of	As noted in Section 3.4 the PSWLP Appendix E water quality standards are not fully met but the farm system changes, GMPs and mitigation measures demonstrate that the significant reduction in contaminant losses

	those standards or sediment guidelines beyond the zone of reasonable mixing; and 2. requiring any application for replacement of an expiring discharge permit to demonstrate how and by when adverse effects will be avoided where practicable and otherwise remedied or mitigated, so that beyond the zone of reasonable mixing water quality will be improved to assist with meeting those standards or sediment guidelines.	to water will result in improvements in water quality. Therefore the proposal is fully compliant with this policy.
16	1. Minimising the adverse environmental effects (including on the quality of water in lakes, rivers, artificial watercourses, modified watercourses, wetlands, tidal estuaries and salt marshes, and groundwater) from farming activities by: (a)… (b) ensuring that, in the interim period prior to the development of freshwater objectives under Freshwater Management Unit processes, applications to establish new, or further intensify existing, dairy farming of cows or intensive winter grazing activities will generally not be granted where: (i) the adverse effects, including cumulatively, on the quality of groundwater, or water in lakes, rivers, artificial watercourses, modified watercourses, wetlands, tidal estuaries and salt marshes cannot be avoided or mitigated; or (ii) existing water quality is already degraded to the point of being overallocated; or (iii) water quality does not meet the Appendix E Water Quality Standards or bed sediments do not meet the Appendix C ANZECC sediment guidelines; and (c)… 2. Requiring all farming activities, including existing activities, to: (a) implement a Farm Environmental Management Plan, as set out in Appendix N; and (b) actively manage sediment run-off risk from farming and hill country development by identifying critical source areas and implementing practices including setbacks from waterbodies, sediment traps, riparian planting, limits on areas or duration of exposed soils and the prevention of stock entering the beds of surface waterbodies; and (c) manage collected and diffuse run-off and leaching of nutrients, microbial contaminants and sediment through the identification and management of critical source areas within individual properties. 3. When considering a resource consent application for farming activities, consideration should be given to the following matters:	1. The key consideration under this policy is the fact that some PSWLP Appendix E water quality standards are not fully met. However, given the other important conclusions of this assessment that the proposal will result in an overall reduction in the contaminant losses to water, it is considered that the exception provided by the policy should be applied particularly in the light of the assessment of the proposal against Policy 15B. 2 The applicant's intentions regarding the FEMP are discussed elsewhere in this report. A Farm Activity Focus Plan has already been developed for the existing dairy platform. This details the setbacks, fencing, riparian planting and avoidance of CSAs that the applicant is already doing. 3. The consent term sought is discussed later in this report.

	(a)… (b) granting a consent duration of at least 5 years.	
17	1. Avoid significant adverse effects on water quality, and avoid, remedy, or mitigate other adverse effects of the operation of, and discharges from, agricultural effluent management systems. 2. Manage agricultural effluent systems and discharges from them by: (a) designing, constructing and locating systems appropriately and in accordance with best practice; and (b) maintaining and operating effluent systems in accordance with best practice guidelines; and (c) avoiding any surface run-off or overland flow, ponding or contamination of water, including via sub-surface drainage, resulting from the application of agricultural effluent to pasture; and (d) avoiding the discharge of untreated agricultural effluent to water.	Collected agricultural effluent is treated and stored by means of a recently-constructed effluent pond, which has been kept in immaculate condition. The rate, depth and location of effluent application is appropriate for the soil types present.
20	Manage the taking, abstraction, use, damming or diversion of surface water and groundwater so as to: 1A. recognise that the use and development of Southland's land and water resources, including for primary production, can have positive effects including enabling people and communities to provide for their social, economic and cultural wellbeing; 1. avoid, remedy or mitigate adverse effects from the use and development of surface water resources on: (a) the quality and quantity of aquatic habitat, including the life supporting capacity and ecosystem health and processes of waterbodies; (b) natural character values, natural features, and amenity, aesthetic and landscape values; (c) areas of significant indigenous vegetation and significant habitats of indigenous fauna; (d) recreational values; (e) the spiritual and cultural values and beliefs of tangata whenua; (f) water quality, including temperature and oxygen content; (g) the reliability of supply for lawful existing surface water users, including those with existing, but not yet implemented, resource consents; (h) groundwater quality and quantity; (j) mātaitai, taiāpure and nohoanga; 2. avoid, remedy or mitigate significant adverse effects from the use and development of groundwater resources on: (a) long-term aquifer storage volumes;	The volume of water sought is reasonable for the intended use and none of the adverse effects listed in this policy will result from the proposed abstraction of groundwater.

	(b) the reliability of supply for lawful existing groundwater users, including those with existing, but not yet implemented, resource consents; (c) surface water flows and levels, particularly in spring-fed streams, natural wetlands, lakes, aquatic ecosystems and habitats (including life supporting capacity and ecosystem health and processes of waterbodies) and their natural character; and (d) water quality; 3. ensure water is used efficiently and reasonably by requiring that the rate and volume of abstraction specified on water permits to take and use water are no more than reasonable for the intended end use following the criteria established in Appendix O and Appendix L.4.	
21	Manage the allocation of surface water and groundwater by: 1. determining the primary allocation for confined aquifers not identified in Appendix L.5, following the methodology established in Appendix L.6; 2. determining that a waterbody is fully allocated when the total volume of water allocated through current resource consents and permitted activities is equal to either: (a) the maximum amount that may be allocated under the rules of this Plan, or (b) the provisions of any water conservation order; 3. enabling secondary allocation of surface water and groundwater subject to appropriate surface water environmental flow regimes, minimum lake and wetland water levels, minimum groundwater level cutoffs or seasonal recovery triggers, to ensure: (a) long-term aquifer storage volumes are maintained; and (b) the reliability of supply for existing groundwater users (including those with existing resource consents for groundwater takes that have not yet been implemented) is not adversely affected; 4. when considering levels of abstraction, recognise the need to exclude takes for nonconsumptive uses that return the same amount (or more) water to the same aquifer or a hydraulically connected lake, river, modified watercourse or natural wetland.	The proposed abstraction of groundwater is a replacement of an existing consent and so there will be no adverse effects related to allocation limits.
22	Manage the effects of surface and groundwater abstractions by: 1. avoiding allocating water to the extent that the effects on surface water flow would not safeguard the mauri of that waterway and mahinga kai, taonga species or the habitat of trout and salmon;	The proposed rate of abstraction is less than 2 L/s as an average over 24 hrs and so none of the adverse effects listed in this policy are expected.

	2. ensuring interference effects are acceptable, in accordance with Appendix L.3; 3. utilising the methodology established in Appendix L.2 to: (a) manage the effects of consented groundwater abstractions on surface waterbodies; and (b) assess and manage the effects of consented groundwater abstractions in groundwater management zones other than those specified in Appendix L.5.	
23	Manage stream depletion effects resulting from groundwater takes which are classified as having a Riparian, Direct, High or Moderate hydraulic connection, as set out in Appendix L.2 Table L.2, to ensure the cumulative effect of those takes does not: 1. exceed any relevant surface water allocation regime (including those established under any water conservation order) for groundwater takes classified as Riparian, Direct, High or Moderate hydraulic connection; or 2. result in abstraction occurring when surface water flows or levels are less than prescribed minimum flows or groundwater levels for takes classified as Riparian, Direct or High hydraulic connection.	The proposed rate of abstraction is less than 2 L/s as an average over 24 hrs and so none of the adverse effects listed in this policy are expected.
39	When considering any application for resource consent for the use of land for a farming activity, the Southland Regional Council should consider all adverse effects of the proposed activity on water quality, whether or not this Plan permits an activity with that effect.	The applications have considered all adverse effects of the proposed activities on water quality. Note this policy cannot override the requirements of Section 104(2) of the RMA.
39A	When considering the cumulative effects of land use and discharge activities within whole catchments, consider: 1. the integrated management of freshwater and the use and development of land including the interactions between freshwater, land and associated ecosystems (including estuaries); and 2. through the Freshwater Management Unit process, facilitating the collective management of nutrient losses, including through initiatives such as nutrient user groups and catchment management groups.	The proposal has incorporated careful consideration of the contaminant transportation mechanisms through the identification of the physiographic zones present. This assessment has considered these interactions, particularly between groundwater and surface water.
40	When determining the term of a resource consent consideration will be given, but not limited, to: 1. granting a shorter duration than that sought by the applicant when there is uncertainty regarding the nature, scale, duration and frequency of adverse effects from the activity or the capacity of the resource;	The consent term sought is discussed later in this report.

	2. relevant tangata whenua values and Ngāi Tahu indicators of health; 3. the duration sought by the applicant and reasons for the duration sought; 4. the permanence and economic life of any capital investment; 5. the desirability of applying a common expiry date for water permits that allocate water from the same resource or land use and discharges that may affect the quality of the same resource; 6. the applicant's compliance with the conditions of any previous resource consent, and the applicant's adoption, particularly voluntarily, of good management practices; and 7. the timing of development of FMU sections of this Plan, and whether granting a shorter or longer duration will better enable implementation of the revised frameworks established in those sections.	
42	When considering resource consent applications for water permits to take and use water: 1. except for non-consumptive uses, consent will not be granted if a water body is over allocated or fully allocated; or to grant consent would result in a water body becoming over allocated or would not allow an allocation target for a water body to be achieved within a time period defined in this Plan; and 2. except for non-consumptive uses, consents replacing an expiring resource consent for an abstraction from an over-allocated water body will generally only be granted at a reduced rate, the reduction being proportional to the amount of over-allocation and previous use, using the method set out in Appendix O; and 3. installation of water measuring devices will be required on all new permits to take and use water and on existing permits in accordance with the Resource Management (Measurement and Reporting of Water Takes) Regulations 2010; and 4. where appropriate, minimum level or flow cut-offs and seasonal recovery triggers on resource consents for groundwater abstraction will be imposed; and 5. conditions will be specified relating to a minimum flow or level, or environmental flow or level regime (which may include flow sharing), in accordance with Appendix K, for all new or replacement resource consents (except for water permits for non-consumptive uses, community water supplies and water bodies subject to minimum flow and level regimes established under any water conservation order) for:	The water sought is within the allocation limits set for the subject aquifer. The take will continue to be metered as it has been. No minimum level cut-offs are necessary.

	(a) surface water abstraction, damming, diversion and use; and (b) groundwater abstraction in accordance with Policy 23.	

Other Documentation

Te Tangi a Tauira is the Iwi Environmental Management Plan for the Murihiku area. This plan replaces Te Whakatau Kaupapa O Murihiku which is recognised in Policy 1.2 of the RPS. The application is not contrary to the relevant policies of Te Tangi a Tauira, particularly as;

- The provision of buffer zones to water abstraction sites and waterways;
- The application of effluent is proposed to land rather than water;
- The applicant proposes best practice for land application of managing farm effluent;
- Those existing riparian margins will be protected;
- Deferred application of FDE is provided for;
- Nutrient loading from effluent discharges to land will be within industry best practice limits;
- The system and management practices are considered appropriate for the risks associated with the receiving environment;
- Water abstraction will be monitored with metering results to be submitted to Council;
- The applicant is not averse to appropriate potential monitoring conditions; and
- Regarding Policies 3.5.14.17 and 3.5.1.17, the consent periods proposed are less than 25 years.

7.3 Sections 105 and 107 of the RMA

In addition to the matters in Section 104(1) of the RMA, if an application is for a discharge permit a consent authority must have regard to the matters as specified in Section 105. The proposed discharge can be undertaken in a manner which avoids contaminants from entering water through controls on application method and conditions of consent. As nutrients can be reused, there is a direct benefit to the property as a method for improving soil fertility. The discharge of effluent to land is the best method for avoiding adverse effects on water as might otherwise occur in the event that the discharge was directly to water, which would result in a worse environmental outcome.

There are no matters under Section 107(1) of the RMA that would require the consent authority to decline this application.

7.4 Section 104 (2A)

The discharge permit and water permit applications are affected by section 124 of the RMA and as such under section 104(2A) regard must be given to the value of the investment. As at 2018, the property has a capital rating valuation of approximately $9 million.

8. CONSENT DURATION, REVIEW AND LAPSE

With regard to consent duration, special consideration has been given to Policies 14A and 43 of the RWPS and Policy 40 of the pSWLP, which have been grouped below for ease of assessment.

Certainty of the nature, scale, duration and frequency of effects

Potential effects of the proposed activities are understood reasonably well and these are to be managed as far as reasonably practicable. Whilst the potential adverse effects of this dairy farm are expected to be similar to those expected from an average dairy farm, it is noted that the level of understanding in this field is increasing. Council's level of knowledge regarding the underlying aquifer, the receiving soils and surface water management zone is also improving, with continued knowledge and research of Southland and the site being achieved in the form of the proposed physiographic units and future catchment specific studies.

Potential adverse effects have in the first instance been mitigated by appropriate management techniques on farm followed by contingency planning, ongoing monitoring and reporting in an auditable format.

Matching consent duration to the level of risk of adverse effects

The extent and nature of the actual and potential adverse effects of the activities on the existing environment (which includes the current dairy farm) were assessed in this document and concluded to be no more than occurring historically in the existing environment, with potential for improvement following the implementation of a FEMP.

Relevant Tangata Whenua values and Ngai Tahu Indicators of Health

The application has been assessed as consistent with the relevant tangata whenua values as outlined in the iwi management plan, with particular regard to the proposed consent duration being less than 25 years.

Duration sought by the applicant and supporting information

A consent term of 10 years is sought for all of the consents applied for.

The permanence and economic life of any investment

Significant investment has been required just to get to the point of making application with expenditure on professional services, including business feasibility studies, nutrient advice, effluent system review, water quality and policy and planning assessments.

Commodity market influence is always a factor in the permanence of individual dairying units, hence why effluent discharge activities are often considered to have semi-permanent economic life. The economic life of the farm is firstly dependent on the granting of the relevant consents. Should consents be granted, the permanence of the dairying operation and associated activities should be inter-generational. Furthermore, the permanence of the economic life of the activity requires resource consents be granted from the Council for a reasonable duration.

Common expiry date for permits that affect the same resource

A common expiration date for all the permits applied for is considered appropriate.

Applicant's compliance history
The applicant has demonstrated an overall good compliance history with the existing resource consents and there is no evidence to suggest that future compliance will not continue to be good, and water records will be provided to Council on time in future.

Timing and development of FMUs
It is considered that granting a longer consent duration (i.e. 15 years) will better enable implementation of any revised framework established in the FMU section of the PSWLP, as Council will be able to review all consents in the catchment collectively, which will serve to better implement any limit setting process.

In conclusion, due to the low level of environmental risk of the proposed activities and a substantial value of investments on the property, 10-year consent durations are considered appropriate.

Review and Lapse
The applicant is agreeable to the Council imposing standard review conditions in accordance with Sections 128 and 129 of the RMA. In accordance with Section 125 of the RMA, the applicant seeks a 5-year lapse period for these consents.

9. CONCLUSION

A decision to grant consent under Section 104B can be made on the basis that:

a) The adverse effects on the environment will be minor or less.
b) The proposal meets the non-notification requirements of Section 95A of the RMA.
c) The proposal is consistent with the requirements of the RMA, relevant planning provisions and other relevant matters.

Granting of the consents will be consistent with the purpose of the RMA for the reasons explained within this report. The proposed activities would contribute to an improvement in water quality and potential adverse effects will be appropriately avoided or mitigated.

Attachment A

Dairy Effluent Storage Calculator
Summary Report

Regional authority: Environment Southland Regional Council
Authorised agent: RDAgritech - KML
Client: Landpro (T Driscoll)
Program version: 1.48
Report date: Thursday, 22 March 2018
General description:

Updated storage model for proposed changes to farm system:
Milking 700 cows 01/08 - 31/05 @ 50L/c/day average water use for peak cows, (as advised by the Client).
The entire property is classified as high risk for effluent application and the Nutrient Budget has calculated a minimum required area of 41ha for effluent application.
Cow numbers are monthly averages with a median calving date of 20 August.
Stormwater from the shed roof is diverted all year, and the yards diverted outside of the milking season only.
Raw stirred effluent is irrigated using RX "Maxi-pods" with a nominal application rate of 4mm/hr at 24m3/hr flow.
No irrigation during June & July (low soil temperatures).
Winter irrigation depth of minimum 2mm @ 48m3/day.
Summer irrigation of minimum 4mm @ 96m3/day.
The existing storage pond allows the required minimum 3 days emergency storage. No sludge buildup is allowed for due to the use of a foot stirrer to incorporate solids into irrigated effluent.

Climate

Rainfall site: Winton
Mean annual rainfall: 958 mm/year

Effluent Block

Area of low risk soil: 0.0 hectares
Minimum area of high risk soil: 41.0 hectares
Surplus area of high risk soil: 73.0 hectares

Wash Water

Yard wash:

- Milking season starts: 01 August
- Milking season ends: 31 May

Month	Number of Cows	Hours in Yard	Wash Volume (cubic metres)
January	700	5.0	35.0
February	700	5.0	35.0
March	700	5.0	35.0
April	677	5.0	34.0
May	608	5.0	31.0
June	0	0.0	0.0
July	0	0.0	0.0
August	280	3.0	27.0
September	537	5.0	28.0
October	700	5.0	35.0
November	700	5.0	35.0
December	700	5.0	35.0

Irrigation

Winter-spring depth: 2 mm
Spring-autumn depth: 4 mm

Winter-spring volume:	48 cubic metres
Spring-autumn volume:	96 cubic metres
Irrigate all year?	No
Don't irrigate start:	01 June
Don't irrigate end:	31 July

Catchments

Yard Area:	1200 square metres
Diverted?	Yes
- diversion start:	01 June
- diversion end:	31 July
Shed Roof Area:	450 square metres
Diverted?	Yes
Feedpad Area:	0 square metres
Covered?	No
Diverted?	Yes
- diversion start:	01 June
- diversion end:	01 August
Animal Shelter Area:	0 square metres
Covered?	Yes
Diverted?	No
Other Areas:	0 square metres

Storage

Pond/s present?	Yes
No. of ponds:	1 pond/s
Includes irregular ponds?	No
Pond 1	
- total volume:	3261 cubic metres
- pumpable volume:	2771 cubic metres
- surface area:	1681 square metres
- width:	41.0 metres
- length:	41.0 metres
- batter:	2.0:1
- total height:	2.5 metres
- pumped?	Yes
Tank/s present?	No
Emergency storage period:	3 days

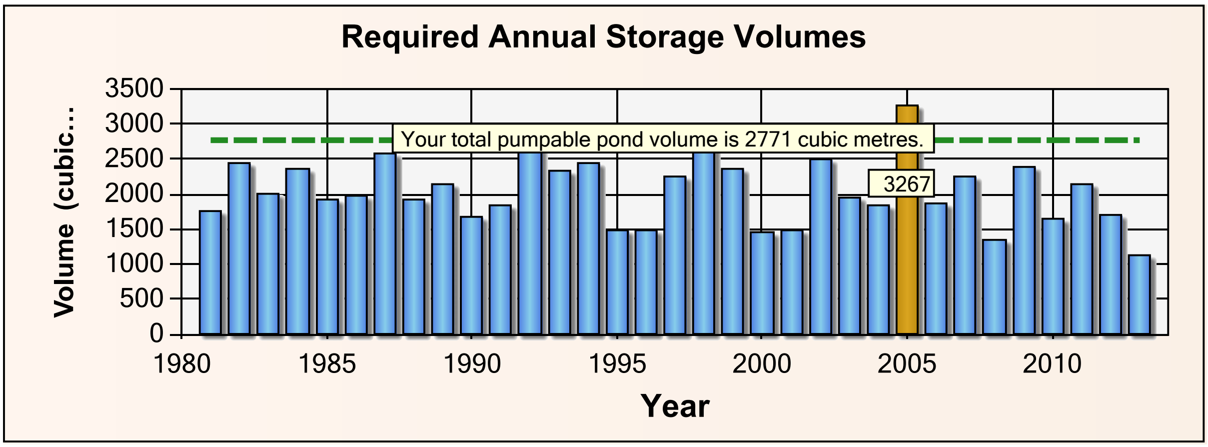
Solids Separation

Solids separator/s present?	No

Outputs

Maximum required storage pond volume:	3267 cubic metres
90 % probability storage pond volume:	2670 cubic metres
During the period from:	01 July 1980

To: 30 June 2013



Attachment B

FARM ENVIRONMENTAL MANAGEMENT PLAN

A: Property Overview

Contact Person(s)	Tim and Jocelyn Driscoll	**Plan Prepared By**	Landpro Ltd
Contact Phone	022 076 9093	**Date**	17 July 2018
Email Address	driscolldairy@gmail.com	**Date of Next Review**	17 July 2019
Physical Address	266 O'Shannessy Road, Winton		
Consent Numbers and Expiry Dates	TBC		
Farm Area	224.5 ha	**Peak Milked Herd Size**	680
Legal Descriptions	Pt Secs 29 & 30 Blk I Winton Hundred, Secs 43 – 45 & 54 Blk I Winton Hundred, Lots 1 & 2 DP 449518		

This FEMP sets out the management practices that will be implemented and adopted to actively manage the operation of the property to ensure that environmental risks are managed appropriately, and resource consent conditions complied with.

Objectives of this plan:

- Comply with all legal requirements related to land use and discharge.
- Take all practicable steps to minimise the risk of harm to onsite and nearby water resources.
- Take all practicable steps to ensure that there is an adequate supply of soil nutrients to meet plant needs.
- Take all practicable steps to minimise the risk of harm to significant vegetation and/or wildlife habitat.

This will be achieved through;

- Identifying and documenting contaminant pathways for the property (based on Physiographic Zones);
- Identifying relevant good management practices (GMP) and where they are required to be implemented to minimise environmental risks; and
- Documenting evidence to be provided to show adherence with consent conditions.

As the person responsible for implementing this plan, I confirm that the information provided is correct:

Name:...Signed:...Date:...

B: Site Plans

This FEMP contains various site plans identifying key features of the subject property in accordance with Part B(3) of Appendix N of the proposed Southland Water and Land Plan, 2018. The following table can be used as a reference point for locating these features.

Table 1: Schedule of where key features have been mapped

	Plan(s) where features are mapped
Site boundary	All site plans in this FEMP
Physiographic zones, variants and soil types	Figure 1: Physiographic zones and variants present
Lakes, rivers, streams ponds, artificial watercourses, modified watercourses and natural wetlands	Attachment B: Existing Waterways and Critical Source Areas (from Environment Southland Farm Activity Focus Plan)
Other critical source areas (gullies, swales etc)	Attachment B: Existing Waterways and Critical Source Areas (from Environment Southland Farm Activity Focus Plan)
Land with a slope greater than 20 degrees	N/A
Existing and proposed riparian vegetation and fences (or other stock exclusion methods) adjacent to waterbodies	Attachment B: Riparian Fencelines and Planting (from Environment Southland Farm Activity Focus Plan)
Places where stock access or cross water bodies (including bridges, culverts and fords)	Attachment B: Riparian Fencelines and Planting (from Environment Southland Farm Activity Focus Plan)
Known subsurface drainage system(s) and the location of drain outlets	TBC
All land that may be cultivated over the next 12 months	TBC
All land that may be intensively winter grazed over the next 12 months	TBC

C: Physiographic Zones and Key Contaminant Pathways

This section of the FEMP documents the physiographic zones and variants present across the property and key contaminant pathways associated these. The Physiographic Plan (figure 1) shows the location and extent of the physiographic zones on the property.

Table 2: Key transport pathways and contaminants for each physiographic zone

Physiographic Zone	Key Contaminant Transport Pathways (✓)	
	Deep Drainage	Artificial Drainage
Oxidising	✓	-
Gleyed	-	✓

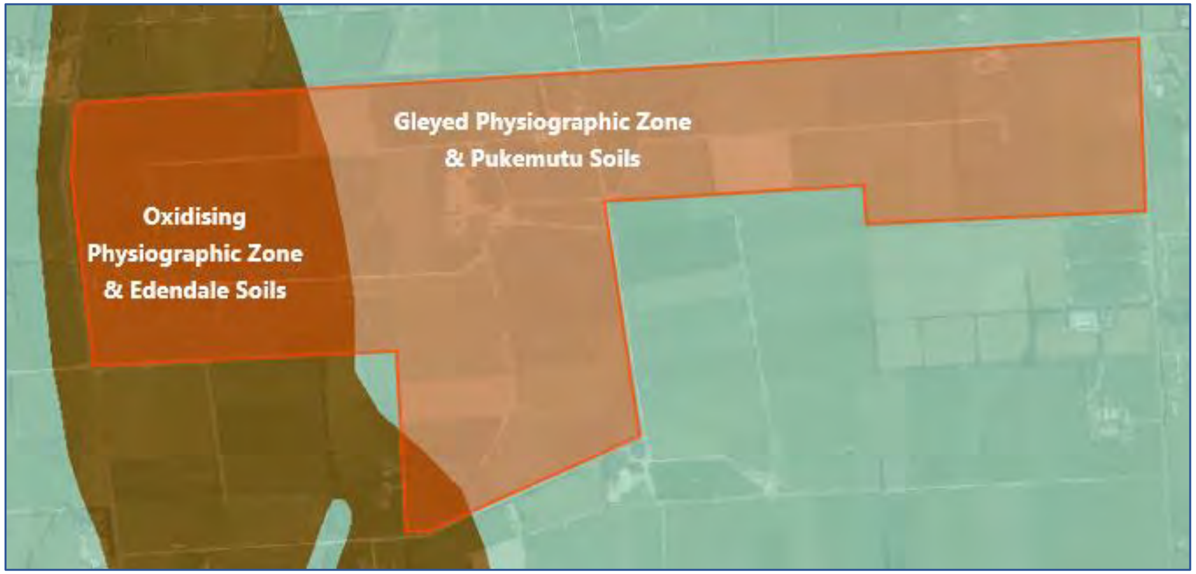


Figure 1: Physiographic Zones and variants present

Figure 1 shows that:

- The Oxidising physiographic zone is the predominant physiographic zone in the western part of the farm.
- The Gleyed physiographic zone is the predominant physiographic zone in central and the eastern part of the farm;
- No variants of either of these physiographic zones are present.
- The key contaminant pathway on the western-most portion of the property is deep drainage and the key contaminant pathway for the rest of the farm is artificial drainage.

D: Good Management Practices

The table below outlines general good management practices which will be undertaken across the whole farm over the 12-month period from the first exercise of the land use consent for expanded dairying. Critical Source Areas (CSAs) for this property consist predominantly of drains and waterways, as shown on the attached maps.

Table 3: Good Management Practices for the Farm

Mitigation	Good Management Practice	Area where most effective
Protect soil structure (will also help to reduce P and N loss)	1. Wintering herd off-site	Whole farm
	2. Re-sow bare soils as soon as possible	
	3. Use stand-off pads when soils are saturated	
Manage Critical Source Areas (will also help to reduce P loss)	4. Avoid working CSAs and their margins following periods of heavy rain or when water is lying in them.	CSAs (see Attachment B)
	5. Leave grassed areas (or native vegetation) around CSAs	
	6. All riparian margins to be fenced and planted	
	7. When winter grazing, leave CSA areas to be grazed last. For sensitive areas leave a 20m buffer.	
Additional P loss reduction GMPs	8. Reduce use of P fertilizer where Olsen P values are above agronomic optimum.	Whole farm
	9. Reduce the risk of run-off to laneways and other sources by ensuring crossings are designed and maintained adequately	
Additional GMPs to reduce accumulation of N in soil	10. Control the duration of grazing of pasture and forage crops by using stand-off pads on shoulder seasons	Whole farm
	11. Time N fertilizer application to meet crop demand using split applications	
	12. Optimise timing and amounts of FDE application	FDE disposal area
Avoid preferential flow of FDE through drains	13. Defer effluent application when soil conditions unsuitable	
	14. Apply effluent at low rates and depths	

The GMPs above have been chosen as being the most optimal methods for minimising the risks associated with the key contaminant pathways identified for the property, which are deep drainage in the western-most portion of the property (oxidising physiographic zone) and artificial drainage for the rest of the farm (gleyed physiographic zone).

Practices that protect soil structure and ensure appropriate management of CSAs to ensure that the risk of sediment and nutrient loss via overland flow is minimised are included in the table above (particularly GMPs 1, 2, 3, 4, 5, 6, 8, 12, 13)

Cultivation practices are included in the table above (particularly GMPs 3, 5, 6, 7, 8, 13, 14). Areas to be cultivated over the forthcoming 12-month period are shown on Attachment X.

Winter grazing practices are also included in the table above (particularly GMPs 2, 4, 12). Areas planted for winter grazing over the forthcoming winter are shown on Attachment X.

Riparian management practices are included in the table above (particularly GMPs 4, 5 6) and addressed in more detail below.

Additional mitigations that are above and beyond the GMPs will be put in place. These are described in the following table. The location of these mitigations are shown on Attachment C.

Mitigation	Additional Mitigation	Area where most effective
Protect soil structure (will also help to reduce P and N loss)	1. Stand springer (calving) cows on the calving pad during period of high soil moisture content to minimise soil damage and leaching risk.	Whole farm
Manage Critical Source Areas (will also help to reduce P loss)	2. Increased buffer width along the laneway at the southern end of the property (paddock 5) **Approx. E1240942 N4874091**	CSAs (see Attachment B)
	3. Water to be directed through vegetated areas to allow for filtering. **As above**	
	4. Additional riparian planting. **Various location, see Attachment C**	
Additional P loss reduction GMPs	5. Change in fertiliser from a water-soluble super phosphorus fertiliser to a non-water-soluble serpentine super and reactive phosphorus rock on the Eastern Block.	Eastern Block.
	6. Reduce Olsen P levels from 32 to 30.	Whole Farm
	7. Improvement of kickboards on bridges/culverts. **Bridge E1240535 N4874788** **Bridge E1240427 N4874409** **Culvert E1240172 N4874765** **Culvert E1240927 N4874158**	
	8. Careful management of bridges/culverts through improvements in structures. **As above**	
Additional GMPs to reduce accumulation of N in soil	10. Effluent applied in accordance with GMPs (less than 150 kg N/ha/yr/ at times when ground conditions are appropriate.)	Whole farm

	11. Correct fertiliser application, at correct rate and not in close proximity of laneways, as per fertiliser recommendation for maintenance fertiliser. >7 degrees soil temper and not when soil is saturated	
	12. Regular soil testing (at least every 3 years)	FDE disposal area

E: Riparian Management

The majority of the property is contained within the Lower Oreti Surface Water Management Zone, and the eastern-most portion is contained within the Tussock Creek catchment/Makarewa Surface Water Management Zone. The Makarewa River is a tributary of the Oreti River.

There are several tributaries of the Oreti River on the property. The tributaries discharge to the Oreti River approximately 3.6 km downstream of the property boundary. As shown on Attachment B, there are no tributaries of Tussock Creek/the Makarewa River on the subject property.

All waterways across the property have been fenced to prevent stock access, as shown on Attachment B. An unnamed tributary of the Oreti River runs through the property in a north-south direction and this is maintained by Envrionment Southland's catchment team. Any drain cleaning works facilitated by the consent holder will be undertaken in accordance with Environment Southlands *Drainage and Channel Maintenance Fact Sheet*.

Where appropriate and as part of good grazing management, temporary fencing will also be erected to prevent any point source discharges occurring. This includes fencing off swale areas where they may directly discharge to surface water. Such practices will be adopted as set out elsewhere in this plan as part of the management of CSAs, and as set out in the Environment Southland Factsheet on *Critical Source Areas,* and *Dairy NZ Wintering in Southland and South Otago Guide*.

Several small culvert crossings exist on the property, as shown on Attachment B. These will all be inspected over the next 12 months and additional containment and diversion mechanisms will be installed as necessary to ensure there is no direct run-off of effluent from any crossing to water, in accordance with the GMPs outlined in the table above.

F: Farm Dairy Effluent

This section of this plan documents the methods that will be employed in the operation of the Farm Dairy Effluent (FDE) System to ensure that the discharge of effluent occurs in accordance with conditions of consent.

Table 4: Effluent System Overview

Total Effluent Disposal Area (ha):	93.3	**Available Storage Volume:**	3,261	**Storage Type:**	Lined pond with mechanical stirrer installed in the pond
Effluent Application Method(s):		RX Plastics Maxi Pods Slurry tanker may also be used on rare occasions		**Maximum Rate and Depth of Application:**	10 mm/hr 25 mm depth

Table 5: FDE Good Management Practices (existing and proposed to continue to be undertaken on farm)

Mitigation	Good Management Practice	Monitoring
Reduction in effluent generation	• Reduce water use in shed by reusing clean water where possible • Treat the herd gently to avoid upset	N/A
Effluent applied only when soil conditions are appropriate	• Sufficient storage provided so that when soils are at or above field capacity and/or during adverse weather conditions, effluent can be stored in the effluent storage pond until conditions are suitable for application • Monitoring of soil moisture and temperature will be used to determine soil water deficits for sustainable application depths, from data obtained from the ES website. • Paddocks will be inspected before effluent application to check that soil water deficit exists. • Low rate application will be used at all times.	Record irrigation dates, times, areas on the Irrigator run sheet (attached)
Avoidance of direct effluent disposal or runoff to sensitive areas	• Effluent discharge will observe a range of buffers from sensitive receiving environments as shown on the Appendix I plan attached to the discharge permit • Low rate effluent discharge will avoid ponding and/or runoff • Effluent will not be discharged onto any land areas that have been grazed within the previous 5 days • Effluent disposal will be to an area of at least 4 ha/100 cows	Record irrigation dates, times, areas on the Irrigator run sheet (attached)

Mitigation	Good Management Practice	Monitoring
Avoidance of effluent contamination in tile drains	• Low rate effluent discharge to reduce the risk of through-drainage and associated risk of effluent entering water	N/A
Efficient and effective collection, storage and delivery infrastructure at all times	• Monthly/frequent system checks will be undertaken using the Monthly Effluent Check Sheet attached • All parts of the effluent system will be checked and maintained regularly • Leaks will be repaired immediately • Fail safe systems will be kept in place and kept in good working order i.e. automatic alarm and shut off system • Application Rates shall be assessed annually thereafter in accordance with the methodology specified in *Dairy NZ Staff Guide to Operating Your Effluent Irrigation System – Low Rate System*	Record all repairs and maintenance Monthly Effluent Check Sheets filled out and signed
Staff appropriately trained in operation and understand the effluent system	• All staff involved in the management of the effluent system are fully trained in its use • All staff are familiar with and understand the conditions of consent • All new staff will be taken through the "Staff Training Guide" (attached) • Staff to take immediate action if incident or breakdowns occur including; - Rectifying the problem - Cleaning up if possible	Keep signed training record in the back off this FEMP Ensure both farm manager and employee sign to confirm training
Application that is not offensive to neighbours	• Wind conditions will be checked to ensure the effluent can be discharged without resulting in spray drift and odour beyond the property boundary • Observation of buffers to dwellings not located on the property (200 m) and property boundaries (20 m)	Complaints received by Environment Southland

G: Compliance & Reporting

This section sets out the records which are required to be kept which will enable the Consent Holder to demonstrate compliance, as well as detailing the reporting requirements of the consents. The Consent Holder will also participate in annual compliance monitoring inspection programs that are to be implemented by Environment Southland.

Table 6: Records to be kept by the consent holder

Record	Date of most recent version
Nutrient budget	
Fertiliser application records	
Soil sampling results	
Water meter certification	
Water abstraction records	
Effluent system Staff Training Record	
Effluent system monthly maintenance check sheets	
Effluent proof of placement	
Effluent application depth test results	

Annual reporting requirements are set out in the conditions of resource consent and include;

- Prior to the first exercise of the Effluent Discharge Consent the Consent Holder shall notify Environment Southland of the operator of the effluent system
- The Farm Environmental Management Plan shall be reviewed annually, and any amendments reported to Environment Southland by 31 June each year
- The Consent Holder shall provide records from the Water Permit to ES by 31 May each year

H: Annual Review & Audit of FEMP

This FEMP shall be reviewed on an at least annual basis. The review shall include (but not be limited to) an assessment of;

- Verification of compliance with conditions of consent
- Details of the implementation of GMPs and identification of any new GMPs that would be appropriate to employ on the farm to manage risks identified
- Review of the data obtained from the monitoring undertaken in accordance with this FEMP and any changes to farming practice required as a consequence
- A report detailing items above shall be submitted to the consent authority each year including an updated version of the FEMP if any amendments made

I: Industry Guidelines

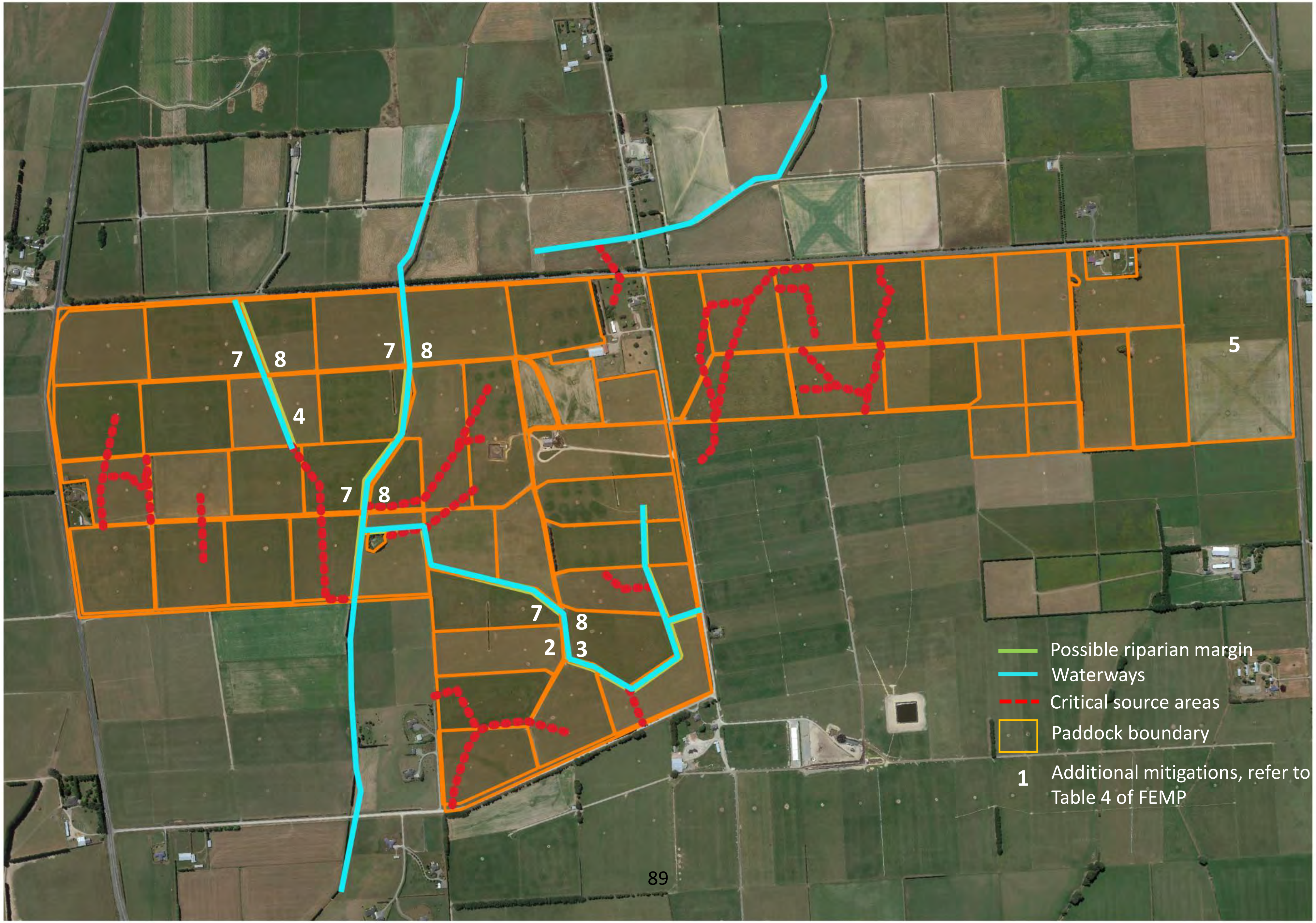
A complete list of the industry guidelines which have been referenced in the development of this FEMP are listed below. The Consent Holder is also referred to the following general sources for guidance in respect to the operation and management of their property.

Environment Southland www.es.govt.nz **Dairy NZ www.dairynz.co.nz** **Fonterra www.fonterra.com**

Dairy NZ – A staff guide to operating your effluent irrigation system – Low Rate System
Dairy NZ – A farmer's guide to managing farm dairy effluent – A good practice guide for land application systems
Dairy NZ – Wintering in Southland and South Otago – A land management guide to good environmental practice
Dairy NZ – Land management on Canterbury Dairy Farms – Managing land to reduce sediment and phosphorous loss
Environment Southland Factsheet – Critical Source Areas
Environment Canterbury – Information Sheet for Farmers on OVERSEER®
Sustainable Dairying: Water Accord

Attachment A – Consents

Attachment B – Farm Plans


7
8
7
8
4
5
7
8
7
8
2
3
Possible riparian margin
Waterways
Critical source areas
Paddock boundary
1
Additional mitigations, refer to Table 4 of FEMP

Attachment C – Nutrient budget for the previous season

Attachment D – Effluent Management

Dairy Shed Effluent Monthly Check Sheet

On a monthly basis the following checks and measures must be undertaken. The details of the monthly check shall be recorded on this sheet, and at the completion of the inspection the sheet shall be filed for future reference. If there are any matters requiring follow up work i.e. you note that an effluent nozzle needs replacing, please make a note of these, and ensure that the actions are followed up immediately.

Employee Name:

Date of Inspection:

Task	**Done? (Y/N)**	**Any further action required?**
Clean out stone trap		
Clean out sump		
Check all inlet and outlet pipes to storage pond to ensure they are free of debris to prevent blockages.		
Check the pond's leak detection system for the presence of effluent (visual and odour)		
Check effluent nozzles are clear and in good working order		
Check effluent irrigator pipe is in good working order and does not have any leaks		
Check well-head(s) remain capped and in good condition		

Effluent Orientation and Training Record

Season___/___

Effluent Competencies	Employee name	Employee name	Employee name
General			
Understands the regional council rules and farm policies for effluent management			
Understands health and safety around the effluent system			
Understands record keeping for irrigator runs and maintenance			
At the Dairy			
Use of stormwater diversion system			
Good hosing practice and water management			
Animal handling to minimise effluent volume			
Cleaning the stone trap			
Sump, pump & pond monitoring and management (including float switches)			
In the Paddock			
When to irrigate: assessing soil and weather conditions			
Where to irrigate: runs, paddock rotations, high risk vs low risk soils etc (mark on farm map)			
Where not to irrigate: near waterways, drains, boundaries, slopes etc (mark on farm map)			
How the irrigator works, how to use it, set up, hose layout and performance checks			
Measuring the depth of effluent application			
Irrigator, pump maintenance/cleaning			
Greasing and general maintenance requirements (how and when)			
How to check and replace rubber nozzles and seals (same time as dairy rubber ware)			
Tyre pressure and condition			
Pipe-work, hose and hydrant condition			
Wire-rope, cam and ratchet condition			
Other			

Trainer signature			
Employee signature			
Date			

Date when staff become competent in each skill. If all training provided in one day, tick and date at the bottom.

DairyNZ

Irrigator run sheet

- ☑ Check the records to ensure effluent is due to be applied to that particular area
- ☑ Allow a minimum interval of 10 days between applications and grazing for animal health
- ☑ Ensure irrigator will be applying effluent to short pasture.

Date	Paddock	Run	Name	Comments

dairynz.co.nz

0800 4 DairyNZ (0800 4 324 7969)

You can use your Fonterra Dairy Diary as an alternative to this form, or photocopy a farm map – draw and date the runs on the copy then file it

DairyNZ

Attachment C

Mo Topham
CNMA
Southland
Ph: 027 279 7449
Email: mo.topham@outlook.com

File Note: T and J Driscoll Family Trust consent application

Please find below a file note in relation to Overseer modelling completed for the T and J Driscoll Family Trust. This file note is intended to be read in conjunction alongside the previous Overseer modelling reports, dated 1st October 2018 and the previous file note “Further information: T And J Driscoll Family trust consent application,” dated 18th December 2018. Both of these reports have been included in the appendices of this file note.

Purpose of this Report

The applicant (T and J Driscoll Family Trust) have instructed further modelling to be undertaken to reduce nutrient loss in the proposed dairy farm.

Previous Modelling Results

Overseer modelling was completed for the T and J Driscoll Trust in October 2018 using Overseer version 6.3.0. Summarised results from this modelling is shown in Table 1.

Table 1. Predicted nitrogen and phosphorus losses in the current and proposed systems (From modelling report dated 1st October 2018 – in appendices)

	Current system	Proposed system
Total Farm N Loss (kg)	11,503	11,345
N Loss/ha (kgN/ha/yr)	51	51
Total Farm P Loss (kg)	262	278
P loss/ha (kgP/ha/yr)	1.2	1.2

Following this modelling, Environment Southland raised concern that the predicted Phosphorus losses using Overseer are higher in the proposed than the current system. A file note was completed to quantify the impact of mitigations that are not accounted for in Overseer. Results including the phosphorus mitigations modelled outside of Overseer 6.3.0 are shown in table 2.

Report disclaimer:
The OverseerFM 6.3.1 model has been utilised to assess the nutrient losses from this property. Details of how the property is operated currently, and how the property will be operated going forward have been gathered from the farm owner. Where accurate data was unavailable, conservative assumptions have been made using professional judgement.

OverseerFM 6.3.1 predicted results have been extracted from the model on 22 August 2019

Table 2. Predicted nitrogen and phosphorus losses in the current and proposed systems, including phosphorus mitigations modelled outside of Overseer 6.3.0 (From "Further information: T and J Driscoll Family Trust consent application" - in appendices)

	Current system	Proposed system
Total Farm N Loss (kg)	11,503	11,345
N Loss/ha (kgN/ha/yr)	51	51
Total Farm P Loss (kg)	229 (including 33kg P mitigation modelled outside of Overseer)	226 (including 52kg P mitigation modelled outside of Overseer)
P loss/ha (kgP/ha/yr)	1.0	1.0

Using the Overseer 6.3.0 model and supporting phosphorus loss calculation outside of Overseer, it is predicted that losses of nitrogen will decrease by 1.4% and losses of phosphorus will decrease by 1.3%.

The key drivers of a decrease in nitrogen loss are shown below. In comparison to the current system, the proposed system has:

- Increased the area that effluent is applied to – reduced N application in effluent to this area
- Reduced nitrogen fertiliser use
- Increased cow numbers – increasing loss risk

The key driver of the decrease in phosphorus loss are shown below. In comparison to the current system the proposed has:

- Improved laneway sediment loss mitigations

Changes in Overseer since October 2018

Since October 2018 there have been two key changes in Overseer:

- Overseer moved to the OverseerFM platform. Please note that this was a change in the Overseer platform and working interface rather than a change to the mechanics of Overseer. This movement therefore created no change in predicted nitrogen and phosphorus losses.
- In February 2019 version 6.3.1 of OverseerFM was released. Version 6.3.1 made a change to the OverseerFM model relating to fodder crops. This has had a small impact on the results predicted for the T and J Driscoll Family Trust.

The Overseer files related to this consent application were reopened in OverseerFM version 6.3.1. Climate location and maintenance fertiliser inputs have been updated and the method is consistent between the current and proposed files. No other changes were made. Summary results from OverseerFM 6.3.1 are shown below with changes shown in red.

Table 3. Predicted nitrogen and phosphorus losses in the current system as modelled in OverseerFM 6.3.1

	Current Dairy Platform (3yr average)	East Block – Sheep (15-16 season)	East Block – Transition (16-17 season)	East Block – Dairy Support (17-18 season)	East block (average of 3yrs)	Current Total (averaged over 3 years)
Total Farm N Loss (kg)	11273	203	132	385	240	11513
N Loss/ha (kgN/ha/yr)	54	14	9	27	17	51
N Concentration in Drainage (ppm)	Pastoral – 10 to 13 Crops – 21 to 42	Pastoral – 3	Pastoral – 2	Pastoral - 6		
Total Farm P Loss (kg)	253	10	9	10	10	263
P loss/ha (kgP/ha/yr)	1.2	0.7	0.7	0.7	0.7	1.2
Overseer - predicted pasture grown (tDM/ha/yr)	16.2	11.8	11.8	11.9		

Table 4. Predicted nitrogen and phosphorus losses in the current and proposed systems, including phosphorus mitigations modelled outside of OverseerFM 6.3.1

	Current system	Proposed system
Total Farm N Loss (kg)	11513	11348
N Loss/ha (kgN/ha/yr)	51	51
N Concentration in Drainage (ppm)		Pastoral – 10 to 29
Total Farm P Loss (kg)	230 (including 33kg P mitigation modelled outside of Overseer)	226 (including 52kg P mitigation modelled outside of Overseer)
P loss/ha (kgP/ha/yr)	1.0	1.0
Overseer - predicted pasture grown (tDM/ha/yr)		16.2

Further Modelling

During conversations with Environment Southland and LandPro it has become clear that under the Proposed Water and Land Plan that the applicant needs to demonstrate a farm system (through modelling) that would contribute to a clear improvement to water quality.

Key changes from the original proposal are as follows (see appendices for detailed assumptions):

- Reduction in peak cows milked (from 700 to 680)
- Reduction in young stock numbers (aligned to reduction in cow numbers)

- Reduction in nitrogen applied as fertiliser overall
- Increased use of barley as a purchased in feed (lower protein feed)
- Increase in area utilised for baleage grass wintering
- A reduction in Olsen P to 30 on the milking platform (note the Olsen P on the East Block will increase from the current 20)

The East Block has been blocked separately and additional mitigation strategies have been implemented on this block (see appendices for detailed assumptions):

- No wintering on this block (June and July)
- No grazing of livestock in the months of May to August, requiring less pasture cover May to August and a subsequent reduction in fertiliser N applications, and consequently overall lower pasture grown on this block
- No supplements fed on block
- Baleage made on the East block due to distance from cowshed
- Low solubility P fertiliser is applied (assumed Reactive Phosphate Rock in the modelling, may also be serpentine super in practice)

The results of these mitigations are shown in Table 5.

Table 5. Predicted nitrogen and phosphorus losses in the current and proposed system before and after further mitigations were included, including phosphorus mitigations modelled outside of OverseerFM 6.3.1

	Current system	**Proposed system (before further mitigations applied)**	**Proposed system (following further mitigations)**
Total Farm N Loss (kg)	11513	11348	9908
N Loss/ha (kgN/ha/yr)	51	51	44
N Concentration in Drainage (ppm)		Pastoral – 10 to 29	Pastoral – 3 to 19
Total Farm P Loss (kg)	230 (including 33kg P mitigation modelled outside of Overseer)	226 (including 52kg P mitigation modelled outside of Overseer)	204 (including 52kg P mitigation modelled outside of Overseer)
P loss/ha (kgP/ha/yr)	1.0	1.0	0.9
OverseerFM - predicted pasture grown (tDM/ha/yr)		16.2	16.0 (excluding East Block) 15.6 (East Block)

Taking into account the further mitigations made to the proposed farm system, OverseerFM predicts that overall nitrogen will decrease by 14% and losses of phosphorus will decrease by 11%. The nutrient budget, nitrogen summary and phosphorus summary are shown for each system in the appendices.

Adjustments to nitrogen losses in the proposed system

Baleage grass wintering:

OverseerFM has estimated that the loss of nitrogen from the grass baleage system is 567kgN (or 81kgN/ha). Modelling of the grass baleage wintering system in OverseerFM is likely to underestimate nitrogen losses as OverseerFM is not able to adequately reflect the on-farm realities of this system. OverseerFM assumes that the pasture plants will regrow post grazing and take up urinary N from the wintering activity. However, in reality, due to the soil type and climate on the applicant's property, the plants are not viable following the winter grazing. As a result the area is cultivated and regrassed in spring.

I am unaware of any research that has quantified the impact of baleage grass wintering in terms of nitrate and phosphorus loss. I have therefore completed a desktop modelling exercise that attempts to more accurately estimate the nutrient losses from this system.

The following assumptions have been made:

- Same as the proposed system file
  - Soils / climatic conditions
  - Tile drains
  - Stock numbers
  - Imported / exported supplement
  - Fertiliser and nitrogen use

- Different from the proposed system file
  - Used kale instead of pasture to allow a defoliation event and regressing activity
  - Used kale as has a similar crude protein to average quality pasture
  - Reduced yield of kale to 3TDM/ha to reflect pasture accumulated for winter in practice
  - Regrassed the area in October in line with when the applicant would usually regrass following a grass baleage wintering event
  - Direct drilled kale (rather than conventional cultivation to minimise the impact of the mineralisation of N during cultivation)

Overseer predicted that the losses from the Kale block would be 99kgN/ha (total of 693kgN lost for the 7ha wintered on). Without comparative research, it is difficult to assess the accuracy of the above results. However, from a common sense perspective, losses from the baleage grass system are likely to be more comparable to a traditional fodder crop paddock than a permanent pasture paddock. Therefore, it is predicted that the losses from the grass baleage wintering system will be 126kgN higher than predicted in the Proposed scenario.

Table 6. Predicted nitrogen and phosphorus losses in the current and proposed system after further mitigations were included, including phosphorus mitigations modelled outside of OverseerFM 6.3.1

	Current system	Proposed system (following further mitigations)	Percentage change in losses
Total Farm N Loss (kg)	11513	10034 (including 126kgN adjustment modelled outside of Overseer)	12.8% reduction
N Loss/ha (kgN/ha/yr)	51	45	
N Concentration in Drainage (ppm)		Pastoral – 3 to 19	
Total Farm P Loss (kg)	230 (including 33kg P mitigation modelled outside of Overseer)	204 (including 52kg P mitigation modelled outside of Overseer)	11.3% reduction
P loss/ha (kgP/ha/yr)	1.0	0.9	
OverseerFM - predicted pasture grown (tDM/ha/yr)		16.0 (excluding East Block) 15.6 (East Block)	

Taking into account the further mitigations to the proposed farm system and the adjustment required for modelling the baleage grass wintering system, Overseer predicts that overall nitrogen will decrease by 13% and losses of phosphorus will decrease by 11.3%.

Off site effects of wintering:

No adjustment to nutrient losses to account for off site effects of wintering has been made as the number of animals wintered off farm (mixed age cows and R2 heifers) is the same in the current as the proposed. All additional stock in the proposed system will be wintered on farm and have therefore been accounted for in the modelling. The number of stock wintered on and off farm are described in detail in the appendices.

Off site effects of young stock:

As a result of the increased cow numbers on farm, there will also be an increase in the number of young stock reared for the property. These animals have been and will continue to be grazed off site with a third party grazier. The applicant does not have direct control over the management of these stock or the property that they are grazing. As agreed between Alex Erceg (ES) and Tanya Copeland (Landpro) in an email dated 21st February, the off site effects of these animals has not been included in the OverseerFM modelling. A copy of the relevant correspondence is available from Landpro upon request.

However, should quantification be required, I have made the following estimation of the scale of the effect of these extra young stock. The applicant rears 28% replacements (calves as a percentage of cows milked at peak). This is equivalent to 160 calves in the current system and 190 calves in the proposed system – an increase of 30 animals. Young stock are grazed off farm from weaning (1st

December), until their return as incalf heifers (1st Jun, 18months later). This system will continue to occur in the proposed scenario.

Rising 1 year old heifers have been traditionally wintered on fodder beet, although in the 2019 winter they were grazed on a baleage grass system. The off site effect of the extra young stock grazing can be estimated as follows:

- 30 rising 1 year olds, wintered on crop for 77days
- Require 5kgDM fodderbeet per head per day (the balance of the diet is made up of supplement as per standard practice)
- 5kgDM/head/day x 77days x 30animals = 11,550kgDM fodderbeet required
- At a 25,000tDM/ha yield of fodderbeet, the stock will require 0.5ha.
- It is assumed that the fodderbeet crop has losses of 225kg N/ha and 1.2kgP/ha. This is based on the losses modelled for the applicant under fodderbeet in the current scenario.

Therefore, it can be estimated that the off site effects of wintering the 30 increased rising 1 year olds is:

- 113kgN/year
- 0.6kgP/year

Please note that this estimate of nutrient losses during winter grazing is conservative, ie it is very likely to be overestimating the actual nutrient losses due to the winter feed type (fodder beet) and the intensity of the wintering (25tDM crop yield).

In addition to the winter grazing it is assumed that the additional 30 head of young stock are grass grazed when they aren't on winter crop. The 30 stock would require approximately 12ha of pasture. If this pasture has an N loss of 30kgN/ha and a p loss of 0.6kgP/ha, it can be estimated that the offsite effect of the young stock pasture grazing is:

- 360kgN/year
- 7.2kgP/year

Therefore, it can be estimated that the total offsite effect of the additional young stock is:

- 473kgN/year
- 7.8kgP/year

Note – the estimate above is intended to give an estimate of scale of effect, rather than to suggest any accuracy. There are too many variables that are unknown (including soil type, climate, stocking rate and fertiliser policy) to provide accuracy.

Table 7. Predicted nitrogen and phosphorus losses in the current and proposed system after further mitigations were included, including phosphorus mitigations modelled outside of OverseerFM 6.3.1

	Current system	**Proposed system (following further mitigations)**	**Percentage change in losses**
Total Farm N Loss (kg)	11513	10507 (including 126kgN grass baleage and 473kgN young stock adjustments modelled outside of Overseer)	8.7% reduction
N Loss/ha (kgN/ha/yr)	51	47	
N Concentration in Drainage (ppm)		Pastoral – 3 to 19	
Total Farm P Loss (kg)	230 (including 33kg P mitigation modelled outside of Overseer)	212 (including 52kg P laneway mitigation and 7.8kgP young stock adjustment modelled outside of Overseer)	7.8% reduction
P loss/ha (kgP/ha/yr)	1.0	0.9	
OverseerFM - predicted pasture grown (tDM/ha/yr)		16.0 (excluding East Block) 15.6 (East Block)	

Taking into account the further mitigations to the proposed farm system and the adjustment required for modelling the baleage grass wintering system, Overseer predicts that overall nitrogen will decrease by 8.7% and losses of phosphorus will decrease by 7.8%.

Conclusions from the modelling

Table 8. Predicted nitrogen and phosphorus losses in the current and proposed system after further mitigations were included, including phosphorus mitigations modelled outside of OverseerFM 6.3.1

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OverseerFM - predicted pasture grown (tDM/ha/yr)		16.0 (excluding East Block) 15.6 (East Block)	

Taking into account the further mitigations to the proposed farm system and the adjustment required for modelling the baleage grass wintering system, Overseer predicts that overall nitrogen will decrease by 8.7% and losses of phosphorus will decrease by 7.8%.

The key drivers of a decrease in nitrogen loss are shown below. In comparison to the current system, the proposed system has:

- Increased the area that effluent is applied to – reduced N application in effluent to this area
- Reduced nitrogen fertiliser use
- Change in the farms culling policy to one of culling earlier
- Lower protein content supplementary feed (Barley)

The key driver of the decrease in phosphorus loss are shown below. In comparison to the current system the proposed has:

- Improved laneway sediment loss mitigations
- A reduction in the Olsen P on the current dairy platform area (although an increase in Olsen P on the East Block)
- Use of Reactive Phosphate Rock fertiliser on the East Block

Appendices:

Appendix 1: Updated detailed description of modelling inputs

Appendix 2: Nutrient budgets taken from OverseerFM

Appendix 3: Overseer modelling report for the purposes of as part of a consent application for expanded dairying, dated October 2018

Appendix 4: Further information: T and J Driscoll Family Trust consent application, December 2018

Appendix 5: T and J Driscoll Family Trust – Farm Maps

Appendix 1: Updated detailed description of modelling inputs

Blocks

The farm has been split into the following pastoral (effluent and non-effluent) and fodder crop blocks. Total farm area has been taken from the legal area (ex the rates demand). The area of each block has been determined using the measure function on Beacon. Soils on the property were assessed utilising the topoclimate information. OverseerFM soil settings were obtained from SMap for all soil types.

Changes from original modelling (dated October 2018) are shown in red. Original modelling inputs are shown in black

Block Name	Soil Type (from Beacon)	Smap Ref	Contour	Current Dairy Platform (ha)	East Block (ha)	Proposed Land Use (ha)
Effluent – Waikiwi	Edendale	Waiki_30a.1	Flat	**20.1**		**41.7 41.1**
Effluent – Pukemutu	Pukemutu	Pukem_6a.1	Flat	**41.9**		**49.9 49.2**
Non Effluent – Waikiwi	Edendale	Waiki_30a.1	Flat	**42.2**		**19.4 19.1**
Non Effluent – Pukemutu	Pukemutu	Pukem_6a.1	Flat	**98.4**		**101.5 86.2**
East Block - Pukemutu	Pukemutu	Pukem_6a.1	Flat		**13.9**	**13.9**
Baleage winter Eff Waikiwi	Edendale	Waiki_30a.1	Flat			**0.8 1.4**
Baleage winter Eff Pukemutu	Pukemutu	Pukem_6a.1	Flat			**0.9 1.6**
Baleage Winter Non Eff Waikiwi	Edendale	Waiki_30a.1	Flat			**0.4 0.7**
Baleage winter Non Eff Pukemutu	Pukemutu	Pukem_6a.1	Flat			**1.9 3.3**
	Effective Farm Area			**202.6**	**13.9**	**216.5**
	Non productive			8.0		8.0
	Total Farm Area			**210.6**	**13.9**	**224.5**
Rotating fodder crops						
Fodder beet				2.8		
Winter Turnips				1.0		

Climate Data

- The following climate information has been used from the OverseerFM climate station tool;
  - 1094mm of rainfall (updated to 1092mm – consistent across all nutrient budgets)
  - 10.1 degrees Celsius mean annual temperature
  - Annual PET of 711mm (updated to 710mm – consistent across all nutrient budgets)

Farm System

Description	**Current Dairy Platform (average of three seasons)**	**East Block – Sheep (15-16 season)**	**East Block – Transition (16-17season)**	**East Block – Dairy Support (17-18season)**	**Proposed Land Use**
File name	CURRENT PLATFORM – AUG19	CURRENT – EAST SHEEP AUG19	CURRENT – EAST TRANSITION AUG19	CURRENT – EAST DAIRY SUPPORT AUG19	PROPOSED – AUG19 MITIGATED
Milk solids production	271,130 kg MS 473 kgMS/cow Median calving date – 20th August Drying off – 31st May				329,000kgMS 319,600 kg MS 470 kgMS/cow Median calving date – 20th August Drying off – 31st May
Cows on farm (Lactating and wintered)	Breed Fr J X Jul 140 Aug 599 Sep 593 Oct 573 Nov 573 Dec 573 Jan 573 Feb 573 Mar 573 Apr 530 May 487 Jun 83 Peak cows: 573 *Note: Some cows wintered off farm at a grazier's property* *June – 516* *June – 459*			Breed Fr J X Winter grazing for 100MA (July) and 125R2 cows (Jun and Jul)	Breed Fr J X Jul 273 252 Aug 732 711 Sep 724 702 Oct 700 680 Nov 700 680 Dec 700 680 Jan 700 680 Feb 700 650 Mar 700 620 Apr 647 590 May 595 570 Jun 216 195 Peak cows: 700 Peak cows: 680 *Note: Some cows wintered off farm at a grazier's property* *June – 516* *July – 459* *Note: change in culling policy*

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
Dairy replacements on farm	Calves are reared on farm until weaning (1-4months old) Aug - 135 Sep - 160 Oct - 160 Nov – 160		Grazing for R2 heifers May 125	Grazing for R2 heifers Jan 125 Feb 125	Calves are reared on farm until weaning (1-4months old) Aug - 152 160 Sep - 187 190 Oct - 187 190 Nov – 187 190 Note: error found in original modelling
Breeding bulls	Thirteen 2yr old Jersey bulls (Dec and Jan)				Fifteen 2yr old Jersey bulls (Dec and Jan)
Sheep		Wintered: 120 MA ewes 46replacements 3rams Coopworth 125% lambing percentage 20% replacement rate Mean lambing date of the 15th September. All non-replacement lambs sold by the end of May			
Relative productivity	No differences between blocks	No differences between blocks	No differences between blocks	No differences between blocks	No differences between blocks Relative productivity of East Block Pukemutu 0.97unit due to lower N useage. All other blocks have a relative productivity of 1.

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
Structures	Calving Pad Not modelled as used when ground conditions are saturated rather than for fixed time				Calving Pad Not modelled as used when ground conditions are saturated rather than for fixed time
In Shed Feeding	Management 100% of milkers fed Aug - May				Management 100% of milkers fed Aug – May
Rotating fodder crop management	2.8ha fodder beet Yield: 25tDM/ha Conventional cultivation October Fertiliser: 500kg/ha Winton Fodder Beet mix at sowing (delivering 50kg/ha N, 32kg/ha P, 75kg/ha K and 27kg/ha S) 100kg/ha Urea in December 100kg/ha Potassium Chloride in December 100kg/ha Urea in January Grazed by dairy cows May – Aug Resown in permanent pasture in September				Cows on farm in June/July are wintered on a baleage grass diet. 4ha 7ha Baleage/Grass wintering This area rotates around all blocks except the East Block Pukemutu the platform. This wintering system forms part of the property's regrassing strategy All feed required is imported (160tDM baleage) (150tDM baleage)
	1.0ha Turnips Yield: 8tDM/ha Conventional cultivation February				

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
	Fertiliser: 150kg/ha DAP and 150kg/ha super at sowing 100kg/ha Urea in March Grazed by dairy cows Jun – Aug Resown in permanent pasture in September				
Imported Supplements	In shed: 236t PKE 38t Barley (typo in original modelling) In paddock: 418tDM silage			In paddock: 65 tDM baleage	In shed: 300tDM PKE 40tDM PKE 100tDM barley 400tDM Barley 100tDM DDG In paddock: 850tDM silage (fed over entire platform) 500tDM silage (fed on all bocks except East Block) For wintering: 160tDM baleage 150tDM baleage Supplement harvested on the East block: 140tDM fed out on all blocks except East Block
Exported Supplements			130tDM baleage		
Soil Fertility	Olsen P 32 (soil test results June 2017) All other values entered at agronomic optimum	All soil test values entered at agronomic optimum (Olsen P of 20)	All soil test values entered at agronomic optimum (Olsen P of 20)	All soil test values entered at agronomic optimum (Olsen P of 20)	Olsen P 32 Olsen P 30 All other values entered at agronomic optimum

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
Fertiliser	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels Note: Phosphorus applied as RPR on the East Block
Pastoral Nitrogen Fertiliser	213 kgN/ha in split applications (Aug – April)				Non Effluent blocks (Excluding East Block) 218kgN/ha (203kgN/ha) in split applications (Aug – April) Effluent Blocks 197kgN/ha (183kgN/ha) in split applications (Aug – April) East Block 154kgN/ha in split applications (Sep – Mar)
Drainage	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained
Farm dairy effluent	Holding pond Solids aren't separated from the liquid Liquid effluent is applied at a depth of <12mm to the "effluent" blocks An effluent area of at least 31 ha is required to achieve a loading of less than 150 kg N / ha / year				Holding pond Solids aren't separated from the liquid Liquid effluent is applied at a depth of <12mm to the "effluent" blocks An effluent area of at least 34 (now 32) ha is required to achieve a loading of less than 150 kg N / ha / year

Appendix 2: Nutrient budgets taken from OverseerFM

Report disclaimer:

The OverseerFM 6.3.1 model has been utilised to assess the nutrient losses from this property. Details of how the property is operated currently, and how the property will be operated going forward have been gathered from the farm owner. Where accurate data was unavailable, conservative assumptions have been made using professional judgement.

OverseerFM 6.3.1 predicted results have been extracted from the model on 22 August 2019

Current system - Dairy Platform (File name - CURRENT PLATFORM - AUG19)

Table 9. Current system whole farm nutrient budget

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	11,273	54
Phosphorus	253	1.2

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	201	26	2	25	0	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	80	11	58	9	9	6	4
Rain/clover fixation	74	0	3	5	3	7	35

NUTRIENTS REMOVED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Leached from root zone	54	1.2	12	38	61	6	20
As product	87	15	21	5	19	2	6
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	89	0	0	0	0	0	0

CHANGE IN POOLS (KG/HA/YR)	N	P	K	S	CA	MG	NA
Organic pool	125	19	11	-3	7	3	1
Inorganic mineral	0	2	-23	0	-2	-3	-3
Inorganic soil pool	1	0	43	0	-72	6	15

Table 10. Current system Nitrogen and Phosphorus summary reports

Nitrogen summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	N IN DRAINAGE (PPM)	N ADDED (KG/HA)	N SURPLUS (KG/HA)
PUKEMUTU EFFLUENT	2474	60	13	287	273
PUKEMUTU NON EFFLUENT	4850	50	11	211	220
WAIKIWI EFFLUENT	1007	51	12	287	265
WAIKIWI NON EFFLUENT	1793	43	10	211	213
FODDER BEET	630	225	42	142	21
TURNIPS	111	111	21	72	2

Phosphorus summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)
PUKEMUTU EFFLUENT	40	1
PUKEMUTU NON EFFLUENT	79	0.8
WAIKIWI EFFLUENT	9	0.5
WAIKIWI NON EFFLUENT	17	0.4
FODDER BEET	3	1.2
TURNIPS	1	1.1

Current system – East Block sheep (File name - CURRENT - EAST SHEEP AUG19)

Table 11. East Block – Sheep whole farm nutrient budget

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	203	14
Phosphorus	10	0.7

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	0	16	0	24	0	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	0	0	0	0	0	0	0
Rain/clover fixation	96	0	3	5	3	7	34

NUTRIENTS REMOVED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Leached from root zone	14	0.7	7	34	33	6	19
As product	20	3	1	3	5	0	1
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	37	0	0	0	0	0	0

CHANGE IN POOLS (KG/HA/YR)	N	P	K	S	CA	MG	NA
Organic pool	25	11	0	-8	0	0	0
Inorganic mineral	0	0	-25	0	-2	-3	-4
Inorganic soil pool	0	2	19	0	-33	4	18

Table 12. East Block - sheep nitrogen and phosphorus summary reports

Nitrogen summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	N IN DRAINAGE (PPM)	N ADDED (KG/HA)	N SURPLUS (KG/HA)
EAST BLOCK - PUKEMUTU	199	14	3	0	74

Phosphorus summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)
EAST BLOCK - PUKEMUTU	9	0.6

East Block – Transition (file name CURRENT - EAST TRANSITION AUG19)

Table 8. East Block – Transition whole farm nutrient budget

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	132	9
Phosphorus	9	0.7

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	0	36	203	33	0	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	0	0	0	0	0	0	0
Rain/clover fixation	150	0	3	5	3	7	34

NUTRIENTS REMOVED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Leached from root zone	9	0.7	15	29	29	6	19
As product	0	0	0	0	0	0	0
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	4	0	0	0	0	0	0

CHANGE IN POOLS (KG/HA/YR)	N	P	K	S	CA	MG	NA
Organic pool	-23	11	6	-8	1	0	0
Inorganic mineral	0	0	-22	0	-2	-3	-4
Inorganic soil pool	0	0	6	0	-71	-7	10

Table 9. East Block - transition nitrogen and Phosphorus summary reports

Nitrogen summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	N IN DRAINAGE (PPM)	N ADDED (KG/HA)	N SURPLUS (KG/HA)
EAST BLOCK - PUKEMUTU	132	9	2	0	-15

Phosphorus summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)
EAST BLOCK - PUKEMUTU	9	0.7

East Block – Dairy support (file name - CURRENT - EAST DAIRY SUPPORT AUG19)

Table 11. East Block – Dairy support whole farm nutrient budget

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	385	27
Phosphorus	10	0.7

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	0	1	0	11	0	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	0	0	0	0	0	0	0
Rain/clover fixation	80	0	3	5	3	7	34

NUTRIENTS REMOVED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Leached from root zone	27	0.7	9	33	43	6	19
As product	9	2	1	1	5	0	0
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	39	0	0	0	0	0	0

CHANGE IN POOLS (KG/HA/YR)	N	P	K	S	CA	MG	NA
Organic pool	78	12	4	-7	1	0	0
Inorganic mineral	0	0	-16	0	-2	-3	-4
Inorganic soil pool	0	0	98	0	-20	12	25

Table 12. East Block – Dairy support nitrogen and phosphorus summary reports

Nitrogen summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	N IN DRAINAGE (PPM)	N ADDED (KG/HA)	N SURPLUS (KG/HA)
EAST BLOCK - PUKEMUTU	381	27	6	0	139

Phosphorus summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)
EAST BLOCK - PUKEMUTU	8	0.6

Proposed system – (file name - PROPOSED - AUG19 MITIGATED)

Table 14. Proposed system whole farm nutrient budget

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	9,908	44
Phosphorus	256	1.1

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	185	22	15	25	8	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	104	14	71	9	15	7	5
Rain/clover fixation	71	0	3	5	3	7	35

NUTRIENTS REMOVED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Leached from root zone	44	1.1	13	39	54	6	20
As product	96	16	23	5	21	2	7
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	84	0	0	0	0	0	0

CHANGE IN POOLS (KG/HA/YR)	N	P	K	S	CA	MG	NA
Organic pool	136	18	13	-5	8	3	1
Inorganic mineral	0	2	-19	0	-2	-3	-3
Inorganic soil pool	0	0	58	0	-54	6	16

Table15. Proposed system nitrogen and phosphorus summary reports

Nitrogen summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	N IN DRAINAGE (PPM)	N ADDED (KG/HA)	N SURPLUS (KG/HA)
BALEAGE WINTER - PUKEMUTU EFF	140	88	19	234	396
BALEAGE WINTER - PUKEMUTU NON EFF	277	84	19	203	368
BALEAGE WINTER - WAIKIWI NON EFF	47	67	16	203	340
BALEAGE WINTER - WAIKIWI EFF	103	74	17	234	382
EAST BLOCK - PUKEMUTU	183	13	3	154	61
PUKEMUTU EFFLUENT	2408	49	11	234	249
PUKEMUTU NON EFFLUENT	3903	45	10	203	218
WAIKIWI EFFLUENT	1700	41	9	234	244
WAIKIWI NON EFFLUENT	719	38	9	203	205

Phosphorus summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)
BALEAGE WINTER - PUKEMUTU EFF	1	0.8
BALEAGE WINTER - PUKEMUTU NON EFF	2	0.7
BALEAGE WINTER - WAIKIWI NON EFF	0	0.4
BALEAGE WINTER - WAIKIWI EFF	1	0.4
EAST BLOCK - PUKEMUTU	10	0.7
PUKEMUTU EFFLUENT	43	0.9
PUKEMUTU NON EFFLUENT	67	0.8
WAIKIWI EFFLUENT	18	0.4
WAIKIWI NON EFFLUENT	8	0.4

Appendix 3: Overseer modelling report for the purposes of as part of a consent application for expanded dairying, dated October 2018

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Report disclaimer:
The OverseerFM 6.3.1 model has been utilised to assess the nutrient losses from this property. Details of how the property is operated currently, and how the property will be operated going forward have been gathered from the farm owner. Where accurate data was unavailable, conservative assumptions have been made using professional judgement.

OverseerFM 6.3.1 predicted results have been extracted from the model on 22 August 2019

T & J Driscoll Family Trust

266 O'Shannessy Road, Winton

Overseer modelling report for the purposes of as part of a consent application for expanded dairying

Report prepared for:
Tim and Jocelyn Driscoll
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1 October 2018

Executive Summary

T & J Driscoll Family Trust operate a high performance dairy farm near Winton, in Central Southland. The partially self-contained 210.6ha total property has a flat contour. There are two soil types on the property – Waikiwi and Pukemutu, separated by a small terrace. Calves are grazed on the platform until weaning and return to the platform as incalf heifers. Over the past three years, an average of 2.8ha of fodder beet and 1ha of winter turnips were planted. The farm has peak milked 573cows on average over the last three seasons.

In October 2016, Tim and Jocelyn purchased a neighbouring 13.9ha sheep grazing block – called the East Block. Following the purchase of the block, Tim and Jocelyn have transitioned the block into dairy support. It is proposed that the East Block (13.9ha) be converted to dairy and incorporated into the milking platform. In the proposed farm system, a portion of the herd will be wintered on 4ha with a baleage and grass diet. Young stock will continue to be grazed off farm from weaning to their return as incalf heifers.

Using Overseer (version 6.3.0) nutrient budgets have been constructed for the current land use and a proposed dairy unit nutrient budget to inform the consent application for expanded dairying. The nutrient budgets show the average nutrient losses for the last three years. Data inputs and methodology are explained in detail within this report.

A summary of the modelling output is given in Table 1. It shows a small decrease (loss than 5%) in the total Nitrogen loss from the property. Total Phosphorus loss from the property is predicted to increase (by less than 7%).

Table 13. Summary data from the Overseer analysis of the T & J Driscoll Family Trust Current and Proposed systems

	Current Total (averaged over 3 years)	Proposed system
Total Farm N Loss (kg)	11503	11345
N Loss/ha (kgN/ha/yr)	51	51
N Concentration in Drainage (ppm)		Pastoral – 9.8 – 29.3
Total Farm P Loss (kg)	262	278
P loss/ha (kgP/ha/yr)	1.2	1.2
Overseer - predicted pasture grown (tDM/ha/yr)		16.2

The key drivers of a decrease in nitrogen loss are shown below. In comparison to the current system, the proposed system has:

- Increased the area that effluent is applied to – reduced effluent N application to this area
- Reduced nitrogen fertiliser use on the effluent block
  Increased cow numbers – increasing loss risk

The key driver of the increase in phosphorus loss is an increase in losses from “other sources”.

Overseer can model a range of good management practices. However, some farm specific good management practices cannot be modelled. Recommendations of further good management practices that cannot be modelled by Overseer are given within this report to further reduce the nutrient losses from this farm system.

Property legal description

Part Section 29 and 30 Block I Winton HUN

Section 1 and 2 SO 12000

Section 43, 44, 45 and 54 Block I Winton HUN

Lot 1 and 2 DP 449518

Report purpose

To quantify the losses of nitrogen and phosphorus from the current and the proposed farm systems being operated on this property. The report details the data inputs, the modelling outputs and areas of environmental risk within the system.

Disclaimer

The Overseer 6.3.0 model has been utilised to assess the nutrient losses from this property. Details of how the property is operated currently, and how the property will be operated going forward have been gathered from the farm owner. Where accurate data was unavailable, conservative assumptions have been made using professional judgement.

The proposal

Farm objectives

T & J Driscoll Family Trust operate their farm business with the following objectives:

- To refine the farm system to maximise farm profitability – targeting $2000/ha EBIT at a $5.00 milk price
- To operate in an environmentally sustainable manner with an emphasis on continual education and improvement
- Consolidate the business to ensure it is resilient
- "Farm for the future" – the property must remain flexible to deal with changes in market forces

Current System

Nutrient budgets have been constructed to determine the average actual nutrient losses over three years (June 2015 – May 2018).

Dairy platform

T & J Driscoll Family Trust operate a high performing dairy farm near Winton, in Central Southland. The farm is owned by the Driscoll trust (JP, CA, TJ and JA Driscoll), and is operated under a lease arrangement by T & J Driscoll Family Trust (Tim and Jocelyn Driscoll). The partially self-contained 210.6ha total property has a flat contour. There are two soil types on the property – Waikiwi and Pukemutu. Calves are grazed on the platform until weaning and return to the platform as incalf heifers.

Over the previous three seasons, the property has milked an average of 573cows at peak. There has been an average of 2.8ha fodder beet and 1ha turnips grown on farm for winter and early spring grazing. Nitrogen fertiliser has been applied at an average of 213kgN/ha in split applications from August to April over the whole milking platform. In the last three seasons, the majority of the herd has been wintered off farm at a graziers property. On average, 83 cows were wintered at home in June and July, while the remaining 516 were off farm. Early calving heifers and cows return to the platform in mid July. Bought in feed has been assumed to ensure that a feasible pasture growth rate is achieved in an average season.

East Block

In October 2016, Tim and Jocelyn purchased a neighbouring 13.9ha sheep grazing block – called the East Block. Following the purchase of the block, Tim and Jocelyn have transitioned the block into dairy support. In order to create accurate actual budgets for the previous three years, three separate budgets have been created for the East Block:

- Pre purchase use (15-16 season) – a sheep grazing block. Accurate stock numbers were not available. A conservative estimation of stocking rate and management practice has been made utilising Google Earth imaging and the Beef and Lamb farm monitoring data.
- Transition (16-17 season) – All feed grown on farm was cut as baleage. This was fed to incalf heifers or exported from the block.

- Dairy support (17-18 season) – 125incalf heifers and 100cows were wintered on a baleage/grass diet on the block. The block was grazed by heifers in January and February of 2018. All other feed grown was made into baleage.

Proposed system:

Through the development of the proposed system, a number of scenarios were run through Overseer. The proposed system detailed below was chosen as it was in line with the farm objectives, the farm system preferences and the proposed Water and Land Plan.

It is proposed that the East Block (13.9ha) be converted and incorporated into the milking platform. The total farm area would then be 224.5ha total and peak cow numbers would be increased to 700 cows. The property will winter 216cows on farm, and continue to winter the remaining 516cows off farm at a graziers property. The cows wintered on farm will be grazed of 4ha with a baleage grass diet. Young stock will continue to be grazed off farm from weaning to their return as incalf heifers. The effluent system will be extended to 93.3ha and fertiliser nitrogen applications will be targeted to 197kgN/ha on the effluent area and 218kgN/ha on the non-effluent area. Bought in feed has been assumed to ensure that a feasible pasture growth rate is achieved in an average season when consented cow numbers are being milked.

Modelling method

Nutrient losses have been estimated using the Overseer Version 6.3.0 model. Overseer is a software application that models nutrient movements within a farm system. Input data detailing the farm system is entered into the software and interpreted through the use of a series of sub-model that calculate the flow of seven major farm nutrients (Nitrogen, Phosphorus, Sulphur, Calcium, Magnesium and Sodium). Output data is reported for interpretation and to inform farm management practices. It currently requires an expert user to describe the physical and management details of a farm.

Overseer assumptions

Within the Overseer software, assumptions have been made of the farm management:

- Long term annual average model
  The model uses annual average input and produces annual average outputs
- Near equilibrium conditions
  Model assumes that that the farm is at a state where there is minimal change each year
- Actual and reasonable inputs
  It is assumed that input data is reasonable and a reflection of the actual farm system. If any parameter changes, it is assumed that all other parameters affected will also be changed.
- Good management practices are followed
  Overseer assumes the property is managed is line with accepted industry good management practice.

Overseer limitations

Key limitations of the Overseer model are:

- Overseer does not predict transformations, attenuation or dilution of nutrients between the root zone or farm boundary and the eventual receiving water body. A catchment model is needed to estimate the effects of the nutrient losses from farms on groundwater, river or lake water quality.
- Overseer does not calculate outcomes from extreme events (floods and droughts), but provides a typical years result based on a long-term average.
- Overseer does not calculate the impacts of a conversion process, rather it predicts the long-term annual average nutrient budgets for changed land use.
- Overseer is not spatially explicit beyond the level of defined blocks
- Not all management practices or activities that have an impact on nutrient losses are captured in the Overseer model
- Overseer does not represent all farm systems in New Zealand
- Components of Overseer have not been calibrated against measured data from every combination of farm systems and environment

Information on Overseer can be obtained from the following reports:

- Technical Description of OVERSEER for Regional Councils, September 2015
- Review of the phosphorus loss submodel in OVERSEER®, September 2016
- Using OVERSEER® in Regulation – Technical Resources and Guidance for Regional Councils, August 2016

Data input standards

Nutrient budgets have been constructed using the Overseer Version 6.3.0 model.

The nutrient budget have been developed in accordance with the Overseer data input protocols - “Overseer, Best Practice Data Input Standards, March 2018.” No deviations have been made from these protocols.

Modelling Inputs

To construct the nutrient budgets the following assumptions have been made;

Blocks

The farm has been split into the following pastoral (effluent and non-effluent) and fodder crop blocks. Total farm area has been taken from the legal area (ex the rates demand). The area of each block has been determined using the measure function on Beacon. Soils on the property were assessed utilising the topoclimate information. Overseer soil settings were obtained from SMap for all soil types.

Block Name	Soil Type (from Beacon)	Smap Ref	Contour	Current Dairy Platform (ha)	East Block (ha)	Proposed Land Use (ha)
Effluent – Waikiwi	Edendale	Waiki_30a.1	Flat	**20.1**		**41.7**
Effluent – Pukemutu	Pukemutu	Pukem_6a.1	Flat	**41.9**		**49.9**
Non Effluent – Waikiwi	Edendale	Waiki_30a.1	Flat	**42.2**		**19.4**
Non Effluent – Pukemutu	Pukemutu	Pukem_6a.1	Flat	**98.4**		**101.5**
East Block - Pukemutu	Pukemutu	Pukem_6a.1	Flat		**13.9**	
Baleage winter Eff Waikiwi	Edendale	Waiki_30a.1	Flat			**0.8**
Baleage winter Eff Pukemutu	Pukemutu	Pukem_6a.1	Flat			**0.9**
Baleage Winter Non Eff Waikiwi	Edendale	Waiki_30a.1	Flat			**0.4**
Baleage winter Non Eff Pukemutu	Pukemutu	Pukem_6a.1	Flat			**1.9**
	Effective Farm Area			**202.6**	**13.9**	**216.5**
	Non productive			8.0		8.0
	Total Farm Area			**210.6**	**13.9**	**224.5**
Rotating fodder crops						
Fodder beet				2.8		
Winter Turnips				1.0		

Climate Data

- Southland as the location setting
- The following climate information has been used from the Overseer climate station tool;
  - 1094mm of rainfall
  - 10.1 degrees Celsius mean annual temperature
  - Daily rainfall pattern setting of 731 to 1450mm, low
  - Mean annual PET of 711mm (moderate variation)

Farm System

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
Milk solids production	271,130 kg MS 473 kgMS/cow Median calving date – 20th August Drying off – 31st May				329,000 kg MS 470 kgMS/cow Median calving date – 20th August Drying off – 31st May
Cows on farm (Lactating and wintered)	Breed Fr J X Jul 140 Aug 599 Sep 593 Oct 573 Nov 573 Dec 573 Jan 573 Feb 573 Mar 573 Apr 530 May 487 Jun 83 Peak cows: 573			Breed Fr J X Winter grazing for 100MA and 125R2 cows (Jun and Jul)	Breed Fr J X Jul 273 Aug 732 Sep 724 Oct 700 Nov 700 Dec 700 Jan 700 Feb 700 Mar 700 Apr 647 May 595 Jun 216 Peak cows: 700
Dairy replacements on farm	Calves are reared on farm until weaning (1-4months old) Aug - 135 Sep - 160 Oct - 160 Nov – 160		Grazing for R2 heifers May 125	Grazing for R2 heifers Jan 125 Feb 125	Calves are reared on farm until weaning (1-4months old) Aug - 152 Sep - 187 Oct - 187 Nov – 187
Breeding bulls	Thirteen 2yr old Jersey bulls (Dec and Jan)				Fifteen 2yr old Jersey bulls (Dec and Jan)
Sheep		Wintered: 120 MA ewes 46replacements 3rams Coopworth 125% lambing percentage 20% replacement rate			

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
		Mean lambing date of the 15th September. All non-replacement lambs sold by the end of May			
Relative productivity	No differences between blocks	No differences between blocks	No differences between blocks	No differences between blocks	No differences between blocks
Structures	Calving Pad Not modelled as used when ground conditions are saturated rather than for fixed time				Calving Pad Not modelled as used when ground conditions are saturated rather than for fixed time
In Shed Feeding	Management 100% of milkers fed Aug - May				Management 100% of milkers fed Aug - May
Rotating fodder crop management	2.8ha fodder beet Yield: 25tDM/ha Conventional cultivation October Fertiliser: 500kg/ha Winton Fodder Beet mix at sowing (delivering 50kg/ha N, 32kg/ha P, 75kg/ha K and 27kg/ha S) 100kg/ha Urea in December 100kg/ha Potassium Chloride in December 100kg/ha Urea in January Grazed by dairy cows May – Aug				Cows on farm in June/July are wintered on a baleage grass diet. 4ha Baleage/Grass wintering This area rotates around the platform and is part of the property's regrassing strategy All feed required is imported (160tDM baleage)

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
	Resown in permanent pasture in September				
	1.0ha Turnips Yield: 8tDM/ha Conventional cultivation February Fertiliser: 150kg/ha DAP and 150kg/ha super at sowing 100kg/ha Urea in March Grazed by dairy cows Jun – Aug Resown in permanent pasture in September				
Imported Supplements	In shed: 236tDM PKE 33tDM Barley In paddock: 418tDM Silage			In paddock: 65 tDM baleage	In shed: 300tDM PKE 100tDM Barley 100tDM DDG In paddock: 850tDM baleage For wintering: 160tDM baleage
Exported Supplements			130tDM baleage		
Soil Fertility	Olsen P 32 (soil test results June 2017) All other values entered at agronomic optimum	All soil test values entered at agronomic optimum (Olsen P of 20)	All soil test values entered at agronomic optimum (Olsen P of 20)	All soil test values entered at agronomic optimum (Olsen P of 20)	Olsen P 32 (soil test results June 2017) All other values entered at agronomic optimum

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
Fertiliser	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels
Nitrogen Fertiliser	213 kgN/ha in split applications (Aug – April)				Non Effluent blocks 218kgN/ha in split applications (Aug – April) Effluent Blocks 197kgN/ha in split applications (Aug – April)
Drainage	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained
Farm dairy effluent	Holding pond Solids aren't separated from the liquid Liquid effluent is applied at a depth of <12mm to the "effluent" blocks An effluent area of at least 39 ha is required to achieve a loading of less than 150 kg N / ha / year				Holding pond Solids aren't separated from the liquid Liquid effluent is applied at a depth of <12mm to the "effluent" blocks An effluent area of at least 34 ha is required to achieve a loading of less than 150 kg N / ha / year

Predicted Overseer Results

Current land use

	Current Dairy Platform (3yr average)	East Block – Sheep (15-16 season)	East Block – Transition (16-17 season)	East Block – Dairy Support (17-18 season)	East block (average of 3yrs)	Current Total (averaged over 3 years)
Total Farm N Loss (kg)	11262	204	132	386	241	11503
N Loss/ha (kgN/ha/yr)	53	15	10	28	17	51

N Concentration in Drainage (ppm)	Pastoral – 9.9 to 12.8 Crops – 21.1 to 42.1	Pastoral – 3.2	Pastoral – 2.1	Pastoral - 6.1		
Total Farm P Loss (kg)	252	10	9	10	10	262
P loss/ha (kgP/ha/yr)	1.2	0.7	0.7	0.7	0.7	1.2
Overseer - predicted pasture grown (tDM/ha/yr)	16.2	11.8	11.8	11.9		

Proposed system

	Current Total (averaged over 3 years)	Proposed system
Total Farm N Loss (kg)	11503	11345
N Loss/ha (kgN/ha/yr)	51	51
N Concentration in Drainage (ppm)		Pastoral – 9.8 – 29.3
Total Farm P Loss (kg)	262	278
P loss/ha (kgP/ha/yr)	1.2	1.2
Overseer - predicted pasture grown (tDM/ha/yr)		16.2

Conclusions from the modelling

Nutrient budgets have been developed for Driscoll Dairy. These budgets compare the nutrient loss of the current farm system with the proposed farm system. Overseer has predicted that losses of nitrogen will decrease slightly (less than 5%) and losses of phosphorus will increase slightly (less than 7%).

The key drivers of a decrease in nitrogen loss are shown below. In comparison to the current system, the proposed system has:

- Increased the area that effluent is applied to – reduced N application in effluent to this area
- Reduced nitrogen fertiliser use on the effluent block
- Increased cow numbers – increasing loss risk
-

The key driver of the increase in phosphorus loss is an increase in losses from "other sources".

Please note: Losses from "other sources" include predicted losses from laneways, calving pads and yards. The increase in losses from other sources is a result of an increase in animal excretion onto laneways. Overseer estimates amount of excreta and assumes all P ends up in dung. Some of this dung is assumed to fall on laneways and 30% of that P is assumed to be lost from the farm. Furthermore, Overseer is not spatially explicit; so it does not take into account critical source area on farms. These critical source areas accumulate overland flow from adjacent areas and deliver overland flow to surface water bodies. On farms where there is not a direct connection (or a less connection) via critical source areas, or where management mitigates risk, Overseer cannot model the impact of these at an individual farm scale.

Recommendations:

Apart from the system changes outlined above, the following recommendations are given to reduce the nutrient losses from this farm system.

Overseer can model a range of good management practices. However, some farm specific good management practices cannot be modelled. It is recommended that the following good management practices are implemented on this property:

- Fertiliser is applied at the correct rate, and is not applied in close proximity to waterways
- Identify and manage critical source areas to reduce the risk of losses. These include loses from laneways, gateways and high traffic zones.
- Stand cows off on the calving pad during periods of high soil moisture content to minimise soil damage and leaching risk.
- Fertiliser applications are made during periods of plant growth.
- An effluent management plan is in place that takes into account soil moisture and temperature, and includes a fail safe system

The nutrient budgets within this report have been developed assuming that the Olsen P is 32 and all other soil fertility measures are at the agronomic optimum. It also assumes that fertiliser is applied at a maintenance rate. A soil testing regime should be implemented and fertiliser recommendations should be developed in line with these soil testing results.

The proposed Southland Water and Land Plan is currently in process. It will be important to stay up to date with developments in Environment Southland policy and rules, including the Limit Setting Process which will develop over the next few years

A farm environmental management plan detailing the recommendations within this report should be developed for the property.

Current system - Dairy Platform

Table 14. Current system whole farm nutrient budget

(kg/ha/yr)	N	P	K	S	Ca	Mg	Na
Nutrients added							
Fertiliser, lime & other	201	24	2	34	0	0	0
Rain/clover N fixation	74	0	3	5	3	7	35
Irrigation	0	0	0	0	0	0	0
Supplements	80	11	58	9	9	6	4
Nutrients removed							
As products	87	15	21	5	19	2	6
Exported effluent	0	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0
To atmosphere	89	0	0	0	0	0	0
To water	53	1.2	12	46	61	6	20
Change in farm pools							
Plant Material	0	0	-2	0	0	0	0
Organic pool	125	19	11	-3	7	3	1
Inorganic mineral	0	2	-23	0	-2	-3	-3
Inorganic soil pool	1	-2	43	0	-72	6	15

Table 15. Current system Nitrogen report

Block name	Total N lost kg N/yr	N lost to water kg N/ha/yr	N in drainage * ppm	N surplus kg N/ha/yr	Added N ** kg N/ha/yr
Waikiwi Effluent	1,003	51	**11.4**	264	285
Pukemutu Effluent	2,464	60	**12.8**	272	285
Waikiwi non effluent	1,793	43	9.9	213	211
Pukemutu non effluent	4,850	50	11.2	220	211
Fodder Beet	630	225	**42.1**	21	142
Turnips	111	111	**21.1**	2	72
Other sources	410				
Whole farm	11,262	53			
Less N removed in wetland	0				
Farm output	11,262	53			

Table 16. Current system Phosphorus report

Block name	Total P lost kg P/yr	P lost to water kg P/ha/yr	P loss categories		
			Soil	Fertiliser	Effluent
Waikiwi Effluent	9	0.5	Low	Low	Low
Pukemutu Effluent	39	0.9	Medium	Low	Medium
Waikiwi non effluent	17	0.4	Low	Low	N/A
Pukemutu non effluent	79	0.8	Medium	Low	N/A
Fodder Beet	3	1.2	N/A	N/A	N/A
Turnips	1	1.1	N/A	N/A	N/A
Other sources	104				
Whole farm	252	1.2			

East Block – Sheep

Table 17. East Block – Sheep whole farm nutrient budget

(kg/ha/yr)	N	P	K	S	Ca	Mg	Na
Nutrients added							
Fertiliser, lime & other	0	16	0	24	0	0	0
Rain/clover N fixation	97	0	3	5	3	7	35
Irrigation	0	0	0	0	0	0	0
Nutrients removed							
As products	20	3	1	3	5	0	1
Exported effluent	0	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0
To atmosphere	37	0	0	0	0	0	0
To water	15	0.7	7	35	33	6	19
Change in farm pools							
Plant Material	0	0	0	0	0	0	0
Organic pool	25	11	0	-8	0	0	0
Inorganic mineral	0	0	-25	0	-2	-3	-4
Inorganic soil pool	0	2	19	0	-33	4	18

Table 18. East Block - sheep nitrogen report

Block name	Total N lost kg N/yr	N lost to water kg N/ha/yr	N in drainage * ppm	N surplus kg N/ha/yr	Added N ** kg N/ha/yr
East block - Pukemutu	200	14	3.2	74	0
Other sources	4				
Whole farm	204	15			
Less N removed in wetland	0				
Farm output	204	15			

Table 19. East Block - Sheep phosphorus report

Block name	Total P lost kg P/yr	P lost to water kg P/ha/yr	P loss categories		
			Soil	Fertiliser	Effluent
East block - Pukemutu	9	0.6	Low	Low	N/A
Other sources	1				
Whole farm	10	0.7			

East Block – Transition

Table 8. East Block – Transition whole farm nutrient budget

(kg/ha/yr)	N	P	K	S	Ca	Mg	Na
Nutrients added							
Fertiliser, lime & other	0	36	204	33	0	0	0
Rain/clover N fixation	152	0	3	5	3	7	35
Irrigation	0	0	0	0	0	0	0
Nutrients removed							
As products	0	0	0	0	0	0	0
Exported effluent	0	0	0	0	0	0	0
As supplements and crop residues	162	24	203	17	46	11	9
To atmosphere	4	0	0	0	0	0	0
To water	10	0.7	15	30	29	6	19
Change in farm pools							
Plant Material	0	0	0	0	0	0	0
Organic pool	-24	12	6	-8	1	0	0
Inorganic mineral	0	0	-22	0	-2	-3	-4
Inorganic soil pool	0	0	5	0	-72	-7	10

Table 9. East Block - transition nitrogen report

Block name	Total N lost kg N/yr	N lost to water kg N/ha/yr	N in drainage * ppm	N surplus kg N/ha/yr	Added N ** kg N/ha/yr
East block - Pukemutu	132	9	2.1	-15	0
Other sources	1				
Whole farm	132	10			
Less N removed in wetland	0				
Farm output	132	10			

Table 10. East Block - Transition phosphorus report

Block name	Total P lost kg P/yr	P lost to water kg P/ha/yr	P loss categories		
			Soil	Fertiliser	Effluent
East block - Pukemutu	9	0.7	Low	Low	N/A
Other sources	0				
Whole farm	9	0.7			

East Block – Dairy support

Table 11. East Block – Dairy support whole farm nutrient budget

(kg/ha/yr)	N	P	K	S	Ca	Mg	Na
Nutrients added							
Fertiliser, lime & other	0	0	0	8	0	0	0
Rain/clover N fixation	81	0	3	5	3	7	35
Irrigation	0	0	0	0	0	0	0
Nutrients removed							
As products	9	2	1	1	5	0	0
Exported effluent	0	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0
To atmosphere	40	0	0	0	0	0	0
To water	28	0.7	9	30	43	6	19
Change in farm pools							
Plant Material	-75	-14	-94	-11	-23	-8	-7
Organic pool	79	12	4	-7	1	0	0
Inorganic mineral	0	0	-16	0	-2	-3	-4
Inorganic soil pool	0	-1	98	0	-21	12	25

Table 12. East Block – Dairy support nitrogen report

Block name	Total N lost kg N/yr	N lost to water kg N/ha/yr	N in drainage * ppm	N surplus kg N/ha/yr	Added N ** kg N/ha/yr
East block - Pukemutu	381	27	6.1	139	0
Other sources	5				
Whole farm	386	28			
Less N removed in wetland	0				
Farm output	386	28			

Table 13. East Block – Dairy support phosphorus report

Block name	Total P lost kg P/yr	P lost to water kg P/ha/yr	P loss categories		
			Soil	Fertiliser	Effluent
East block - Pukemutu	8	0.6	Low	N/A	N/A
Other sources	2				
Whole farm	10	0.7			

Proposed system

Table 14. Proposed system whole farm nutrient budget

(kg/ha/yr)	N	P	K	S	Ca	Mg	Na
Nutrients added							
Fertiliser, lime & other	199	21	0	30	0	0	0
Rain/clover N fixation	73	0	3	5	3	7	35
Irrigation	0	0	0	0	0	0	0
Supplements	103	21	97	18	22	11	7
Nutrients removed							
As products	99	17	24	5	21	2	7
Exported effluent	0	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0
To atmosphere	87	0	0	0	0	0	0
To water	51	1.2	13	49	59	8	20
Change in farm pools							
Plant Material	0	0	0	0	0	0	0
Organic pool	138	20	15	-3	8	4	1
Inorganic mineral	0	2	-19	0	-2	-3	-3
Inorganic soil pool	0	2	67	0	-62	9	17

Table15. Proposed system nitrogen report

Block name	Total N lost kg N/yr	N lost to water kg N/ha/yr	N in drainage * ppm	N surplus kg N/ha/yr	Added N ** kg N/ha/yr
Waikiwi Effluent	1,887	45	10.2	241	249
Pukemutu Effluent	2,662	53	**11.5**	249	249
Waikiwi non effluent	830	43	9.8	210	215
Pukemutu non effluent	5,030	50	11.1	217	215
Baleage winter - waikiwi Eff	88	111	**25.2**	506	249
Baleage winter - Pukemutu Eff	120	133	**29.3**	530	249
Baleage winter - Waikiwi Non Eff	40	99	**22.6**	451	215
Baleage winter - Pukemutu Non Eff	240	126	**28.3**	498	215
Other sources	449				
Whole farm	11,345	51			
Less N removed in wetland	0				
Farm output	11,345	51			

Table 20. Proposed system phosphorus report

Block name	Total P lost kg P/yr	P lost to water kg P/ha/yr	P loss categories		
			Soil	Fertiliser	Effluent
Waikiwi Effluent	19	0.5	Low	Low	Low
Pukemutu Effluent	46	0.9	Medium	Low	Medium
Waikiwi non effluent	8	0.4	Low	Low	N/A
Pukemutu non effluent	82	0.8	Medium	Low	N/A
Baleage winter - waikiwi Eff	0	0.5	Low	Low	Low
Baleage winter - Pukemutu Eff	1	0.9	Medium	Low	Medium
Baleage winter - Waikiwi Non Eff	0	0.4	Low	Low	N/A
Baleage winter - Pukemutu Non Eff	2	0.8	Medium	Low	N/A
Other sources	121				
Whole farm	278	1.2			

Farm Map

Figure 1. Driscolls farm map showing the current and proposed effluent areas

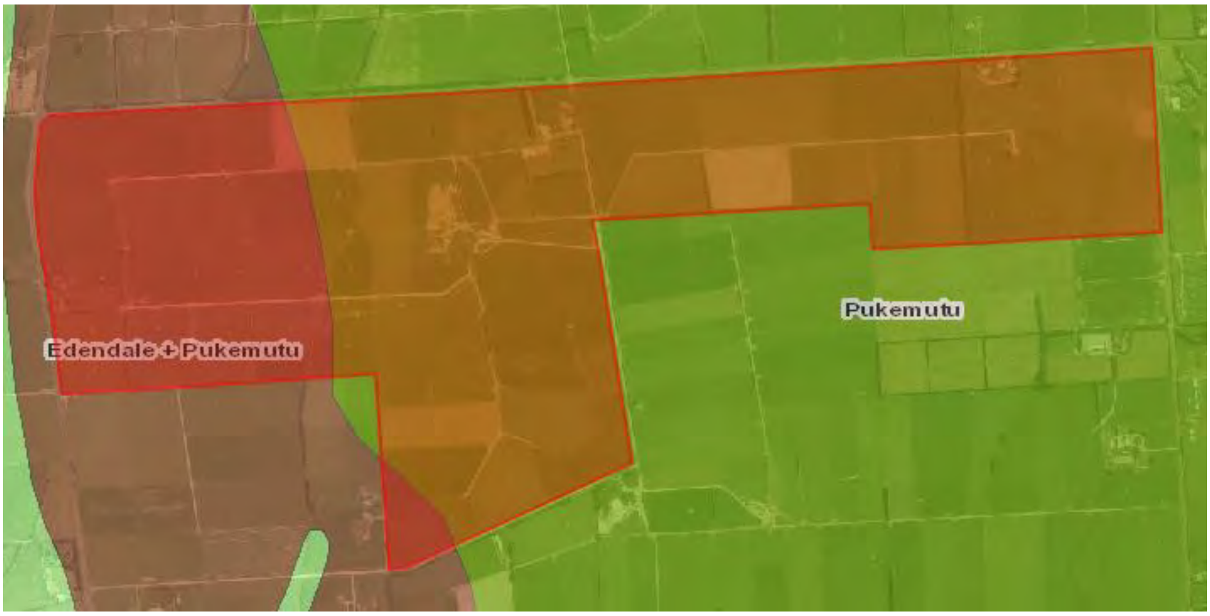

Figure 2. Driscolls farm map showing the soil types on farm

Report disclaimer:
The OverseerFM 6.3.1 model has been utilised to assess the nutrient losses from this property. Details of how the property is operated currently, and how the property will be operated going forward have been gathered from the farm owner. Where accurate data was unavailable, conservative assumptions have been made using professional judgement.

OverseerFM 6.3.1 predicted results have been extracted from the model on 22 August 2019

Appendix 4: Further information: T and J Driscoll Family Trust consent application, December 2018

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Further information: T and J Driscoll Family Trust consent application

Please find below a file note in relation to Overseer modelling completed for the T and J Driscoll Family Trust. This file note is intended to be read alongside the Overseer Modelling Report, dated 1st October, 2018.

Executive summary

An application for consent to use land for dairying was made by the T and J Driscoll Family Trust in October 2018. This application utilised Overseer data to quantify predicted losses of nitrogen and phosphorus from the current and proposed systems. Environment Southland has raised concern that the predicted P losses using Overseer are higher in the proposed system than the current system. However, there are a range of P loss mitigations that are not accounted for, or are not fully accounted for, in Overseer. This file note seeks to quantitatively estimate the difference in P loss between the current and proposed systems using both Overseer and the results of recent New Zealand research.

Overseer has predicted the following total P loss:

Current situation	262 kg P/yr
Proposed situation	278 kg P/yr
Difference	**16 kg P/yr increase**

The Overseer model has a reasonable degree of calibration and evaluation/validation within the nitrogen leaching sub-model. However, the P loss sub-model has been developed using a less extensive calibration and evaluation/validation base. The model is not spatially explicit and as such it uses a number of assumptions to make estimates of both N and P loss. It is important to appreciate that there are significant uncertainties associated with Overseer nutrient loss estimates and Overseer currently only provides for a very limited range of mitigation options to be incorporated.

We have considered the current mitigations in place to reduce nutrient loss from laneways and further mitigations planned. These are described in the report. Revised Overseer P loss estimates have been calculated, taking into account the effect of the laneway mitigations for the current and proposed systems:

	Overseer P loss estimate	– estimated P loss mitigated	= revised P loss
Current system	262 kg P/yr	- 33kg P	= 229kgP
Proposed system	278 kg P/yr – 19.1kgP	- 52kg P	= 226kgP
Difference			**= 3kg P/yr decrease**

Further mitigations that may be implemented in the future are to apply 50% of the phosphorus fertiliser in a low solubility form and to lower the Olsen P to 30. Overseer predicts that these mitigations would reduce P loss from the pastoral areas by a further 10 kg P.

Report disclaimer:
The OverseerFM 6.3.1 model has been utilised to assess the nutrient losses from this property. Details of how the property is operated currently, and how the property will be operated going forward have been gathered from the farm owner. Where accurate data was unavailable, conservative assumptions have been made using professional judgement.

OverseerFM 6.3.1 predicted results have been extracted from the model on 22 August 2019

P runoff from laneways

Overseer has a built in assumption that 30% of phosphorus deposited on laneways as dung is lost. This is accounted for in the "other sources" losses within the Phosphorus report (shown in the appendices of the consent application). Research has shown that a dairy cow consuming 15.5kgDM/day on a pasture diet will consume 0.4 kg P/week, of which 66% will be deposited in dung (shown in the table below, source: Massey University). Assuming that the farm has a lactation season of 270 days, each cow will ingest 15.4 kg P/cow, and **10.2kgP/animal would be deposited as dung.** A study by Ledgard *et al.* (1999) reported that **5% of cow excreta was deposited on laneways.** We have assumed that Overseer incorporates this information. Overseer then assumes that for phosphorus deposited on laneways in dung, **30% is lost from the system to water.**

Table 1.4 The fate of minerals ingested by a lactating dairy cow (ingesting 15.5 kg DM/day) (adapted from During 1984).

Element	Consumption Kg /week	Percentage in Faeces	Urine	Milk	Retained
N	5.1	26	53	17	4
P	0.4	66	-	26	8
K	2.9	11	81	5	3
Mg	0.2	80	12	3	5
Ca	0.4	77	3	11	9
Na	0.4	30	56	8	6

There is opportunity to mitigate the losses from laneways through careful management of bridges/culverts, buffer zone planting, laneway cambering and siting laneways away from waterways. These mitigations all reduce P loss by ensuring laneway runoff is filtered through a vegetated buffer strip. Research has shown that vegetated buffer strips can reduce P losses by 38-59% (figure 1). None of these mitigation strategies are provided for in Overseer.

As described in the application for consent, this property has already implemented some mitigations to reduce phosphorus loss from laneways. These include kickboards on the two bridges (see pictures in consent application) and having some cut outs from the lane that direct runoff into paddocks rather than into waterways. The process of applying for consent has identified areas where further mitigations could be implemented. This includes improving the kickboards on the bridges, and improving the camber and increasing the size of the buffer on the laneway south of the cowshed which runs alongside an open drain. Water flow will be redirected through vegetated areas to allow for filtering. These areas of laneway are considered critical source areas – small areas that contribute a relatively high proportion of nutrient/phosphorus losses.

These improvements in laneway management will further mitigate losses of P. A study in the Mangakino stream by McDowell et al. (2006) found that the majority (c. 80%) of P losses were occurring from a small tributary that contributed less than 20% of the flow. Investigation of the tributary found that there was a heavily used, poorly managed dairy farm stream crossing less than 200m upstream from the confluence. Management of these high risk areas of laneway can therefore have significant positive effects on Predicted losses.

Given the evidence above, it has been assumed that the Driscoll property is currently mitigating at the low end of the range of reported mitigation, i.e., 38% of the losses from laneways assumed by Overseer, for the current 573 cows.

P loss mitigated	= Cows	x	P in dung	x	Excreted on lanes	x	assumed losses	x	current mitigations
Current system	= 573	x	10.2kg P	x	5%	x	30%	x	38%
	= 33 kg P/yr								

Revised Overseer estimated P loss (current system) = 262 kg P – 33kg P = 229 kg P

Going forward, as a result of this consent application, the Driscolls will make further mitigations to reduce laneway losses through increased use of vegetated buffers, as described above. We consider that these improvements can reduce annual P loss from laneways to the midpoint of the range of reported mitigation, i.e., 49% of the losses assumed by Overseer, for the proposed 700cows.

P loss mitigated	= Cows	x	P in dung	x	Excreted on lanes	x	assumed losses	x	extra mitigations
Proposed system	= 700	x	10.2kgP	x	5%	x	30%	x	49%
	= 52 kg P/yr								

Revised Overseer estimated P loss (proposed system) = 278 kg P – 52kg P = 226 kg P

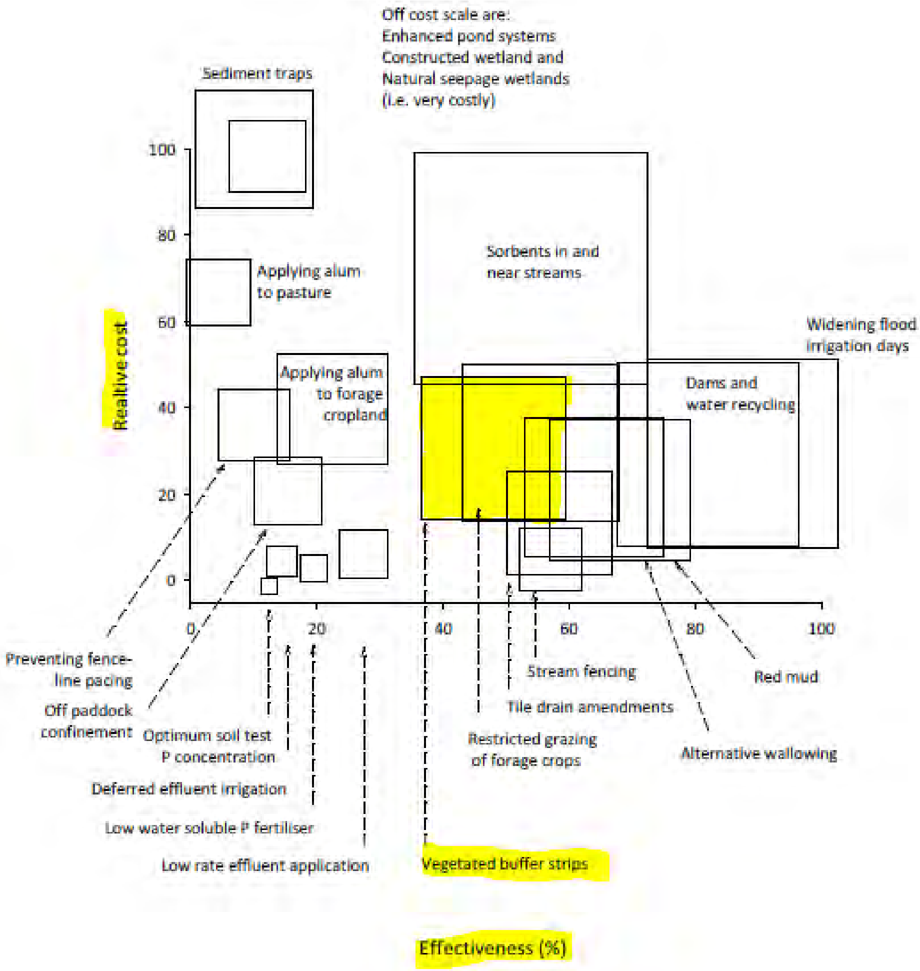

Figure 3. Diagram of the cost and effectiveness of strategies to mitigate phosphorus losses to water at the farm-scale. Cost is shown as the cost per kg of P mitigated relative to the most expensive strategy - sediment traps at $360 per kg P retained/ha/yr. From McDowell et al (2013)

Further future mitigation options:

Lower solubility Phosphorus fertilisers

The modelling completed assumed that fertiliser P would be applied as super phosphate – the most commonly used P fertiliser in New Zealand. This assumption was made in order to show a conservative estimate of losses, and to ensure that the systems were compared fairly. Going forward, the Driscolls have indicated that they are considering using RPR/serpentine super instead of super phosphate. This was not shown in the modelling as a transition to RPR/serpentine super should be untaken over a number of years in order to maintain pasture production.

Super phosphate fertiliser is 100% water soluble. In comparison, serpentine super and Reactive Phosphate Rock (RPR) have lower water solubility - 2.9% and 0% respectively (McNaught et al, 1968). As a result, the risk of P loss is higher in situations where super phosphate has been applied compared to RPR or serpentine super.

To show the effectiveness of this as a mitigation, I have modelled applying a maintenance application of P as 50% super phosphate and 50% RPR instead of 100% super phosphate. Please note

that the amount of P, in kg P per ha, has not changed, but the form of the fertiliser has. Overseer assumes that serpentine super has the same solubility as superphosphate (Wheeler and Watkins, 2016), and therefore the same fertiliser runoff risk profile. However, due to it's similar water solubility, serpentine super is expected to have similar losses of P as RPR. **This change in fertiliser form has resulted in a reduction in predicted P loss by 4kgP**. The Overseer P loss reports are shown in the appendices.

Soil Olsen P

Olsen P is a commonly used measure of plant available soil P. From an agronomic perspective, the optimum Olsen P level is 30. The Driscolls have an average Olsen P of 32. In the modelling completed for the Driscoll's it was assumed that maintenance fertiliser would be applied going forward, and that the Olsen P would therefore remain the same.

The consent application process has highlighted the environmental risk of a higher Olsen P to Tim and Jocelyn. As a result Tim and Jocelyn are considering reducing their Olsen P. **Overseer predicts that a reduction in Olsen P from 32 to 30 is expected to reduce P loss by 6kgP**. The Overseer P loss reports are shown in the appendices.

Conclusions:

Overseer has predicted the following total P loss:

Current situation	262 kg P/yr
Proposed situation	278 kg P/yr
Difference	**16 kg P/yr increase**

We have considered the current mitigations in place to reduce nutrient loss from laneways and further mitigations planned. These are described in the report. Revised Overseer estimates have been calculated, taking into account the effect of the laneway mitigations for the current and proposed systems:

	Overseer P loss estimate –	estimated P loss mitigated	= revised P loss
Current system	262 kg P/yr	- 33kg P	= 229kgP
Proposed system	278 kg P/yr – 19.1kgP	- 52kg P	= 226kgP
Difference			**= 3kg P/yr decrease**

Further mitigations that may be implemented in the future are to apply 50% of the phosphorus fertiliser in a low solubility form and to lower the Olsen P to 30. Overseer predicts that these mitigations would reduce P loss from the pastoral areas by 10 kg P.

References

Ledgard, S., Penno, J., & Sprosen, M. (1999). Nitrogen inputs and losses from clover/grass pastures grazed by dairy cows, as affected by nitrogen fertiliser application. *Journal of Agricultural Science 132*, 215-225.

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McDowell, R., Wilcock, B., & Hamilton, D. (2013). *Assessment of Strategies to Mitigate the Impact or Loss of Contaminants from Agricultural Land to Fresh Waters.* Prepared for MfE.

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Appendices:

Table 21. Block P loss table, as estimated by overseer for the Proposed system (same as in the consent application)

Farm name: Driscolls Proposed FINAL 1Oct

Block Phosphorus

Block name	Total P lost (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Waikiwi Effluent	19	0.5	Low	Low	Low
Pukemutu Effluent	46	0.9	Medium	Low	Medium
Waikiwi non effluent	8	0.4	Low	Low	n/a
Pukemutu non effluent	82	0.8	Medium	Low	n/a
Baleage winter - waikiwi Eff	0	0.5	Low	Low	Low
Baleage winter - Pukemutu Eff	1	0.9	Medium	Low	Medium
Baleage winter - Waikiwi Non Eff	0	0.4	Low	Low	n/a
Baleage winter - Pukemutu Non Eff	2	0.8	Medium	Low	n/a
Other farm sources	121				
Whole farm	278	1.2			

Table 22 Block P loss table, as estimated by overseer for the Proposed system – after applying 50% of the phosphorus fertiliser in a lower solubility form.

Farm name: Driscolls Proposed FINAL 1Oct - 50% RPR

Block Phosphorus

Block name	Total P lost (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Waikiwi Effluent	19	0.4	Low	Low	Low
Pukemutu Effluent	45	0.9	Medium	Low	Medium
Waikiwi non effluent	8	0.4	Low	Low	n/a
Pukemutu non effluent	79	0.8	Medium	Low	n/a
Baleage winter - waikiwi Eff	0	0.4	Low	Low	Low
Baleage winter - Pukemutu Eff	1	0.9	Medium	Low	Medium
Baleage winter - Waikiwi Non Eff	0	0.4	Low	Low	n/a
Baleage winter - Pukemutu Non Eff	1	0.8	Medium	Low	n/a
Other farm sources	121				
Whole farm	274	1.2			

Table 23. Block P loss table, as estimated by overseer for the Proposed system – after reducing Olsen P to 30.

Farm name: Driscolls Proposed FINAL 1Oct - Olsen P 30

Block Phosphorus

Block name	Total P lost (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Waikiwi Effluent	19	0.4	Low	Low	Low
Pukemutu Effluent	44	0.9	Medium	Low	Medium
Waikiwi non effluent	8	0.4	Low	Low	n/a
Pukemutu non effluent	79	0.8	Medium	Low	n/a
Baleage winter - waikiwi Eff	0	0.4	Low	Low	Low
Baleage winter - Pukemutu Eff	1	0.9	Medium	Low	Medium
Baleage winter - Waikiwi Non Eff	0	0.4	Low	Low	n/a
Baleage winter - Pukemutu Non Eff	2	0.8	Medium	Low	n/a
Other farm sources	120				
Whole farm	272	1.2			

Appendix 5: T and J Driscoll Family Trust – Farm Maps

Farm Map

Figure 4. Driscolls farm map showing the current and proposed effluent areas, and the East Block.

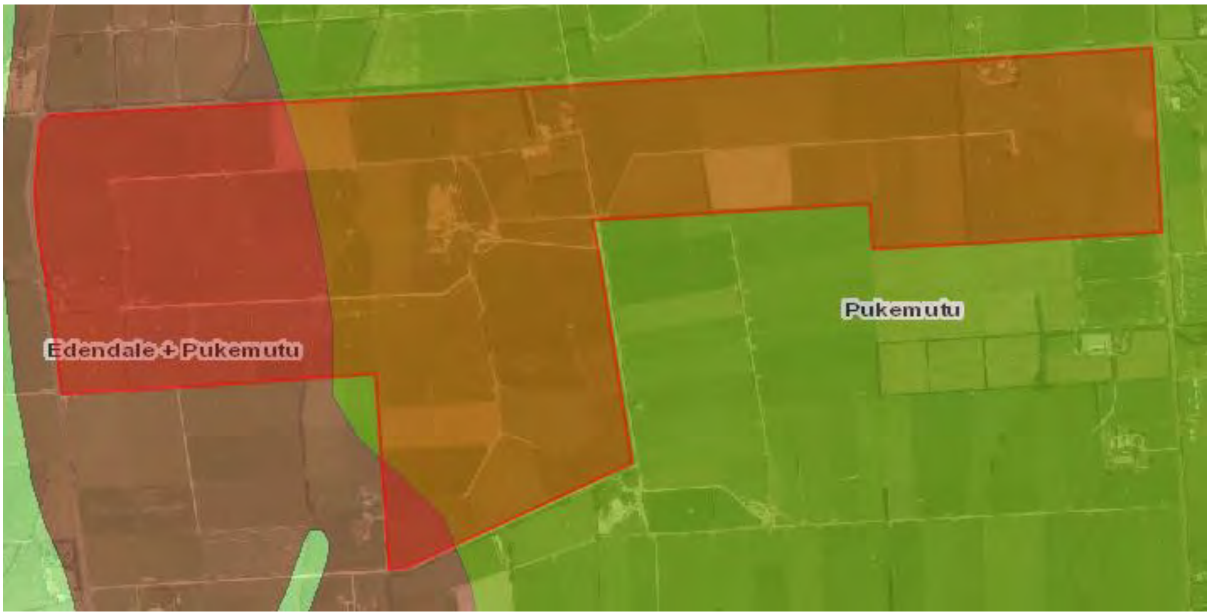

Figure 5. Driscolls farm map showing the soil types on farm

Further Information

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File Note: T and J Driscoll Family Trust consent application

Please find below a file note in relation to Overseer modelling completed for the T and J Driscoll Family Trust. This file note is intended to be read in conjunction alongside the previous Overseer modelling reports, dated 1st October 2018 and the previous file note "Further information: T And J Driscoll Family trust consent application," dated 18th December 2018. Both of these reports have been included in the appendices of this file note.

Purpose of this Report

The applicant (T and J Driscoll Family Trust) have instructed further modelling to be undertaken to reduce nutrient loss in the proposed dairy farm.

Previous Modelling Results

Overseer modelling was completed for the T and J Driscoll Trust in October 2018 using Overseer version 6.3.0. Summarised results from this modelling is shown in Table 1.

Table 1. Predicted nitrogen and phosphorus losses in the current and proposed systems (From modelling report dated 1st October 2018 – in appendices)

	Current system	Proposed system
Total Farm N Loss (kg)	11,503	11,345
N Loss/ha (kgN/ha/yr)	51	51
Total Farm P Loss (kg)	262	278
P loss/ha (kgP/ha/yr)	1.2	1.2

Following this modelling, Environment Southland raised concern that the predicted Phosphorus losses using Overseer are higher in the proposed than the current system. A file note was completed to quantify the impact of mitigations that are not accounted for in Overseer. Results including the phosphorus mitigations modelled outside of Overseer 6.3.0 are shown in table 2.

Report disclaimer:
The OverseerFM 6.3.1 model has been utilised to assess the nutrient losses from this property. Details of how the property is operated currently, and how the property will be operated going forward have been gathered from the farm owner. Where accurate data was unavailable, conservative assumptions have been made using professional judgement.

OverseerFM 6.3.1 predicted results have been extracted from the model on 22 August 2019

Table 2. Predicted nitrogen and phosphorus losses in the current and proposed systems, including phosphorus mitigations modelled outside of Overseer 6.3.0 (From "Further information: T and J Driscoll Family Trust consent application" - in appendices)

	Current system	Proposed system
Total Farm N Loss (kg)	11,503	11,345
N Loss/ha (kgN/ha/yr)	51	51
Total Farm P Loss (kg)	229 (including 33kg P mitigation modelled outside of Overseer)	226 (including 52kg P mitigation modelled outside of Overseer)
P loss/ha (kgP/ha/yr)	1.0	1.0

Using the Overseer 6.3.0 model and supporting phosphorus loss calculation outside of Overseer, it is predicted that losses of nitrogen will decrease by 1.4% and losses of phosphorus will decrease by 1.3%.

The key drivers of a decrease in nitrogen loss are shown below. In comparison to the current system, the proposed system has:

- Increased the area that effluent is applied to – reduced N application in effluent to this area
- Reduced nitrogen fertiliser use
- Increased cow numbers – increasing loss risk

The key driver of the decrease in phosphorus loss are shown below. In comparison to the current system the proposed has:

- Improved laneway sediment loss mitigations

Changes in Overseer since October 2018

Since October 2018 there have been two key changes in Overseer:

- Overseer moved to the OverseerFM platform. Please note that this was a change in the Overseer platform and working interface rather than a change to the mechanics of Overseer. This movement therefore created no change in predicted nitrogen and phosphorus losses.
- In February 2019 version 6.3.1 of OverseerFM was released. Version 6.3.1 made a change to the OverseerFM model relating to fodder crops. This has had a small impact on the results predicted for the T and J Driscoll Family Trust.

The Overseer files related to this consent application were reopened in OverseerFM version 6.3.1. Climate location and maintenance fertiliser inputs have been updated and the method is consistent between the current and proposed files. No other changes were made. Summary results from OverseerFM 6.3.1 are shown below with changes shown in red.

Table 3. Predicted nitrogen and phosphorus losses in the current system as modelled in OverseerFM 6.3.1

	Current Dairy Platform (3yr average)	East Block – Sheep (15-16 season)	East Block – Transition (16-17 season)	East Block – Dairy Support (17-18 season)	East block (average of 3yrs)	Current Total (averaged over 3 years)
Total Farm N Loss (kg)	11273	203	132	385	240	11513
N Loss/ha (kgN/ha/yr)	54	14	9	27	17	51
N Concentration in Drainage (ppm)	Pastoral – 10 to 13 Crops – 21 to 42	Pastoral – 3	Pastoral – 2	Pastoral - 6		
Total Farm P Loss (kg)	253	10	9	10	10	263
P loss/ha (kgP/ha/yr)	1.2	0.7	0.7	0.7	0.7	1.2
Overseer - predicted pasture grown (tDM/ha/yr)	16.2	11.8	11.8	11.9		

Table 4. Predicted nitrogen and phosphorus losses in the current and proposed systems, including phosphorus mitigations modelled outside of OverseerFM 6.3.1

	Current system	Proposed system
Total Farm N Loss (kg)	11513	11348
N Loss/ha (kgN/ha/yr)	51	51
N Concentration in Drainage (ppm)		Pastoral – 10 to 29
Total Farm P Loss (kg)	230 (including 33kg P mitigation modelled outside of Overseer)	226 (including 52kg P mitigation modelled outside of Overseer)
P loss/ha (kgP/ha/yr)	1.0	1.0
Overseer - predicted pasture grown (tDM/ha/yr)		16.2

Further Modelling

During conversations with Environment Southland and LandPro it has become clear that under the Proposed Water and Land Plan that the applicant needs to demonstrate a farm system (through modelling) that would contribute to a clear improvement to water quality.

Key changes from the original proposal are as follows (see appendices for detailed assumptions):

- Reduction in peak cows milked (from 700 to 680)
- Reduction in young stock numbers (aligned to reduction in cow numbers)

- Reduction in nitrogen applied as fertiliser overall
- Increased use of barley as a purchased in feed (lower protein feed)
- Increase in area utilised for baleage grass wintering
- A reduction in Olsen P to 30 on the milking platform (note the Olsen P on the East Block will increase from the current 20)

The East Block has been blocked separately and additional mitigation strategies have been implemented on this block (see appendices for detailed assumptions):

- No wintering on this block (June and July)
- No grazing of livestock in the months of May to August, requiring less pasture cover May to August and a subsequent reduction in fertiliser N applications, and consequently overall lower pasture grown on this block
- No supplements fed on block
- Baleage made on the East block due to distance from cowshed
- Low solubility P fertiliser is applied (assumed Reactive Phosphate Rock in the modelling, may also be serpentine super in practice)

The results of these mitigations are shown in Table 5.

Table 5. Predicted nitrogen and phosphorus losses in the current and proposed system before and after further mitigations were included, including phosphorus mitigations modelled outside of OverseerFM 6.3.1

	Current system	**Proposed system (before further mitigations applied)**	**Proposed system (following further mitigations)**
Total Farm N Loss (kg)	11513	11348	9908
N Loss/ha (kgN/ha/yr)	51	51	44
N Concentration in Drainage (ppm)		Pastoral – 10 to 29	Pastoral – 3 to 19
Total Farm P Loss (kg)	230 (including 33kg P mitigation modelled outside of Overseer)	226 (including 52kg P mitigation modelled outside of Overseer)	204 (including 52kg P mitigation modelled outside of Overseer)
P loss/ha (kgP/ha/yr)	1.0	1.0	0.9
OverseerFM - predicted pasture grown (tDM/ha/yr)		16.2	16.0 (excluding East Block) 15.6 (East Block)

Taking into account the further mitigations made to the proposed farm system, OverseerFM predicts that overall nitrogen will decrease by 14% and losses of phosphorus will decrease by 11%. The nutrient budget, nitrogen summary and phosphorus summary are shown for each system in the appendices.

Adjustments to nitrogen losses in the proposed system

Baleage grass wintering:

OverseerFM has estimated that the loss of nitrogen from the grass baleage system is 567kgN (or 81kgN/ha). Modelling of the grass baleage wintering system in OverseerFM is likely to underestimate nitrogen losses as OverseerFM is not able to adequately reflect the on-farm realities of this system. OverseerFM assumes that the pasture plants will regrow post grazing and take up urinary N from the wintering activity. However, in reality, due to the soil type and climate on the applicant's property, the plants are not viable following the winter grazing. As a result the area is cultivated and regrassed in spring.

I am unaware of any research that has quantified the impact of baleage grass wintering in terms of nitrate and phosphorus loss. I have therefore completed a desktop modelling exercise that attempts to more accurately estimate the nutrient losses from this system.

The following assumptions have been made:

- Same as the proposed system file
    - Soils / climatic conditions
    - Tile drains
    - Stock numbers
    - Imported / exported supplement
    - Fertiliser and nitrogen use

- Different from the proposed system file
    - Used kale instead of pasture to allow a defoliation event and regressing activity
    - Used kale as has a similar crude protein to average quality pasture
    - Reduced yield of kale to 3TDM/ha to reflect pasture accumulated for winter in practice
    - Regrassed the area in October in line with when the applicant would usually regrass following a grass baleage wintering event
    - Direct drilled kale (rather than conventional cultivation to minimise the impact of the mineralisation of N during cultivation)

Overseer predicted that the losses from the Kale block would be 99kgN/ha (total of 693kgN lost for the 7ha wintered on). Without comparative research, it is difficult to assess the accuracy of the above results. However, from a common sense perspective, losses from the baleage grass system are likely to be more comparable to a traditional fodder crop paddock than a permanent pasture paddock. Therefore, it is predicted that the losses from the grass baleage wintering system will be 126kgN higher than predicted in the Proposed scenario.

Table 6. Predicted nitrogen and phosphorus losses in the current and proposed system after further mitigations were included, including phosphorus mitigations modelled outside of OverseerFM 6.3.1

	Current system	Proposed system (following further mitigations)	Percentage change in losses
Total Farm N Loss (kg)	11513	10034 (including 126kgN adjustment modelled outside of Overseer)	12.8% reduction
N Loss/ha (kgN/ha/yr)	51	45	
N Concentration in Drainage (ppm)		Pastoral – 3 to 19	
Total Farm P Loss (kg)	230 (including 33kg P mitigation modelled outside of Overseer)	204 (including 52kg P mitigation modelled outside of Overseer)	11.3% reduction
P loss/ha (kgP/ha/yr)	1.0	0.9	
OverseerFM - predicted pasture grown (tDM/ha/yr)		16.0 (excluding East Block) 15.6 (East Block)	

Taking into account the further mitigations to the proposed farm system and the adjustment required for modelling the baleage grass wintering system, Overseer predicts that overall nitrogen will decrease by 13% and losses of phosphorus will decrease by 11.3%.

Off site effects of wintering:

No adjustment to nutrient losses to account for off site effects of wintering has been made as the number of animals wintered off farm (mixed age cows and R2 heifers) is the same in the current as the proposed. All additional stock in the proposed system will be wintered on farm and have therefore been accounted for in the modelling. The number of stock wintered on and off farm are described in detail in the appendices.

Off site effects of young stock:

As a result of the increased cow numbers on farm, there will also be an increase in the number of young stock reared for the property. These animals have been and will continue to be grazed off site with a third party grazier. The applicant does not have direct control over the management of these stock or the property that they are grazing. As agreed between Alex Erceg (ES) and Tanya Copeland (Landpro) in an email dated 21st February, the off site effects of these animals has not been included in the OverseerFM modelling. A copy of the relevant correspondence is available from Landpro upon request.

However, should quantification be required, I have made the following estimation of the scale of the effect of these extra young stock. The applicant rears 28% replacements (calves as a percentage of cows milked at peak). This is equivalent to 160 calves in the current system and 190 calves in the proposed system – an increase of 30 animals. Young stock are grazed off farm from weaning (1st

December), until their return as incalf heifers (1st Jun, 18months later). This system will continue to occur in the proposed scenario.

Rising 1 year old heifers have been traditionally wintered on fodder beet, although in the 2019 winter they were grazed on a baleage grass system. The off site effect of the extra young stock grazing can be estimated as follows:

- 30 rising 1 year olds, wintered on crop for 77days
- Require 5kgDM fodderbeet per head per day (the balance of the diet is made up of supplement as per standard practice)
- 5kgDM/head/day x 77days x 30animals = 11,550kgDM fodderbeet required
- At a 25,000tDM/ha yield of fodderbeet, the stock will require 0.5ha.
- It is assumed that the fodderbeet crop has losses of 225kg N/ha and 1.2kgP/ha. This is based on the losses modelled for the applicant under fodderbeet in the current scenario.

Therefore, it can be estimated that the off site effects of wintering the 30 increased rising 1 year olds is:

- 113kgN/year
- 0.6kgP/year

Please note that this estimate of nutrient losses during winter grazing is conservative, ie it is very likely to be overestimating the actual nutrient losses due to the winter feed type (fodder beet) and the intensity of the wintering (25tDM crop yield).

In addition to the winter grazing it is assumed that the additional 30 head of young stock are grass grazed when they aren't on winter crop. The 30 stock would require approximately 12ha of pasture. If this pasture has an N loss of 30kgN/ha and a p loss of 0.6kgP/ha, it can be estimated that the offsite effect of the young stock pasture grazing is:

- 360kgN/year
- 7.2kgP/year

Therefore, it can be estimated that the total offsite effect of the additional young stock is:

- 473kgN/year
- 7.8kgP/year

Note – the estimate above is intended to give an estimate of scale of effect, rather than to suggest any accuracy. There are too many variables that are unknown (including soil type, climate, stocking rate and fertiliser policy) to provide accuracy.

Table 7. Predicted nitrogen and phosphorus losses in the current and proposed system after further mitigations were included, including phosphorus mitigations modelled outside of OverseerFM 6.3.1

	Current system	Proposed system (following further mitigations)	Percentage change in losses
Total Farm N Loss (kg)	11513	10507 (including 126kgN grass baleage and 473kgN young stock adjustments modelled outside of Overseer)	8.7% reduction
N Loss/ha (kgN/ha/yr)	51	47	
N Concentration in Drainage (ppm)		Pastoral – 3 to 19	
Total Farm P Loss (kg)	230 (including 33kg P mitigation modelled outside of Overseer)	212 (including 52kg P laneway mitigation and 7.8kgP young stock adjustment modelled outside of Overseer)	7.8% reduction
P loss/ha (kgP/ha/yr)	1.0	0.9	
OverseerFM - predicted pasture grown (tDM/ha/yr)		16.0 (excluding East Block) 15.6 (East Block)	

Taking into account the further mitigations to the proposed farm system and the adjustment required for modelling the baleage grass wintering system, Overseer predicts that overall nitrogen will decrease by 8.7% and losses of phosphorus will decrease by 7.8%.

Conclusions from the modelling

Table 8. Predicted nitrogen and phosphorus losses in the current and proposed system after further mitigations were included, including phosphorus mitigations modelled outside of OverseerFM 6.3.1

	Current system	Proposed system (following further mitigations)	Percentage change in losses
Total Farm N Loss (kg)	11513	10507 (including 126kgN grass baleage and 473kgN young stock adjustments modelled outside of Overseer)	8.7% reduction
N Loss/ha (kgN/ha/yr)	51	47	
N Concentration in Drainage (ppm)		Pastoral – 3 to 19	
Total Farm P Loss (kg)	230 (including 33kg P mitigation modelled outside of Overseer)	212 (including 52kg P laneway mitigation and 7.8kgP young stock adjustment modelled outside of Overseer)	7.8% reduction
P loss/ha (kgP/ha/yr)	1.0	0.9	
OverseerFM - predicted pasture grown (tDM/ha/yr)		16.0 (excluding East Block) 15.6 (East Block)	

Taking into account the further mitigations to the proposed farm system and the adjustment required for modelling the baleage grass wintering system, Overseer predicts that overall nitrogen will decrease by 8.7% and losses of phosphorus will decrease by 7.8%.

The key drivers of a decrease in nitrogen loss are shown below. In comparison to the current system, the proposed system has:

- Increased the area that effluent is applied to – reduced N application in effluent to this area
- Reduced nitrogen fertiliser use
- Change in the farms culling policy to one of culling earlier
- Lower protein content supplementary feed (Barley)

The key driver of the decrease in phosphorus loss are shown below. In comparison to the current system the proposed has:

- Improved laneway sediment loss mitigations
- A reduction in the Olsen P on the current dairy platform area (although an increase in Olsen P on the East Block)
- Use of Reactive Phosphate Rock fertiliser on the East Block

Appendices:

Appendix 1: Updated detailed description of modelling inputs

Appendix 2: Nutrient budgets taken from OverseerFM

Appendix 3: Overseer modelling report for the purposes of as part of a consent application for expanded dairying, dated October 2018

Appendix 4: Further information: T and J Driscoll Family Trust consent application, December 2018

Appendix 5: T and J Driscoll Family Trust – Farm Maps

Appendix 1: Updated detailed description of modelling inputs

Blocks

The farm has been split into the following pastoral (effluent and non-effluent) and fodder crop blocks. Total farm area has been taken from the legal area (ex the rates demand). The area of each block has been determined using the measure function on Beacon. Soils on the property were assessed utilising the topoclimate information. OverseerFM soil settings were obtained from SMap for all soil types.

Changes from original modelling (dated October 2018) are shown in red. Original modelling inputs are shown in black

Block Name	Soil Type (from Beacon)	Smap Ref	Contour	Current Dairy Platform (ha)	East Block (ha)	Proposed Land Use (ha)
Effluent – Waikiwi	Edendale	Waiki_30a.1	Flat	**20.1**		**41.7 41.1**
Effluent – Pukemutu	Pukemutu	Pukem_6a.1	Flat	**41.9**		**49.9 49.2**
Non Effluent – Waikiwi	Edendale	Waiki_30a.1	Flat	**42.2**		**19.4 19.1**
Non Effluent – Pukemutu	Pukemutu	Pukem_6a.1	Flat	**98.4**		**101.5 86.2**
East Block - Pukemutu	Pukemutu	Pukem_6a.1	Flat		**13.9**	**13.9**
Baleage winter Eff Waikiwi	Edendale	Waiki_30a.1	Flat			**0.8 1.4**
Baleage winter Eff Pukemutu	Pukemutu	Pukem_6a.1	Flat			**0.9 1.6**
Baleage Winter Non Eff Waikiwi	Edendale	Waiki_30a.1	Flat			**0.4 0.7**
Baleage winter Non Eff Pukemutu	Pukemutu	Pukem_6a.1	Flat			**1.9 3.3**
	Effective Farm Area			**202.6**	**13.9**	**216.5**
	Non productive			8.0		8.0
	Total Farm Area			**210.6**	**13.9**	**224.5**
Rotating fodder crops						
Fodder beet				2.8		
Winter Turnips				1.0		

Climate Data

- The following climate information has been used from the OverseerFM climate station tool;
  - 1094mm of rainfall (updated to 1092mm – consistent across all nutrient budgets)
  - 10.1 degrees Celsius mean annual temperature
  - Annual PET of 711mm (updated to 710mm – consistent across all nutrient budgets)

Farm System

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
File name	CURRENT PLATFORM – AUG19	CURRENT – EAST SHEEP AUG19	CURRENT – EAST TRANSITION AUG19	CURRENT – EAST DAIRY SUPPORT AUG19	PROPOSED – AUG19 MITIGATED
Milk solids production	271,130 kg MS 473 kgMS/cow Median calving date – 20th August Drying off – 31st May				329,000kgMS 319,600 kg MS 470 kgMS/cow Median calving date – 20th August Drying off – 31st May
Cows on farm (Lactating and wintered)	Breed Fr J X Jul 140 Aug 599 Sep 593 Oct 573 Nov 573 Dec 573 Jan 573 Feb 573 Mar 573 Apr 530 May 487 Jun 83 Peak cows: 573 *Note: Some cows wintered off farm at a grazier's property* *June – 516* *June – 459*			Breed Fr J X Winter grazing for 100MA (July) and 125R2 cows (Jun and Jul)	Breed Fr J X Jul 273 252 Aug 732 711 Sep 724 702 Oct 700 680 Nov 700 680 Dec 700 680 Jan 700 680 Feb 700 650 Mar 700 620 Apr 647 590 May 595 570 Jun 216 195 Peak cows: 700 Peak cows: 680 *Note: Some cows wintered off farm at a grazier's property* *June – 516* *July – 459* *Note: change in culling policy*

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
Dairy replacements on farm	Calves are reared on farm until weaning (1-4months old) Aug - 135 Sep - 160 Oct - 160 Nov – 160		Grazing for R2 heifers May 125	Grazing for R2 heifers Jan 125 Feb 125	Calves are reared on farm until weaning (1-4months old) Aug - 152 160 Sep - 187 190 Oct - 187 190 Nov – 187 190 Note: error found in original modelling
Breeding bulls	Thirteen 2yr old Jersey bulls (Dec and Jan)				Fifteen 2yr old Jersey bulls (Dec and Jan)
Sheep		Wintered: 120 MA ewes 46replacements 3rams Coopworth 125% lambing percentage 20% replacement rate Mean lambing date of the 15th September. All non-replacement lambs sold by the end of May			
Relative productivity	No differences between blocks	No differences between blocks	No differences between blocks	No differences between blocks	No differences between blocks Relative productivity of East Block Pukemutu 0.97unit due to lower N useage. All other blocks have a relative productivity of 1.

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
Structures	Calving Pad Not modelled as used when ground conditions are saturated rather than for fixed time				Calving Pad Not modelled as used when ground conditions are saturated rather than for fixed time
In Shed Feeding	Management 100% of milkers fed Aug - May				Management 100% of milkers fed Aug – May
Rotating fodder crop management	2.8ha fodder beet Yield: 25tDM/ha Conventional cultivation October Fertiliser: 500kg/ha Winton Fodder Beet mix at sowing (delivering 50kg/ha N, 32kg/ha P, 75kg/ha K and 27kg/ha S) 100kg/ha Urea in December 100kg/ha Potassium Chloride in December 100kg/ha Urea in January Grazed by dairy cows May – Aug Resown in permanent pasture in September				Cows on farm in June/July are wintered on a baleage grass diet. 4ha 7ha Baleage/Grass wintering This area rotates around all blocks except the East Block Pukemutu the platform. This wintering system forms part of the property's regrassing strategy All feed required is imported (160tDM baleage) (150tDM baleage)
	1.0ha Turnips Yield: 8tDM/ha Conventional cultivation February				

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
	Fertiliser: 150kg/ha DAP and 150kg/ha super at sowing 100kg/ha Urea in March Grazed by dairy cows Jun – Aug Resown in permanent pasture in September				
Imported Supplements	In shed: 236t PKE 38t Barley (typo in original modelling) In paddock: 418tDM silage			In paddock: 65 tDM baleage	In shed: 300tDM PKE 40tDM PKE 100tDM barley 400tDM Barley 100tDM DDG In paddock: 850tDM silage (fed over entire platform) 500tDM silage (fed on all bocks except East Block) For wintering: 160tDM baleage 150tDM baleage Supplement harvested on the East block: 140tDM fed out on all blocks except East Block
Exported Supplements			130tDM baleage		
Soil Fertility	Olsen P 32 (soil test results June 2017) All other values entered at agronomic optimum	All soil test values entered at agronomic optimum (Olsen P of 20)	All soil test values entered at agronomic optimum (Olsen P of 20)	All soil test values entered at agronomic optimum (Olsen P of 20)	Olsen P 32 Olsen P 30 All other values entered at agronomic optimum

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
Fertiliser	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels Note: Phosphorus applied as RPR on the East Block
Pastoral Nitrogen Fertiliser	213 kgN/ha in split applications (Aug – April)				Non Effluent blocks (Excluding East Block) 218kgN/ha (203kgN/ha) in split applications (Aug – April) Effluent Blocks 197kgN/ha (183kgN/ha) in split applications (Aug – April) East Block 154kgN/ha in split applications (Sep – Mar)
Drainage	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained
Farm dairy effluent	Holding pond Solids aren't separated from the liquid Liquid effluent is applied at a depth of <12mm to the "effluent" blocks An effluent area of at least 31 ha is required to achieve a loading of less than 150 kg N / ha / year				Holding pond Solids aren't separated from the liquid Liquid effluent is applied at a depth of <12mm to the "effluent" blocks An effluent area of at least 34 (now 32) ha is required to achieve a loading of less than 150 kg N / ha / year

Appendix 2: Nutrient budgets taken from OverseerFM

Report disclaimer:

The OverseerFM 6.3.1 model has been utilised to assess the nutrient losses from this property. Details of how the property is operated currently, and how the property will be operated going forward have been gathered from the farm owner. Where accurate data was unavailable, conservative assumptions have been made using professional judgement.

OverseerFM 6.3.1 predicted results have been extracted from the model on 22 August 2019

Current system - Dairy Platform (File name - CURRENT PLATFORM - AUG19)

Table 9. Current system whole farm nutrient budget

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	11,273	54
Phosphorus	253	1.2

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	201	26	2	25	0	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	80	11	58	9	9	6	4
Rain/clover fixation	74	0	3	5	3	7	35

NUTRIENTS REMOVED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Leached from root zone	54	1.2	12	38	61	6	20
As product	87	15	21	5	19	2	6
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	89	0	0	0	0	0	0

CHANGE IN POOLS (KG/HA/YR)	N	P	K	S	CA	MG	NA
Organic pool	125	19	11	-3	7	3	1
Inorganic mineral	0	2	-23	0	-2	-3	-3
Inorganic soil pool	1	0	43	0	-72	6	15

Table 10. Current system Nitrogen and Phosphorus summary reports

Nitrogen summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	N IN DRAINAGE (PPM)	N ADDED (KG/HA)	N SURPLUS (KG/HA)
PUKEMUTU EFFLUENT	2474	60	13	287	273
PUKEMUTU NON EFFLUENT	4850	50	11	211	220
WAIKIWI EFFLUENT	1007	51	12	287	265
WAIKIWI NON EFFLUENT	1793	43	10	211	213
FODDER BEET	630	225	42	142	21
TURNIPS	111	111	21	72	2

Phosphorus summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)
PUKEMUTU EFFLUENT	40	1
PUKEMUTU NON EFFLUENT	79	0.8
WAIKIWI EFFLUENT	9	0.5
WAIKIWI NON EFFLUENT	17	0.4
FODDER BEET	3	1.2
TURNIPS	1	1.1

Current system – East Block sheep (File name - CURRENT - EAST SHEEP AUG19)

Table 11. East Block – Sheep whole farm nutrient budget

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	203	14
Phosphorus	10	0.7

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	0	16	0	24	0	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	0	0	0	0	0	0	0
Rain/clover fixation	96	0	3	5	3	7	34

NUTRIENTS REMOVED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Leached from root zone	14	0.7	7	34	33	6	19
As product	20	3	1	3	5	0	1
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	37	0	0	0	0	0	0

CHANGE IN POOLS (KG/HA/YR)	N	P	K	S	CA	MG	NA
Organic pool	25	11	0	-8	0	0	0
Inorganic mineral	0	0	-25	0	-2	-3	-4
Inorganic soil pool	0	2	19	0	-33	4	18

Table 12. East Block - sheep nitrogen and phosphorus summary reports

Nitrogen summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	N IN DRAINAGE (PPM)	N ADDED (KG/HA)	N SURPLUS (KG/HA)
EAST BLOCK - PUKEMUTU	199	14	3	0	74

Phosphorus summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)
EAST BLOCK - PUKEMUTU	9	0.6

East Block – Transition (file name CURRENT - EAST TRANSITION AUG19)

Table 8. East Block – Transition whole farm nutrient budget

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	132	9
Phosphorus	9	0.7

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	0	36	203	33	0	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	0	0	0	0	0	0	0
Rain/clover fixation	150	0	3	5	3	7	34

NUTRIENTS REMOVED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Leached from root zone	9	0.7	15	29	29	6	19
As product	0	0	0	0	0	0	0
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	4	0	0	0	0	0	0

CHANGE IN POOLS (KG/HA/YR)	N	P	K	S	CA	MG	NA
Organic pool	-23	11	6	-8	1	0	0
Inorganic mineral	0	0	-22	0	-2	-3	-4
Inorganic soil pool	0	0	6	0	-71	-7	10

Table 9. East Block - transition nitrogen and Phosphorus summary reports

Nitrogen summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	N IN DRAINAGE (PPM)	N ADDED (KG/HA)	N SURPLUS (KG/HA)
EAST BLOCK - PUKEMUTU	132	9	2	0	-15

Phosphorus summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)
EAST BLOCK - PUKEMUTU	9	0.7

East Block – Dairy support (file name - CURRENT - EAST DAIRY SUPPORT AUG19)

Table 11. East Block – Dairy support whole farm nutrient budget

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	385	27
Phosphorus	10	0.7

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	0	1	0	11	0	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	0	0	0	0	0	0	0
Rain/clover fixation	80	0	3	5	3	7	34
NUTRIENTS REMOVED (KG/HA/YR)	**N**	**P**	**K**	**S**	**CA**	**MG**	**NA**
Leached from root zone	27	0.7	9	33	43	6	19
As product	9	2	1	1	5	0	0
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	39	0	0	0	0	0	0
CHANGE IN POOLS (KG/HA/YR)	**N**	**P**	**K**	**S**	**CA**	**MG**	**NA**
Organic pool	78	12	4	-7	1	0	0
Inorganic mineral	0	0	-16	0	-2	-3	-4
Inorganic soil pool	0	0	98	0	-20	12	25

Table 12. East Block – Dairy support nitrogen and phosphorus summary reports

Nitrogen summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	N IN DRAINAGE (PPM)	N ADDED (KG/HA)	N SURPLUS (KG/HA)
EAST BLOCK - PUKEMUTU	381	27	6	0	139

Phosphorus summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)
EAST BLOCK - PUKEMUTU	8	0.6

Proposed system – (file name - PROPOSED - AUG19 MITIGATED)

Table 14. Proposed system whole farm nutrient budget

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	9,908	44
Phosphorus	256	1.1

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	185	22	15	25	8	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	104	14	71	9	15	7	5
Rain/clover fixation	71	0	3	5	3	7	35

NUTRIENTS REMOVED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Leached from root zone	44	1.1	13	39	54	6	20
As product	96	16	23	5	21	2	7
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	84	0	0	0	0	0	0

CHANGE IN POOLS (KG/HA/YR)	N	P	K	S	CA	MG	NA
Organic pool	136	18	13	-5	8	3	1
Inorganic mineral	0	2	-19	0	-2	-3	-3
Inorganic soil pool	0	0	58	0	-54	6	16

Table15. Proposed system nitrogen and phosphorus summary reports

Nitrogen summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	N IN DRAINAGE (PPM)	N ADDED (KG/HA)	N SURPLUS (KG/HA)
BALEAGE WINTER - PUKEMUTU EFF	140	88	19	234	396
BALEAGE WINTER - PUKEMUTU NON EFF	277	84	19	203	368
BALEAGE WINTER - WAIKIWI NON EFF	47	67	16	203	340
BALEAGE WINTER - WAIKIWI EFF	103	74	17	234	382
EAST BLOCK - PUKEMUTU	183	13	3	154	61
PUKEMUTU EFFLUENT	2408	49	11	234	249
PUKEMUTU NON EFFLUENT	3903	45	10	203	218
WAIKIWI EFFLUENT	1700	41	9	234	244
WAIKIWI NON EFFLUENT	719	38	9	203	205

Phosphorus summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)
BALEAGE WINTER - PUKEMUTU EFF	1	0.8
BALEAGE WINTER - PUKEMUTU NON EFF	2	0.7
BALEAGE WINTER - WAIKIWI NON EFF	0	0.4
BALEAGE WINTER - WAIKIWI EFF	1	0.4
EAST BLOCK - PUKEMUTU	10	0.7
PUKEMUTU EFFLUENT	43	0.9
PUKEMUTU NON EFFLUENT	67	0.8
WAIKIWI EFFLUENT	18	0.4
WAIKIWI NON EFFLUENT	8	0.4

Appendix 3: Overseer modelling report for the purposes of as part of a consent application for expanded dairying, dated October 2018

Report disclaimer:
The OverseerFM 6.3.1 model has been utilised to assess the nutrient losses from this property. Details of how the property is operated currently, and how the property will be operated going forward have been gathered from the farm owner. Where accurate data was unavailable, conservative assumptions have been made using professional judgement.

OverseerFM 6.3.1 predicted results have been extracted from the model on 22 August 2019

T & J Driscoll Family Trust

266 O'Shannessy Road, Winton

Overseer modelling report for the purposes of as part of a consent application for expanded dairying

Report prepared for:
Tim and Jocelyn Driscoll
266 Thomsons Crossing Road East
RD1, Winton

Prepared By:
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1 October 2018

Report Peer Reviewed By:
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B.Agr.Sci

Executive Summary

T & J Driscoll Family Trust operate a high performance dairy farm near Winton, in Central Southland. The partially self-contained 210.6ha total property has a flat contour. There are two soil types on the property – Waikiwi and Pukemutu, separated by a small terrace. Calves are grazed on the platform until weaning and return to the platform as incalf heifers. Over the past three years, an average of 2.8ha of fodder beet and 1ha of winter turnips were planted. The farm has peak milked 573cows on average over the last three seasons.

In October 2016, Tim and Jocelyn purchased a neighbouring 13.9ha sheep grazing block – called the East Block. Following the purchase of the block, Tim and Jocelyn have transitioned the block into dairy support. It is proposed that the East Block (13.9ha) be converted to dairy and incorporated into the milking platform. In the proposed farm system, a portion of the herd will be wintered on 4ha with a baleage and grass diet. Young stock will continue to be grazed off farm from weaning to their return as incalf heifers.

Using Overseer (version 6.3.0) nutrient budgets have been constructed for the current land use and a proposed dairy unit nutrient budget to inform the consent application for expanded dairying. The nutrient budgets show the average nutrient losses for the last three years. Data inputs and methodology are explained in detail within this report.

A summary of the modelling output is given in Table 1. It shows a small decrease (loss than 5%) in the total Nitrogen loss from the property. Total Phosphorus loss from the property is predicted to increase (by less than 7%).

Table 13. Summary data from the Overseer analysis of the T & J Driscoll Family Trust Current and Proposed systems

	Current Total (averaged over 3 years)	Proposed system
Total Farm N Loss (kg)	11503	11345
N Loss/ha (kgN/ha/yr)	51	51
N Concentration in Drainage (ppm)		Pastoral – 9.8 – 29.3
Total Farm P Loss (kg)	262	278
P loss/ha (kgP/ha/yr)	1.2	1.2
Overseer - predicted pasture grown (tDM/ha/yr)		16.2

The key drivers of a decrease in nitrogen loss are shown below. In comparison to the current system, the proposed system has:

- Increased the area that effluent is applied to – reduced effluent N application to this area
- Reduced nitrogen fertiliser use on the effluent block
  Increased cow numbers – increasing loss risk

The key driver of the increase in phosphorus loss is an increase in losses from “other sources”.

Overseer can model a range of good management practices. However, some farm specific good management practices cannot be modelled. Recommendations of further good management practices that cannot be modelled by Overseer are given within this report to further reduce the nutrient losses from this farm system.

Property legal description

Part Section 29 and 30 Block I Winton HUN

Section 1 and 2 SO 12000

Section 43, 44, 45 and 54 Block I Winton HUN

Lot 1 and 2 DP 449518

Report purpose

To quantify the losses of nitrogen and phosphorus from the current and the proposed farm systems being operated on this property. The report details the data inputs, the modelling outputs and areas of environmental risk within the system.

Disclaimer

The Overseer 6.3.0 model has been utilised to assess the nutrient losses from this property. Details of how the property is operated currently, and how the property will be operated going forward have been gathered from the farm owner. Where accurate data was unavailable, conservative assumptions have been made using professional judgement.

The proposal

Farm objectives

T & J Driscoll Family Trust operate their farm business with the following objectives:

- To refine the farm system to maximise farm profitability – targeting $2000/ha EBIT at a $5.00 milk price
- To operate in an environmentally sustainable manner with an emphasis on continual education and improvement
- Consolidate the business to ensure it is resilient
- "Farm for the future" – the property must remain flexible to deal with changes in market forces

Current System

Nutrient budgets have been constructed to determine the average actual nutrient losses over three years (June 2015 – May 2018).

Dairy platform

T & J Driscoll Family Trust operate a high performing dairy farm near Winton, in Central Southland. The farm is owned by the Driscoll trust (JP, CA, TJ and JA Driscoll), and is operated under a lease arrangement by T & J Driscoll Family Trust (Tim and Jocelyn Driscoll). The partially self-contained 210.6ha total property has a flat contour. There are two soil types on the property – Waikiwi and Pukemutu. Calves are grazed on the platform until weaning and return to the platform as incalf heifers.

Over the previous three seasons, the property has milked an average of 573cows at peak. There has been an average of 2.8ha fodder beet and 1ha turnips grown on farm for winter and early spring grazing. Nitrogen fertiliser has been applied at an average of 213kgN/ha in split applications from August to April over the whole milking platform. In the last three seasons, the majority of the herd has been wintered off farm at a graziers property. On average, 83 cows were wintered at home in June and July, while the remaining 516 were off farm. Early calving heifers and cows return to the platform in mid July. Bought in feed has been assumed to ensure that a feasible pasture growth rate is achieved in an average season.

East Block

In October 2016, Tim and Jocelyn purchased a neighbouring 13.9ha sheep grazing block – called the East Block. Following the purchase of the block, Tim and Jocelyn have transitioned the block into dairy support. In order to create accurate actual budgets for the previous three years, three separate budgets have been created for the East Block:

- Pre purchase use (15-16 season) – a sheep grazing block. Accurate stock numbers were not available. A conservative estimation of stocking rate and management practice has been made utilising Google Earth imaging and the Beef and Lamb farm monitoring data.
- Transition (16-17 season) – All feed grown on farm was cut as baleage. This was fed to incalf heifers or exported from the block.

- Dairy support (17-18 season) – 125incalf heifers and 100cows were wintered on a baleage/grass diet on the block. The block was grazed by heifers in January and February of 2018. All other feed grown was made into baleage.

Proposed system:

Through the development of the proposed system, a number of scenarios were run through Overseer. The proposed system detailed below was chosen as it was in line with the farm objectives, the farm system preferences and the proposed Water and Land Plan.

It is proposed that the East Block (13.9ha) be converted and incorporated into the milking platform. The total farm area would then be 224.5ha total and peak cow numbers would be increased to 700 cows. The property will winter 216cows on farm, and continue to winter the remaining 516cows off farm at a graziers property. The cows wintered on farm will be grazed of 4ha with a baleage grass diet. Young stock will continue to be grazed off farm from weaning to their return as incalf heifers. The effluent system will be extended to 93.3ha and fertiliser nitrogen applications will be targeted to 197kgN/ha on the effluent area and 218kgN/ha on the non-effluent area. Bought in feed has been assumed to ensure that a feasible pasture growth rate is achieved in an average season when consented cow numbers are being milked.

Modelling method

Nutrient losses have been estimated using the Overseer Version 6.3.0 model. Overseer is a software application that models nutrient movements within a farm system. Input data detailing the farm system is entered into the software and interpreted through the use of a series of sub-model that calculate the flow of seven major farm nutrients (Nitrogen, Phosphorus, Sulphur, Calcium, Magnesium and Sodium). Output data is reported for interpretation and to inform farm management practices. It currently requires an expert user to describe the physical and management details of a farm.

Overseer assumptions

Within the Overseer software, assumptions have been made of the farm management:

- Long term annual average model
  The model uses annual average input and produces annual average outputs
- Near equilibrium conditions
  Model assumes that that the farm is at a state where there is minimal change each year
- Actual and reasonable inputs
  It is assumed that input data is reasonable and a reflection of the actual farm system. If any parameter changes, it is assumed that all other parameters affected will also be changed.
- Good management practices are followed
  Overseer assumes the property is managed is line with accepted industry good management practice.

Overseer limitations

Key limitations of the Overseer model are:

- Overseer does not predict transformations, attenuation or dilution of nutrients between the root zone or farm boundary and the eventual receiving water body. A catchment model is needed to estimate the effects of the nutrient losses from farms on groundwater, river or lake water quality.
- Overseer does not calculate outcomes from extreme events (floods and droughts), but provides a typical years result based on a long-term average.
- Overseer does not calculate the impacts of a conversion process, rather it predicts the long-term annual average nutrient budgets for changed land use.
- Overseer is not spatially explicit beyond the level of defined blocks
- Not all management practices or activities that have an impact on nutrient losses are captured in the Overseer model
- Overseer does not represent all farm systems in New Zealand
- Components of Overseer have not been calibrated against measured data from every combination of farm systems and environment

Information on Overseer can be obtained from the following reports:

- Technical Description of OVERSEER for Regional Councils, September 2015
- Review of the phosphorus loss submodel in OVERSEER®, September 2016
- Using OVERSEER® in Regulation – Technical Resources and Guidance for Regional Councils, August 2016

Data input standards

Nutrient budgets have been constructed using the Overseer Version 6.3.0 model.

The nutrient budget have been developed in accordance with the Overseer data input protocols - “Overseer, Best Practice Data Input Standards, March 2018.” No deviations have been made from these protocols.

Modelling Inputs

To construct the nutrient budgets the following assumptions have been made;

Blocks

The farm has been split into the following pastoral (effluent and non-effluent) and fodder crop blocks. Total farm area has been taken from the legal area (ex the rates demand). The area of each block has been determined using the measure function on Beacon. Soils on the property were assessed utilising the topoclimate information. Overseer soil settings were obtained from SMap for all soil types.

Block Name	Soil Type (from Beacon)	Smap Ref	Contour	Current Dairy Platform (ha)	East Block (ha)	Proposed Land Use (ha)
Effluent – Waikiwi	Edendale	Waiki_30a.1	Flat	**20.1**		**41.7**
Effluent – Pukemutu	Pukemutu	Pukem_6a.1	Flat	**41.9**		**49.9**
Non Effluent – Waikiwi	Edendale	Waiki_30a.1	Flat	**42.2**		**19.4**
Non Effluent – Pukemutu	Pukemutu	Pukem_6a.1	Flat	**98.4**		**101.5**
East Block - Pukemutu	Pukemutu	Pukem_6a.1	Flat		**13.9**	
Baleage winter Eff Waikiwi	Edendale	Waiki_30a.1	Flat			**0.8**
Baleage winter Eff Pukemutu	Pukemutu	Pukem_6a.1	Flat			**0.9**
Baleage Winter Non Eff Waikiwi	Edendale	Waiki_30a.1	Flat			**0.4**
Baleage winter Non Eff Pukemutu	Pukemutu	Pukem_6a.1	Flat			**1.9**
	Effective Farm Area			**202.6**	**13.9**	**216.5**
	Non productive			8.0		8.0
	Total Farm Area			**210.6**	**13.9**	**224.5**
Rotating fodder crops						
Fodder beet				2.8		
Winter Turnips				1.0		

Climate Data

- Southland as the location setting
- The following climate information has been used from the Overseer climate station tool;
    - 1094mm of rainfall
    - 10.1 degrees Celsius mean annual temperature
    - Daily rainfall pattern setting of 731 to 1450mm, low
    - Mean annual PET of 711mm (moderate variation)

Farm System

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
Milk solids production	271,130 kg MS 473 kgMS/cow Median calving date – 20th August Drying off – 31st May				329,000 kg MS 470 kgMS/cow Median calving date – 20th August Drying off – 31st May
Cows on farm (Lactating and wintered)	Breed Fr J X Jul 140 Aug 599 Sep 593 Oct 573 Nov 573 Dec 573 Jan 573 Feb 573 Mar 573 Apr 530 May 487 Jun 83 Peak cows: 573			Breed Fr J X Winter grazing for 100MA and 125R2 cows (Jun and Jul)	Breed Fr J X Jul 273 Aug 732 Sep 724 Oct 700 Nov 700 Dec 700 Jan 700 Feb 700 Mar 700 Apr 647 May 595 Jun 216 Peak cows: 700
Dairy replacements on farm	Calves are reared on farm until weaning (1-4months old) Aug - 135 Sep - 160 Oct - 160 Nov – 160		Grazing for R2 heifers May 125	Grazing for R2 heifers Jan 125 Feb 125	Calves are reared on farm until weaning (1-4months old) Aug - 152 Sep - 187 Oct - 187 Nov – 187
Breeding bulls	Thirteen 2yr old Jersey bulls (Dec and Jan)				Fifteen 2yr old Jersey bulls (Dec and Jan)
Sheep		Wintered: 120 MA ewes 46replacements 3rams Coopworth 125% lambing percentage 20% replacement rate			

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
		Mean lambing date of the 15th September. All non-replacement lambs sold by the end of May			
Relative productivity	No differences between blocks	No differences between blocks	No differences between blocks	No differences between blocks	No differences between blocks
Structures	Calving Pad Not modelled as used when ground conditions are saturated rather than for fixed time				Calving Pad Not modelled as used when ground conditions are saturated rather than for fixed time
In Shed Feeding	Management 100% of milkers fed Aug - May				Management 100% of milkers fed Aug - May
Rotating fodder crop management	2.8ha fodder beet Yield: 25tDM/ha Conventional cultivation October Fertiliser: 500kg/ha Winton Fodder Beet mix at sowing (delivering 50kg/ha N, 32kg/ha P, 75kg/ha K and 27kg/ha S) 100kg/ha Urea in December 100kg/ha Potassium Chloride in December 100kg/ha Urea in January Grazed by dairy cows May – Aug				Cows on farm in June/July are wintered on a baleage grass diet. 4ha Baleage/Grass wintering This area rotates around the platform and is part of the property's regrassing strategy All feed required is imported (160tDM baleage)

Description	**Current Dairy Platform (average of three seasons)**	**East Block – Sheep (15-16 season)**	**East Block – Transition (16-17season)**	**East Block – Dairy Support (17-18season)**	**Proposed Land Use**
	Resown in permanent pasture in September				
	1.0ha Turnips Yield: 8tDM/ha Conventional cultivation February Fertiliser: 150kg/ha DAP and 150kg/ha super at sowing 100kg/ha Urea in March Grazed by dairy cows Jun – Aug Resown in permanent pasture in September				
Imported Supplements	In shed: 236tDM PKE 33tDM Barley In paddock: 418tDM Silage			In paddock: 65 tDM baleage	In shed: 300tDM PKE 100tDM Barley 100tDM DDG In paddock: 850tDM baleage For wintering: 160tDM baleage
Exported Supplements			130tDM baleage		
Soil Fertility	Olsen P 32 (soil test results June 2017) All other values entered at agronomic optimum	All soil test values entered at agronomic optimum (Olsen P of 20)	All soil test values entered at agronomic optimum (Olsen P of 20)	All soil test values entered at agronomic optimum (Olsen P of 20)	Olsen P 32 (soil test results June 2017) All other values entered at agronomic optimum

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
Fertiliser	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels
Nitrogen Fertiliser	213 kgN/ha in split applications (Aug – April)				Non Effluent blocks 218kgN/ha in split applications (Aug – April) Effluent Blocks 197kgN/ha in split applications (Aug – April)
Drainage	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained
Farm dairy effluent	Holding pond Solids aren't separated from the liquid Liquid effluent is applied at a depth of <12mm to the "effluent" blocks An effluent area of at least 39 ha is required to achieve a loading of less than 150 kg N / ha / year				Holding pond Solids aren't separated from the liquid Liquid effluent is applied at a depth of <12mm to the "effluent" blocks An effluent area of at least 34 ha is required to achieve a loading of less than 150 kg N / ha / year

Predicted Overseer Results

Current land use

	Current Dairy Platform (3yr average)	East Block – Sheep (15-16 season)	East Block – Transition (16-17 season)	East Block – Dairy Support (17-18 season)	East block (average of 3yrs)	Current Total (averaged over 3 years)
Total Farm N Loss (kg)	11262	204	132	386	241	11503
N Loss/ha (kgN/ha/yr)	53	15	10	28	17	51

N Concentration in Drainage (ppm)	Pastoral – 9.9 to 12.8 Crops – 21.1 to 42.1	Pastoral – 3.2	Pastoral – 2.1	Pastoral - 6.1		
Total Farm P Loss (kg)	252	10	9	10	10	262
P loss/ha (kgP/ha/yr)	1.2	0.7	0.7	0.7	0.7	1.2
Overseer - predicted pasture grown (tDM/ha/yr)	16.2	11.8	11.8	11.9		

Proposed system

	Current Total (averaged over 3 years)	Proposed system
Total Farm N Loss (kg)	11503	11345
N Loss/ha (kgN/ha/yr)	51	51
N Concentration in Drainage (ppm)		Pastoral – 9.8 – 29.3
Total Farm P Loss (kg)	262	278
P loss/ha (kgP/ha/yr)	1.2	1.2
Overseer - predicted pasture grown (tDM/ha/yr)		16.2

Conclusions from the modelling

Nutrient budgets have been developed for Driscoll Dairy. These budgets compare the nutrient loss of the current farm system with the proposed farm system. Overseer has predicted that losses of nitrogen will decrease slightly (less than 5%) and losses of phosphorus will increase slightly (less than 7%).

The key drivers of a decrease in nitrogen loss are shown below. In comparison to the current system, the proposed system has:

- Increased the area that effluent is applied to – reduced N application in effluent to this area
- Reduced nitrogen fertiliser use on the effluent block
- Increased cow numbers – increasing loss risk
-

The key driver of the increase in phosphorus loss is an increase in losses from "other sources".

Please note: Losses from "other sources" include predicted losses from laneways, calving pads and yards. The increase in losses from other sources is a result of an increase in animal excretion onto laneways. Overseer estimates amount of excreta and assumes all P ends up in dung. Some of this dung is assumed to fall on laneways and 30% of that P is assumed to be lost from the farm. Furthermore, Overseer is not spatially explicit; so it does not take into account critical source area on farms. These critical source areas accumulate overland flow from adjacent areas and deliver overland flow to surface water bodies. On farms where there is not a direct connection (or a less connection) via critical source areas, or where management mitigates risk, Overseer cannot model the impact of these at an individual farm scale.

Recommendations:

Apart from the system changes outlined above, the following recommendations are given to reduce the nutrient losses from this farm system.

Overseer can model a range of good management practices. However, some farm specific good management practices cannot be modelled. It is recommended that the following good management practices are implemented on this property:

- Fertiliser is applied at the correct rate, and is not applied in close proximity to waterways
- Identify and manage critical source areas to reduce the risk of losses. These include loses from laneways, gateways and high traffic zones.
- Stand cows off on the calving pad during periods of high soil moisture content to minimise soil damage and leaching risk.
- Fertiliser applications are made during periods of plant growth.
- An effluent management plan is in place that takes into account soil moisture and temperature, and includes a fail safe system

The nutrient budgets within this report have been developed assuming that the Olsen P is 32 and all other soil fertility measures are at the agronomic optimum. It also assumes that fertiliser is applied at a maintenance rate. A soil testing regime should be implemented and fertiliser recommendations should be developed in line with these soil testing results.

The proposed Southland Water and Land Plan is currently in process. It will be important to stay up to date with developments in Environment Southland policy and rules, including the Limit Setting Process which will develop over the next few years

A farm environmental management plan detailing the recommendations within this report should be developed for the property.

Current system - Dairy Platform

Table 14. Current system whole farm nutrient budget

(kg/ha/yr)	N	P	K	S	Ca	Mg	Na
Nutrients added							
Fertiliser, lime & other	201	24	2	34	0	0	0
Rain/clover N fixation	74	0	3	5	3	7	35
Irrigation	0	0	0	0	0	0	0
Supplements	80	11	58	9	9	6	4
Nutrients removed							
As products	87	15	21	5	19	2	6
Exported effluent	0	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0
To atmosphere	89	0	0	0	0	0	0
To water	53	1.2	12	46	61	6	20
Change in farm pools							
Plant Material	0	0	-2	0	0	0	0
Organic pool	125	19	11	-3	7	3	1
Inorganic mineral	0	2	-23	0	-2	-3	-3
Inorganic soil pool	1	-2	43	0	-72	6	15

Table 15. Current system Nitrogen report

Block name	Total N lost kg N/yr	N lost to water kg N/ha/yr	N in drainage * ppm	N surplus kg N/ha/yr	Added N ** kg N/ha/yr
Waikiwi Effluent	1,003	51	**11.4**	264	285
Pukemutu Effluent	2,464	60	**12.8**	272	285
Waikiwi non effluent	1,793	43	9.9	213	211
Pukemutu non effluent	4,850	50	11.2	220	211
Fodder Beet	630	225	**42.1**	21	142
Turnips	111	111	**21.1**	2	72
Other sources	410				
Whole farm	11,262	53			
Less N removed in wetland	0				
Farm output	11,262	53			

Table 16. Current system Phosphorus report

Block name	Total P lost kg P/yr	P lost to water kg P/ha/yr	P loss categories		
			Soil	Fertiliser	Effluent
Waikiwi Effluent	9	0.5	Low	Low	Low
Pukemutu Effluent	39	0.9	Medium	Low	Medium
Waikiwi non effluent	17	0.4	Low	Low	N/A
Pukemutu non effluent	79	0.8	Medium	Low	N/A
Fodder Beet	3	1.2	N/A	N/A	N/A
Turnips	1	1.1	N/A	N/A	N/A
Other sources	104				
Whole farm	252	1.2			

East Block – Sheep

Table 17. East Block – Sheep whole farm nutrient budget

(kg/ha/yr)	N	P	K	S	Ca	Mg	Na
Nutrients added							
Fertiliser, lime & other	0	16	0	24	0	0	0
Rain/clover N fixation	97	0	3	5	3	7	35
Irrigation	0	0	0	0	0	0	0
Nutrients removed							
As products	20	3	1	3	5	0	1
Exported effluent	0	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0
To atmosphere	37	0	0	0	0	0	0
To water	15	0.7	7	35	33	6	19
Change in farm pools							
Plant Material	0	0	0	0	0	0	0
Organic pool	25	11	0	-8	0	0	0
Inorganic mineral	0	0	-25	0	-2	-3	-4
Inorganic soil pool	0	2	19	0	-33	4	18

Table 18. East Block - sheep nitrogen report

Block name	Total N lost kg N/yr	N lost to water kg N/ha/yr	N in drainage * ppm	N surplus kg N/ha/yr	Added N ** kg N/ha/yr
East block - Pukemutu	200	14	3.2	74	0
Other sources	4				
Whole farm	204	15			
Less N removed in wetland	0				
Farm output	204	15			

Table 19. East Block - Sheep phosphorus report

Block name	Total P lost kg P/yr	P lost to water kg P/ha/yr	P loss categories		
			Soil	Fertiliser	Effluent
East block - Pukemutu	9	0.6	Low	Low	N/A
Other sources	1				
Whole farm	10	0.7			

East Block – Transition

Table 8. East Block – Transition whole farm nutrient budget

(kg/ha/yr)	N	P	K	S	Ca	Mg	Na
Nutrients added							
Fertiliser, lime & other	0	36	204	33	0	0	0
Rain/clover N fixation	152	0	3	5	3	7	35
Irrigation	0	0	0	0	0	0	0
Nutrients removed							
As products	0	0	0	0	0	0	0
Exported effluent	0	0	0	0	0	0	0
As supplements and crop residues	162	24	203	17	46	11	9
To atmosphere	4	0	0	0	0	0	0
To water	10	0.7	15	30	29	6	19
Change in farm pools							
Plant Material	0	0	0	0	0	0	0
Organic pool	-24	12	6	-8	1	0	0
Inorganic mineral	0	0	-22	0	-2	-3	-4
Inorganic soil pool	0	0	5	0	-72	-7	10

Table 9. East Block - transition nitrogen report

Block name	Total N lost kg N/yr	N lost to water kg N/ha/yr	N in drainage * ppm	N surplus kg N/ha/yr	Added N ** kg N/ha/yr
East block - Pukemutu	132	9	2.1	-15	0
Other sources	1				
Whole farm	132	10			
Less N removed in wetland	0				
Farm output	132	10			

Table 10. East Block - Transition phosphorus report

Block name	Total P lost kg P/yr	P lost to water kg P/ha/yr	P loss categories		
			Soil	Fertiliser	Effluent
East block - Pukemutu	9	0.7	Low	Low	N/A
Other sources	0				
Whole farm	9	0.7			

East Block – Dairy support

Table 11. East Block – Dairy support whole farm nutrient budget

(kg/ha/yr)	N	P	K	S	Ca	Mg	Na
Nutrients added							
Fertiliser, lime & other	0	0	0	8	0	0	0
Rain/clover N fixation	81	0	3	5	3	7	35
Irrigation	0	0	0	0	0	0	0
Nutrients removed							
As products	9	2	1	1	5	0	0
Exported effluent	0	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0
To atmosphere	40	0	0	0	0	0	0
To water	28	0.7	9	30	43	6	19
Change in farm pools							
Plant Material	-75	-14	-94	-11	-23	-8	-7
Organic pool	79	12	4	-7	1	0	0
Inorganic mineral	0	0	-16	0	-2	-3	-4
Inorganic soil pool	0	-1	98	0	-21	12	25

Table 12. East Block – Dairy support nitrogen report

Block name	Total N lost kg N/yr	N lost to water kg N/ha/yr	N in drainage * ppm	N surplus kg N/ha/yr	Added N ** kg N/ha/yr
East block - Pukemutu	381	27	6.1	139	0
Other sources	5				
Whole farm	386	28			
Less N removed in wetland	0				
Farm output	386	28			

Table 13. East Block – Dairy support phosphorus report

Block name	Total P lost kg P/yr	P lost to water kg P/ha/yr	P loss categories		
			Soil	Fertiliser	Effluent
East block - Pukemutu	8	0.6	Low	N/A	N/A
Other sources	2				
Whole farm	10	0.7			

Proposed system

Table 14. Proposed system whole farm nutrient budget

(kg/ha/yr)	N	P	K	S	Ca	Mg	Na
Nutrients added							
Fertiliser, lime & other	199	21	0	30	0	0	0
Rain/clover N fixation	73	0	3	5	3	7	35
Irrigation	0	0	0	0	0	0	0
Supplements	103	21	97	16	22	11	7
Nutrients removed							
As products	99	17	24	5	21	2	7
Exported effluent	0	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0
To atmosphere	87	0	0	0	0	0	0
To water	51	1.2	13	49	59	6	20
Change in farm pools							
Plant Material	0	0	0	0	0	0	0
Organic pool	138	20	15	-3	8	4	1
Inorganic mineral	0	2	-19	0	-2	-3	-3
Inorganic soil pool	0	2	67	0	-62	9	17

Table15. Proposed system nitrogen report

Block name	Total N lost kg N/yr	N lost to water kg N/ha/yr	N in drainage * ppm	N surplus kg N/ha/yr	Added N ** kg N/ha/yr
Waikiwi Effluent	1,887	45	10.2	241	249
Pukemutu Effluent	2,662	53	**11.5**	249	249
Waikiwi non effluent	830	43	9.8	210	215
Pukemutu non effluent	5,030	50	11.1	217	215
Baleage winter - waikiwi Eff	88	111	**25.2**	506	249
Baleage winter - Pukemutu Eff	120	133	**29.3**	530	249
Baleage winter - Waikiwi Non Eff	40	99	**22.6**	451	215
Baleage winter - Pukemutu Non Eff	240	126	**28.3**	498	215
Other sources	449				
Whole farm	11,345	51			
Less N removed in wetland	0				
Farm output	11,345	51			

Table 20. Proposed system phosphorus report

Block name	Total P lost	P lost to water	P loss categories		
	kg P/yr	kg P/ha/yr	Soil	Fertiliser	Effluent
Waikiwi Effluent	19	0.5	Low	Low	Low
Pukemutu Effluent	46	0.9	Medium	Low	Medium
Waikiwi non effluent	8	0.4	Low	Low	N/A
Pukemutu non effluent	82	0.8	Medium	Low	N/A
Baleage winter - waikiwi Eff	0	0.5	Low	Low	Low
Baleage winter - Pukemutu Eff	1	0.9	Medium	Low	Medium
Baleage winter - Waikiwi Non Eff	0	0.4	Low	Low	N/A
Baleage winter - Pukemutu Non Eff	2	0.8	Medium	Low	N/A
Other sources	121				
Whole farm	278	1.2			

Farm Map

Figure 1. Driscolls farm map showing the current and proposed effluent areas

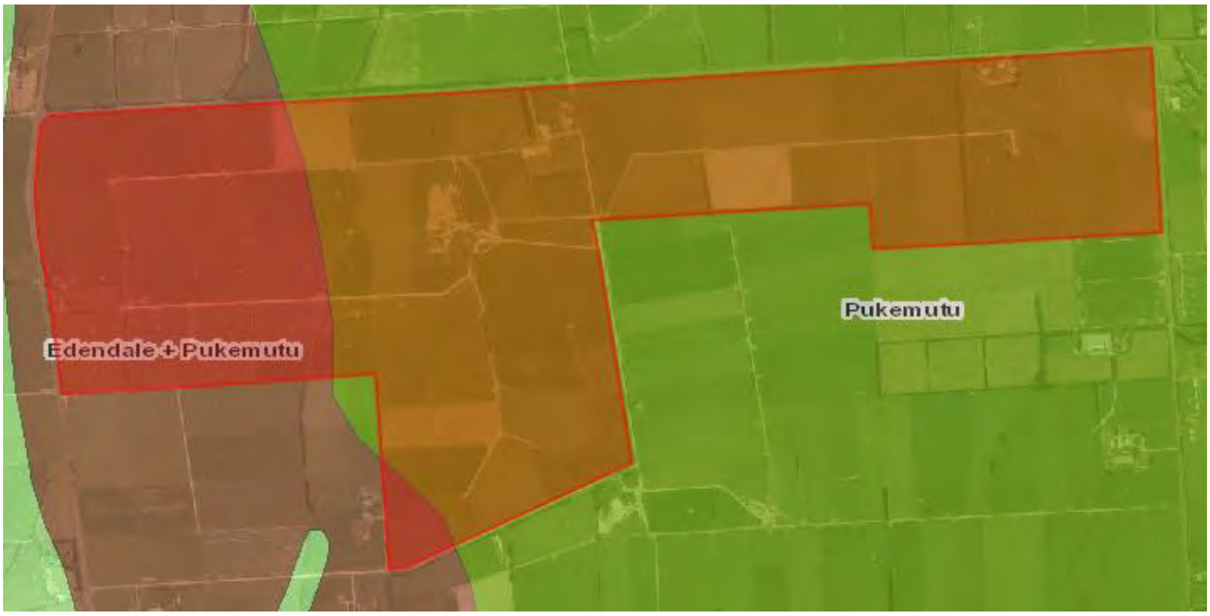

Figure 2. Driscolls farm map showing the soil types on farm

Report disclaimer:
The OverseerFM 6.3.1 model has been utilised to assess the nutrient losses from this property. Details of how the property is operated currently, and how the property will be operated going forward have been gathered from the farm owner. Where accurate data was unavailable, conservative assumptions have been made using professional judgement.

OverseerFM 6.3.1 predicted results have been extracted from the model on 22 August 2019

Appendix 4: Further information: T and J Driscoll Family Trust consent application, December 2018

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Further information: T and J Driscoll Family Trust consent application

Please find below a file note in relation to Overseer modelling completed for the T and J Driscoll Family Trust. This file note is intended to be read alongside the Overseer Modelling Report, dated 1st October, 2018.

Executive summary

An application for consent to use land for dairying was made by the T and J Driscoll Family Trust in October 2018. This application utilised Overseer data to quantify predicted losses of nitrogen and phosphorus from the current and proposed systems. Environment Southland has raised concern that the predicted P losses using Overseer are higher in the proposed system than the current system. However, there are a range of P loss mitigations that are not accounted for, or are not fully accounted for, in Overseer. This file note seeks to quantitatively estimate the difference in P loss between the current and proposed systems using both Overseer and the results of recent New Zealand research.

Overseer has predicted the following total P loss:

Current situation	262 kg P/yr
Proposed situation	278 kg P/yr
Difference	**16 kg P/yr increase**

The Overseer model has a reasonable degree of calibration and evaluation/validation within the nitrogen leaching sub-model. However, the P loss sub-model has been developed using a less extensive calibration and evaluation/validation base. The model is not spatially explicit and as such it uses a number of assumptions to make estimates of both N and P loss. It is important to appreciate that there are significant uncertainties associated with Overseer nutrient loss estimates and Overseer currently only provides for a very limited range of mitigation options to be incorporated.

We have considered the current mitigations in place to reduce nutrient loss from laneways and further mitigations planned. These are described in the report. Revised Overseer P loss estimates have been calculated, taking into account the effect of the laneway mitigations for the current and proposed systems:

	Overseer P loss estimate	– estimated P loss mitigated	= revised P loss
Current system	262 kg P/yr	- 33kg P	= 229kgP
Proposed system	278 kg P/yr – 19.1kgP	- 52kg P	= 226kgP
Difference			**= 3kg P/yr decrease**

Further mitigations that may be implemented in the future are to apply 50% of the phosphorus fertiliser in a low solubility form and to lower the Olsen P to 30. Overseer predicts that these mitigations would reduce P loss from the pastoral areas by a further 10 kg P.

P runoff from laneways

Overseer has a built in assumption that 30% of phosphorus deposited on laneways as dung is lost. This is accounted for in the "other sources" losses within the Phosphorus report (shown in the appendices of the consent application). Research has shown that a dairy cow consuming 15.5kgDM/day on a pasture diet will consume 0.4 kg P/week, of which 66% will be deposited in dung (shown in the table below, source: Massey University). Assuming that the farm has a lactation season of 270 days, each cow will ingest 15.4 kg P/cow, and **10.2kgP/animal would be deposited as dung.** A study by Ledgard *et al.* (1999) reported that **5% of cow excreta was deposited on laneways.** We have assumed that Overseer incorporates this information. Overseer then assumes that for phosphorus deposited on laneways in dung, **30% is lost from the system to water.**

Table 1.4 The fate of minerals ingested by a lactating dairy cow (ingesting 15.5 kg DM/day) (adapted from During 1984).

Element	Consumption Kg /week	Percentage in Faeces	Urine	Milk	Retained
N	5.1	26	53	17	4
P	0.4	66	-	26	8
K	2.9	11	81	5	3
Mg	0.2	80	12	3	5
Ca	0.4	77	3	11	9
Na	0.4	30	56	8	6

There is opportunity to mitigate the losses from laneways through careful management of bridges/culverts, buffer zone planting, laneway cambering and siting laneways away from waterways. These mitigations all reduce P loss by ensuring laneway runoff is filtered through a vegetated buffer strip. Research has shown that vegetated buffer strips can reduce P losses by 38-59% (figure 1). None of these mitigation strategies are provided for in Overseer.

As described in the application for consent, this property has already implemented some mitigations to reduce phosphorus loss from laneways. These include kickboards on the two bridges (see pictures in consent application) and having some cut outs from the lane that direct runoff into paddocks rather than into waterways. The process of applying for consent has identified areas where further mitigations could be implemented. This includes improving the kickboards on the bridges, and improving the camber and increasing the size of the buffer on the laneway south of the cowshed which runs alongside an open drain. Water flow will be redirected through vegetated areas to allow for filtering. These areas of laneway are considered critical source areas – small areas that contribute a relatively high proportion of nutrient/phosphorus losses.

These improvements in laneway management will further mitigate losses of P. A study in the Mangakino stream by McDowell et al. (2006) found that the majority (c. 80%) of P losses were occurring from a small tributary that contributed less than 20% of the flow. Investigation of the tributary found that there was a heavily used, poorly managed dairy farm stream crossing less than 200m upstream from the confluence. Management of these high risk areas of laneway can therefore have significant positive effects on Predicted losses.

Given the evidence above, it has been assumed that the Driscoll property is currently mitigating at the low end of the range of reported mitigation, i.e., 38% of the losses from laneways assumed by Overseer, for the current 573 cows.

P loss mitigated	= Cows	x	P in dung	x	Excreted on lanes	x	assumed losses	x	current mitigations
Current system	= 573	x	10.2kg P	x	5%	x	30%	x	38%
	= 33 kg P/yr								

Revised Overseer estimated P loss (current system) = 262 kg P – 33kg P = 229 kg P

Going forward, as a result of this consent application, the Driscolls will make further mitigations to reduce laneway losses through increased use of vegetated buffers, as described above. We consider that these improvements can reduce annual P loss from laneways to the midpoint of the range of reported mitigation, i.e., 49% of the losses assumed by Overseer, for the proposed 700cows.

P loss mitigated	= Cows	x	P in dung	x	Excreted on lanes	x	assumed losses	x	extra mitigations
Proposed system	= 700	x	10.2kgP	x	5%	x	30%	x	49%
	= 52 kg P/yr								

Revised Overseer estimated P loss (proposed system) = 278 kg P – 52kg P = 226 kg P

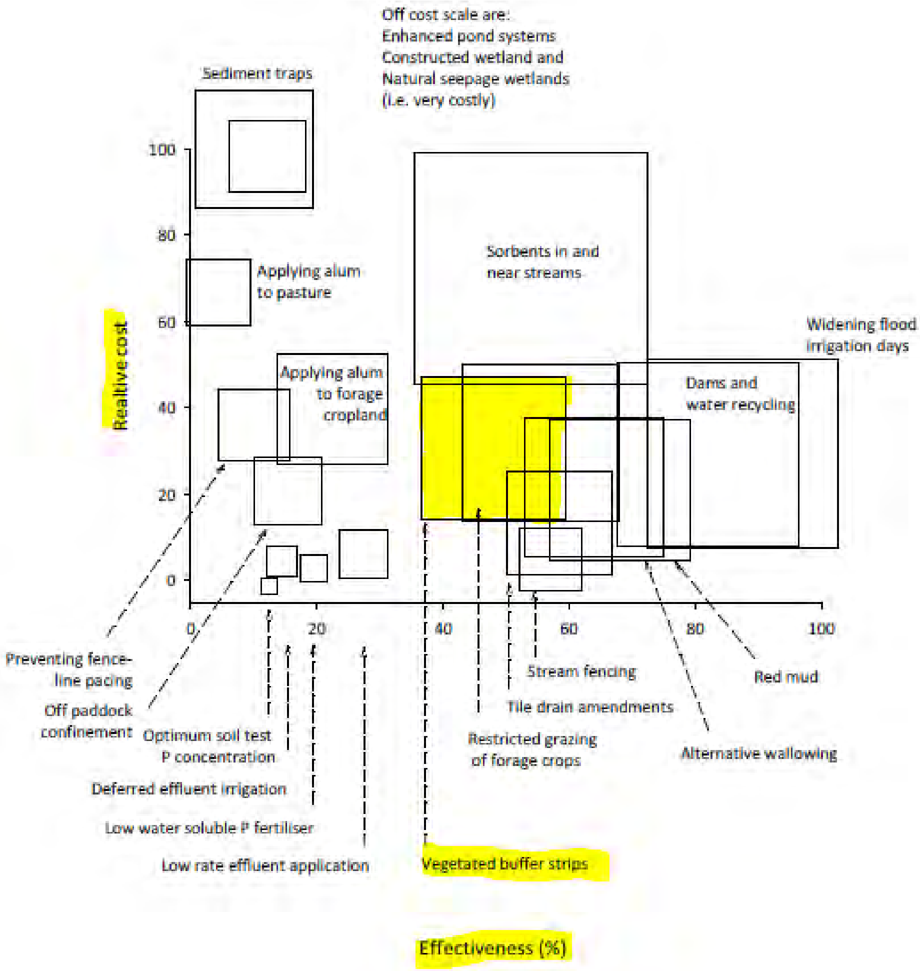

Figure 3. Diagram of the cost and effectiveness of strategies to mitigate phosphorus losses to water at the farm-scale. Cost is shown as the cost per kg of P mitigated relative to the most expensive strategy - sediment traps at $360 per kg P retained/ha/yr. From McDowell et al (2013)

Further future mitigation options:

Lower solubility Phosphorus fertilisers

The modelling completed assumed that fertiliser P would be applied as super phosphate – the most commonly used P fertiliser in New Zealand. This assumption was made in order to show a conservative estimate of losses, and to ensure that the systems were compared fairly. Going forward, the Driscolls have indicated that they are considering using RPR/serpentine super instead of super phosphate. This was not shown in the modelling as a transition to RPR/serpentine super should be untaken over a number of years in order to maintain pasture production.

Super phosphate fertiliser is 100% water soluble. In comparison, serpentine super and Reactive Phosphate Rock (RPR) have lower water solubility - 2.9% and 0% respectively (McNaught et al, 1968). As a result, the risk of P loss is higher in situations where super phosphate has been applied compared to RPR or serpentine super.

To show the effectiveness of this as a mitigation, I have modelled applying a maintenance application of P as 50% super phosphate and 50% RPR instead of 100% super phosphate. Please note

that the amount of P, in kg P per ha, has not changed, but the form of the fertiliser has. Overseer assumes that serpentine super has the same solubility as superphosphate (Wheeler and Watkins, 2016), and therefore the same fertiliser runoff risk profile. However, due to it's similar water solubility, serpentine super is expected to have similar losses of P as RPR. **This change in fertiliser form has resulted in a reduction in predicted P loss by 4kgP**. The Overseer P loss reports are shown in the appendices.

Soil Olsen P

Olsen P is a commonly used measure of plant available soil P. From an agronomic perspective, the optimum Olsen P level is 30. The Driscolls have an average Olsen P of 32. In the modelling completed for the Driscoll's it was assumed that maintenance fertiliser would be applied going forward, and that the Olsen P would therefore remain the same.

The consent application process has highlighted the environmental risk of a higher Olsen P to Tim and Jocelyn. As a result Tim and Jocelyn are considering reducing their Olsen P. **Overseer predicts that a reduction in Olsen P from 32 to 30 is expected to reduce P loss by 6kgP**. The Overseer P loss reports are shown in the appendices.

Conclusions:

Overseer has predicted the following total P loss:

Current situation	262 kg P/yr
Proposed situation	278 kg P/yr
Difference	**16 kg P/yr increase**

We have considered the current mitigations in place to reduce nutrient loss from laneways and further mitigations planned. These are described in the report. Revised Overseer estimates have been calculated, taking into account the effect of the laneway mitigations for the current and proposed systems:

	Overseer P loss estimate –	estimated P loss mitigated	= revised P loss
Current system	262 kg P/yr	- 33kg P	= 229kgP
Proposed system	278 kg P/yr – 19.1kgP	- 52kg P	= 226kgP
Difference			**= 3kg P/yr decrease**

Further mitigations that may be implemented in the future are to apply 50% of the phosphorus fertiliser in a low solubility form and to lower the Olsen P to 30. Overseer predicts that these mitigations would reduce P loss from the pastoral areas by 10 kg P.

References

Ledgard, S., Penno, J., & Sprosen, M. (1999). Nitrogen inputs and losses from clover/grass pastures grazed by dairy cows, as affected by nitrogen fertiliser application. *Journal of Agricultural Science 132*, 215-225.

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McDowell, R., Wilcock, B., & Hamilton, D. (2013). *Assessment of Strategies to Mitigate the Impact or Loss of Contaminants from Agricultural Land to Fresh Waters.* Prepared for MfE.

McNaught, K., Karlovsky, J., & Hogg, D. (1968). Serpentine-superphosphate and dolomite as magnesium sources on Whakarewarewa sandy loam. *New Zealand Journal of Agricultural Research*, 849-862.

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Wheeler, D., & Watkins, N. (2016). *Overseer Technical Manual: Characteristics of Fertilisers.* AgResearch.

Appendices:

Table 21. Block P loss table, as estimated by overseer for the Proposed system (same as in the consent application)

Farm name: Driscolls Proposed FINAL 1Oct

Block Phosphorus

Block name	Total P lost (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Waikiwi Effluent	19	0.5	Low	Low	Low
Pukemutu Effluent	46	0.9	Medium	Low	Medium
Waikiwi non effluent	8	0.4	Low	Low	n/a
Pukemutu non effluent	82	0.8	Medium	Low	n/a
Baleage winter - waikiwi Eff	0	0.5	Low	Low	Low
Baleage winter - Pukemutu Eff	1	0.9	Medium	Low	Medium
Baleage winter - Waikiwi Non Eff	0	0.4	Low	Low	n/a
Baleage winter - Pukemutu Non Eff	2	0.8	Medium	Low	n/a
Other farm sources	121				
Whole farm	278	1.2			

Table 22 Block P loss table, as estimated by overseer for the Proposed system – after applying 50% of the phosphorus fertiliser in a lower solubility form.

Farm name: Driscolls Proposed FINAL 1Oct - 50% RPR

Block Phosphorus

Block name	Total P lost (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Waikiwi Effluent	19	0.4	Low	Low	Low
Pukemutu Effluent	45	0.9	Medium	Low	Medium
Waikiwi non effluent	8	0.4	Low	Low	n/a
Pukemutu non effluent	79	0.8	Medium	Low	n/a
Baleage winter - waikiwi Eff	0	0.4	Low	Low	Low
Baleage winter - Pukemutu Eff	1	0.9	Medium	Low	Medium
Baleage winter - Waikiwi Non Eff	0	0.4	Low	Low	n/a
Baleage winter - Pukemutu Non Eff	1	0.8	Medium	Low	n/a
Other farm sources	121				
Whole farm	274	1.2			

Table 23. Block P loss table, as estimated by overseer for the Proposed system – after reducing Olsen P to 30.

Farm name: Driscolls Proposed FINAL 1Oct - Olsen P 30

Block Phosphorus

Block name	Total P lost (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Waikiwi Effluent	19	0.4	Low	Low	Low
Pukemutu Effluent	44	0.9	Medium	Low	Medium
Waikiwi non effluent	8	0.4	Low	Low	n/a
Pukemutu non effluent	79	0.8	Medium	Low	n/a
Baleage winter - waikiwi Eff	0	0.4	Low	Low	Low
Baleage winter - Pukemutu Eff	1	0.9	Medium	Low	Medium
Baleage winter - Waikiwi Non Eff	0	0.4	Low	Low	n/a
Baleage winter - Pukemutu Non Eff	2	0.8	Medium	Low	n/a
Other farm sources	120				
Whole farm	272	1.2			

Appendix 5: T and J Driscoll Family Trust – Farm Maps

Farm Map

Figure 4. Driscolls farm map showing the current and proposed effluent areas, and the East Block.

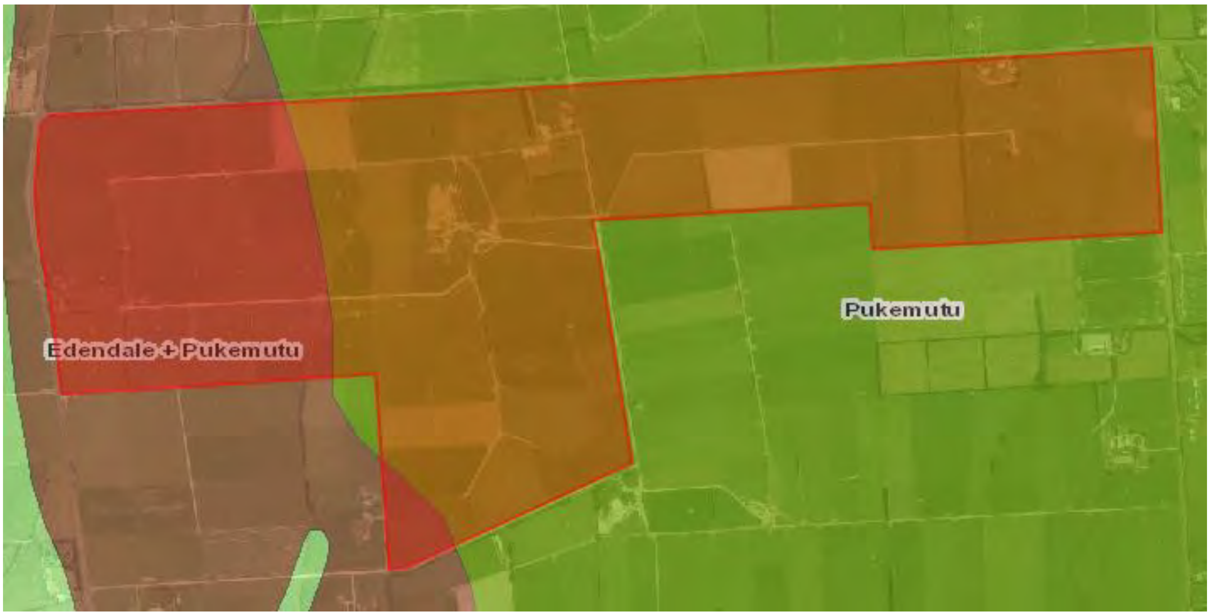

Figure 5. Driscolls farm map showing the soil types on farm

Detailed Nurtrient Budget Assumptions

Appendix 1: Updated detailed description of modelling inputs (Dec2019)

A detailed description of modelling inputs is shown below for the budgets included in Dec2019 modelling.

Blocks

The farm has been split into the following pastoral (effluent and non-effluent) and fodder crop blocks. Total farm area has been taken from the legal area (ex the rates demand). The area of each block has been determined using the measure function on Beacon. Soils on the property were assessed utilising the topoclimate information. OverseerFM soil settings were obtained from SMap for all soil types.

Changes from the file note (dated August 2019) are shown in red. Original modelling inputs are shown in black

Block Name	Soil Type (from Beacon)	Smap Ref	Contour	Current Dairy Platform (15-16 season to 17-18 season – 3yrs) (ha)	Current Dairy Platform (18-19 season) (ha)	East Block (ha)	Proposed Land Use (ha)
Effluent – Waikiwi	Edendale	Waiki_30a.1	Flat	**20.1**	**20.1**		**41.1**
Effluent – Pukemutu	Pukemutu	Pukem_6a.1	Flat	**41.9**	**37.9**		**49.2**
Non Effluent – Waikiwi	Edendale	Waiki_30a.1	Flat	**42.2**	**40.0**		**19.1**
Non Effluent – Pukemutu	Pukemutu	Pukem_6a.1	Flat	**98.4**	**92.4**		**86.2**
East Block - Pukemutu	Pukemutu	Pukem_6a.1	Flat			**13.9**	**13.9**
Baleage winter Eff Waikiwi	Edendale	Waiki_30a.1	Flat				**1.4**
Baleage winter Eff Pukemutu	Pukemutu	Pukem_6a.1	Flat		**4.0**		**1.6**
Baleage Winter Non Eff Waikiwi	Edendale	Waiki_30a.1	Flat		**2.2**		**0.7**
Baleage winter Non Eff Pukemutu	Pukemutu	Pukem_6a.1	Flat		**6.0**		**3.3**
	Effective Farm Area			**202.6**	**202.6**	**13.9**	**216.5**
	Non productive			8.0	8.0		8.0
	Total Farm Area			**210.6**	**210.6**	**13.9**	**224.5**
Rotating fodder crops							
Fodder beet				2.8			
Winter Turnips				1.0			

Appendix 1: Updated detailed description of modelling inputs (Dec2019)

Climate Data

- The following climate information has been used from the OverseerFM climate station tool;
  - 1092mm of rainfall
  - 10.1 degrees Celsius mean annual temperature
  - Annual PET of 710mm

Farm System

Description	Current Dairy Platform (15-16 season to 17-18 season – 3yrs)	Current Dairy Platform (18-19 season)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	East Block – Dairy Support (18-19 season)	Proposed Land Use
File name	CURRENT PLATFORM – AUG19 DEC2019	CURRENT PLATFORM 1819 season – DEC2019	CURRENT – EAST SHEEP AUG19	CURRENT – EAST TRANSITION AUG19	CURRENT – EAST DAIRY SUPPORT AUG19	CURRENT – EAST 1819 SEASON	PROPOSED – AUG19 MITIGATED
Milk solids production	271,130 kg MS 473 kgMS/cow Median calving date – 20th August Drying off – 31st May	307,406kgMS 513kgMS/cow Median cavling date – 21st August Drying off date – 31st May					319,600 kg MS 470 kgMS/cow Median calving date – 20th August Drying off – 31st May

Appendix 1: Updated detailed description of modelling inputs (Dec2019)

Description	Current Dairy Platform (15-16 season to 17-18 season – 3yrs)	Current Dairy Platform (18-19 season)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	East Block – Dairy Support (18-19 season)	Proposed Land Use
Cows on farm (Lactating and wintered)	Breed Fr J X Jul 140 Aug 599 Sep 593 Oct 573 Nov 573 Dec 573 Jan 573 Feb 573 Mar 573 Apr 530 May 487 Jun 83 Peak cows: 573 *Note: Some cows wintered off farm at a grazier's property June – 516 June – 459*	Breed Fr J X Jul 75 Aug 630 Sep 615 Oct 599 Nov 599 Dec 599 Jan 595 Feb 570 Mar 540 Apr 510 May 490 Jun 75 Peak cows: 599 *Note: Some cows wintered off farm at a grazier's property June – 555 June – 555*			Breed Fr J X Winter grazing for 100MA (July) and 125R2 cows (Jun and Jul)		Breed Fr J X Jul 252 Aug 711 Sep 702 Oct 680 Nov 680 Dec 680 Jan 680 Feb 650 Mar 620 Apr 590 May 570 Jun 195 Peak cows: 680 *Note: Some cows wintered off farm at a grazier's property June – 516 July – 459*

Appendix 1: Updated detailed description of modelling inputs (Dec2019)

Description	Current Dairy Platform (15-16 season to 17-18 season – 3yrs)	Current Dairy Platform (18-19 season)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	East Block – Dairy Support (18-19 season)	Proposed Land Use
Dairy replacements on farm	Calves are reared on farm until weaning (1-4months old) Aug - 135 Sep - 160 Oct - 160 Nov – 160	Calves are reared on farm until weaning (1-4months old) Aug - 170 Sep - 200 Oct - 200 Nov – 200		Grazing for R2 heifers May 125	Grazing for R2 heifers Jan 125 Feb 125	Grazing for calves Nov 100 (4mths old)	Calves are reared on farm until weaning (1-4months old) Aug - 160 Sep - 190 Oct - 190 Nov – 190
Breeding bulls	Thirteen 2yr old Jersey bulls (Dec and Jan)	Fourteen 2yr old Jersey bulls (Dec – 6th Jan)					Fifteen 2yr old Jersey bulls (Dec and Jan)
Sheep			Wintered: 120 MA ewes 46replacements 3rams Coopworth 125% lambing percentage 20% replacement rate Mean lambing date of the 15th September. All non-replacement lambs sold by the end of May				

Appendix 1: Updated detailed description of modelling inputs (Dec2019)

Description	Current Dairy Platform (15-16 season to 17-18 season – 3yrs)	Current Dairy Platform (18-19 season)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	East Block – Dairy Support (18-19 season)	Proposed Land Use
Relative productivity	No differences between blocks	No differences between blocks	No differences between blocks	No differences between blocks	No differences between blocks	No differences between blocks	No differences between blocks Relative productivity of East Block Pukemutu 0.97unit due to lower N useage. All other blocks have a relative productivity of 1.
Structures	Calving Pad Not modelled as used when ground conditions are saturated rather than for fixed time	Calving Pad Not modelled as used when ground conditions are saturated rather than for fixed time					Calving Pad Not modelled as used when ground conditions are saturated rather than for fixed time
In Shed Feeding	Management 100% of milkers fed Aug - May	Management 100% of milkers fed Aug - May					Management 100% of milkers fed Aug – May

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Rotating fodder crop management	2.8ha fodder beet Yield: 25tDM/ha Conventional cultivation October Fertiliser: 500kg/ha Winton Fodder Beet mix at sowing (delivering 50kg/ha N, 32kg/ha P, 75kg/ha K and 27kg/ha S) 100kg/ha Urea in December 100kg/ha Potassium Chloride in December 100kg/ha Urea in January Grazed by dairy cows May – Aug	Cows on farm in June/July are wintered on a baleage grass diet. 12.2ha Baleage/Grass wintering In the 1819 season baleage wintering occurred on the Pukemutu non effluent (6.0ha), Waikiwi non eff (2.2ha) and Pukemutu eff (4.0ha) blocks. All feed required is imported (225tDM baleage)					Cows on farm in June/July are wintered on a baleage grass diet. 7ha Baleage/Grass wintering This area rotates around all blocks except the East Block Pukemutu the platform. This wintering system forms part of the property's regrassing strategy All feed required is imported (150tDM baleage)

Description	Current Dairy Platform (15-16 season to 17-18 season – 3yrs)	Current Dairy Platform (18-19 season)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	East Block – Dairy Support (18-19 season)	Proposed Land Use
	Resown in permanent pasture in September						
	<u>1.0ha Turnips</u> Yield: 8tDM/ha Conventional cultivation February Fertiliser: 150kg/ha DAP and 150kg/ha super at sowing 100kg/ha Urea in March Grazed by dairy cows Jun – Aug Resown in permanent pasture in September						

Appendix 1: Updated detailed description of modelling inputs (Dec2019)

Description	Current Dairy Platform (15-16 season to 17-18 season – 3yrs)	Current Dairy Platform (18-19 season)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	East Block – Dairy Support (18-19 season)	Proposed Land Use
Imported Supplements	In shed: 236t PKE 38t Barley In paddock: 418tDM silage Note: imported feed level assumed to ensure a feasible pasture grown in an average season	In Shed: 100tDM PKE 149tDM DDG In paddock: 100tDM PKE 50tDM baleage 415tDM Silage For wintering: 225tDM baleage Note: imported feed level assumed to ensure a feasible pasture grown in an average season			In paddock: 65 tDM baleage		In shed: 40tDM PKE 400tDM Barley 100tDM DDG In paddock: 500tDM silage (fed on all bocks except East Block) For wintering: 150tDM baleage Supplement harvested on the East block: 140tDM fed out on all blocks except East Block Note: imported feed level assumed to ensure a feasible pasture grown in an average season

Appendix 1: Updated detailed description of modelling inputs (Dec2019)

Description	Current Dairy Platform (15-16 season to 17-18 season – 3yrs)	Current Dairy Platform (18-19 season)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	East Block – Dairy Support (18-19 season)	Proposed Land Use
Exported Supplements				130tDM baleage		154tDM baleage	
Soil Fertility	Olsen P 32 (soil test results June 2017) All other values entered at agronomic optimum	Soil testing May 2019 Olsen P 28 QT K 6 QT Ca 10 QT Mg 19 Org S 15	All soil test values entered at agronomic optimum (Olsen P of 20)	All soil test values entered at agronomic optimum (Olsen P of 20)	All soil test values entered at agronomic optimum (Olsen P of 20)	All soil test values entered at agronomic optimum (Olsen P of 20)	Olsen P 30 All other values entered at agronomic optimum
Fertiliser	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels Note: Phosphorus applied as RPR on the East Block

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Description	Current Dairy Platform (15-16 season to 17-18 season – 3yrs)	Current Dairy Platform (18-19 season)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	East Block – Dairy Support (18-19 season)	Proposed Land Use
Pastoral Nitrogen Fertiliser	213 kgN/ha in split applications (Aug – April)	Baleage winter blocks: 115kgN/ha in split applications (Jan – Apr) All other blocks: 188kgN/ha in split applications (Aug – Apr)				185kgN/ha in split applications (Aug – Mar)	Non Effluent blocks (Excluding East Block) (203kgN/ha) in split applications (Aug – April) Effluent Blocks 183kgN/ha in split applications (Aug – April) East Block 154kgN/ha in split applications (Sep – Mar)
Drainage	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained
Farm dairy effluent	Holding pond Solids aren't separated from the liquid Liquid effluent is applied at a depth of	Holding pond Solids aren't separated from the liquid Liquid effluent is applied at a depth of					Holding pond Solids aren't separated from the liquid Liquid effluent is applied at a depth of

Description	Current Dairy Platform (15-16 season to 17-18 season – 3yrs)	Current Dairy Platform (18-19 season)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	East Block – Dairy Support (18-19 season)	Proposed Land Use
	<12mm to the "effluent" blocks An effluent area of at least 31 ha is required to achieve a loading of less than 150 kg N / ha / year	<12mm to the "effluent" blocks An effluent area of at least 33 ha is required to achieve a loading of less than 150 kg N / ha / year					<12mm to the "effluent" blocks An effluent area of at least 32ha is required to achieve a loading of less than 150 kg N / ha / year

Current system - Dairy Platform (File name - CURRENT PLATFORM - DEC19)

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	11,510	55
Phosphorus	255	1.2

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	201	26	2	25	0	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	80	11	58	9	9	6	4
Rain/clover fixation	79	0	3	5	3	7	35

NUTRIENTS REMOVED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Leached from root zone	55	1.2	12	37	62	6	20
As product	87	15	21	5	19	2	6
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	91	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0

CHANGE IN POOLS (KG/HA/YR)	N	P	K	S	CA	MG	NA
Organic pool	127	20	11	-3	7	3	1
Inorganic mineral	0	2	-24	0	-2	-3	-3
Inorganic soil pool	1	0	44	0	-73	6	15

Nitrogen summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	N IN DRAINAGE (PPM)	ADDED (KG/HA)	SURPLUS (KG/HA)	FERTILISER (KG/HA)	IRRIGATION (KG/HA)	EFFLUENT (KG/HA)
PUKEMUTU EFFLUENT	2531	62	13	288	278	211	0	78
PUKEMUTU NON EFFLUENT	4953	51	12	211	224	211	0	0
WAIKIWI EFFLUENT	1030	52	12	288	270	211	0	78
WAIKIWI NON EFFLUENT	1831	44	10	211	217	211	0	0
FODDER BEET	636	227	43	142	22	142	0	0
TURNIPS	113	113	21	72	2	72	0	0

Phosphorus summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	FERTILISER (KG/HA)	IRRIGATION (KG/HA)	EFFLUENT (KG/HA)
PUKEMUTU EFFLUENT	40	1	24	0	4
PUKEMUTU NON EFFLUENT	79	0.8	28	0	0
WAIKIWI EFFLUENT	9	0.5	23	0	4
WAIKIWI NON EFFLUENT	17	0.4	27	0	0
FODDER BEET	3	1.2	32	0	0
TURNIPS	1	1.1	44	0	0

Current system - Dairy Platform (File name - CURRENT - PLATFORM 1819 SEASON DEC19)

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	11,201	53
Phosphorus	250	1.2

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	177	20	0	26	0	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	114	19	85	13	26	12	9
Rain/clover fixation	95	0	3	5	3	7	35

NUTRIENTS REMOVED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Leached from root zone	53	1.2	11	53	66	7	18
As product	99	17	24	5	21	2	7
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	93	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0

CHANGE IN POOLS (KG/HA/YR)	N	P	K	S	CA	MG	NA
Organic pool	142	18	13	-14	9	4	1
Inorganic mineral	0	1	-22	0	-2	-3	-3
Inorganic soil pool	0	1	62	0	-66	9	22

Appendix 2: Nutrient budgets and N/P summaries taken from OverseerFM version 6.3.2 (Dec2019)

Nitrogen summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	N IN DRAINAGE (PPM)	ADDED (KG/HA)	SURPLUS (KG/HA)	FERTILISER (KG/HA)	IRRIGATION (KG/HA)	EFFLUENT (KG/HA)
BALEAGE WINTER - WAIKIWI NON EFF	142	64	15	115	301	115	0	0
BALEAGE WINTER PUKEMUTU NON EFF	453	75	17	115	314	115	0	0
BALEAGE WINTERING - PUKE EFF	366	92	20	194	368	115	0	79
PUKEMUTU EFFLUENT	2362	62	13	267	282	188	0	79
PUKEMUTU NON EFFLUENT	4644	50	11	188	226	188	0	0
WAIKIWI EFFLUENT	1060	53	12	267	274	188	0	79
WAIKIWI NON EFFLUENT	1737	43	10	188	219	188	0	0

Phosphorus summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	FERTILISER (KG/HA)	IRRIGATION (KG/HA)	EFFLUENT (KG/HA)
BALEAGE WINTER - WAIKIWI NON EFF	1	0.4	0	0	0
BALEAGE WINTER PUKEMUTU NON EFF	4	0.7	0	0	0
BALEAGE WINTERING - PUKE EFF	3	0.9	0	0	5
PUKEMUTU EFFLUENT	34	0.9	19	0	5
PUKEMUTU NON EFFLUENT	69	0.7	23	0	0
WAIKIWI EFFLUENT	9	0.5	19	0	5
WAIKIWI NON EFFLUENT	16	0.4	23	0	0

Current system – East Block sheep (File name - CURRENT - EAST SHEEP DEC19)

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	203	14
Phosphorus	10	0.7

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	0	16	0	24	0	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	0	0	0	0	0	0	0
Rain/clover fixation	96	0	3	5	3	7	34

NUTRIENTS REMOVED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Leached from root zone	14	0.7	7	34	33	6	19
As product	20	3	1	3	5	0	1
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	37	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0

CHANGE IN POOLS (KG/HA/YR)	N	P	K	S	CA	MG	NA
Organic pool	25	11	0	-8	0	0	0
Inorganic mineral	0	0	-25	0	-2	-3	-4
Inorganic soil pool	0	2	19	0	-33	4	18

Nitrogen summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	N IN DRAINAGE (PPM)	ADDED (KG/HA)	SURPLUS (KG/HA)	FERTILISER (KG/HA)	IRRIGATION (KG/HA)	EFFLUENT (KG/HA)
EAST BLOCK - PUKEMUTU	199	14	3	0	74	0	0	0

Phosphorus summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	FERTILISER (KG/HA)	IRRIGATION (KG/HA)	EFFLUENT (KG/HA)
EAST BLOCK - PUKEMUTU	9	0.6	16	0	0

East Block – Transition (file name CURRENT - EAST TRANSITION DEC19)

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	138	10
Phosphorus	9	0.7

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	0	36	203	33	0	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	0	0	0	0	0	0	0
Rain/clover fixation	151	0	3	5	3	7	34

NUTRIENTS REMOVED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Leached from root zone	10	0.7	15	29	29	6	19
As product	0	0	0	0	0	0	0
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	4	0	0	0	0	0	0
As supplements and crop residues	160	23	201	17	46	11	9

CHANGE IN POOLS (KG/HA/YR)	N	P	K	S	CA	MG	NA
Organic pool	-23	11	6	-8	1	0	0
Inorganic mineral	0	0	-22	0	-2	-3	-4
Inorganic soil pool	0	0	6	0	-71	-7	10

Nitrogen summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	N IN DRAINAGE (PPM)	ADDED (KG/HA)	SURPLUS (KG/HA)	FERTILISER (KG/HA)	IRRIGATION (KG/HA)	EFFLUENT (KG/HA)
EAST BLOCK - PUKEMUTU	138	10	2	0	-14	0	0	0

Phosphorus summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	FERTILISER (KG/HA)	IRRIGATION (KG/HA)	EFFLUENT (KG/HA)
EAST BLOCK - PUKEMUTU	9	0.7	36	0	0

East Block – Dairy support (file name - CURRENT - EAST DAIRY SUPPORT DEC19)

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	405	29
Phosphorus	10	0.7

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	0	2	0	11	0	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	0	0	0	0	0	0	0
Rain/clover fixation	87	0	3	5	3	7	34

NUTRIENTS REMOVED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Leached from root zone	29	0.7	9	32	44	6	19
As product	9	2	1	1	5	0	0
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	41	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0

CHANGE IN POOLS (KG/HA/YR)	N	P	K	S	CA	MG	NA
Organic pool	81	12	4	-7	1	0	0
Inorganic mineral	0	0	-16	0	-2	-3	-4
Inorganic soil pool	0	1	97	0	-21	12	25

Nitrogen summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	N IN DRAINAGE (PPM)	ADDED (KG/HA)	SURPLUS (KG/HA)	FERTILISER (KG/HA)	IRRIGATION (KG/HA)	EFFLUENT (KG/HA)
EAST BLOCK - PUKEMUTU	400	29	7	0	145	0	0	0

Phosphorus summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	FERTILISER (KG/HA)	IRRIGATION (KG/HA)	EFFLUENT (KG/HA)
EAST BLOCK - PUKEMUTU	8	0.6	2	0	0

East Block – Dairy support 18-19 year (file name - CURRENT - EAST 1819 SEASON DEC19)

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	70	5
Phosphorus	9	0.7

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	183	40	237	35	0	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	0	0	0	0	0	0	0
Rain/clover fixation	70	0	3	5	3	7	34

NUTRIENTS REMOVED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Leached from root zone	5	0.7	16	29	25	6	19
As product	0	0	0	0	0	0	0
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	11	0	0	0	0	0	0
As supplements and crop residues	198	28	242	20	55	13	10

CHANGE IN POOLS (KG/HA/YR)	N	P	K	S	CA	MG	NA
Organic pool	39	11	0	-9	0	0	0
Inorganic mineral	0	0	-22	0	-2	-3	-4
Inorganic soil pool	0	0	3	0	-75	-8	8

Nitrogen summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	N IN DRAINAGE (PPM)	ADDED (KG/HA)	SURPLUS (KG/HA)	FERTILISER (KG/HA)	IRRIGATION (KG/HA)	EFFLUENT (KG/HA)
EAST BLOCK - PUKEMUTU	70	5	1	185	56	185	0	0

Phosphorus summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	FERTILISER (KG/HA)	IRRIGATION (KG/HA)	EFFLUENT (KG/HA)
EAST BLOCK - PUKEMUTU	9	0.7	40	0	0

Proposed system – (file name - PROPOSED - DEC19)

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	10,193	45
Phosphorus	260	1.2

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	185	24	15	26	8	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	104	14	71	9	15	7	5
Rain/clover fixation	77	0	3	5	3	7	35

NUTRIENTS REMOVED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Leached from root zone	45	1.2	13	40	55	6	20
As product	96	16	23	5	21	2	7
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	86	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0

CHANGE IN POOLS (KG/HA/YR)	N	P	K	S	CA	MG	NA
Organic pool	138	18	14	-4	8	3	1
Inorganic mineral	0	2	-19	0	-2	-3	-3
Inorganic soil pool	0	1	58	0	-55	6	16

Appendix 2: Nutrient budgets and N/P summaries taken from OverseerFM version 6.3.2 (Dec2019)

Nitrogen summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	N IN DRAINAGE (PPM)	ADDED (KG/HA)	SURPLUS (KG/HA)	FERTILISER (KG/HA)	IRRIGATION (KG/HA)	EFFLUENT (KG/HA)
BALEAGE WINTER - PUKEMUTU EFF	143	90	20	235	403	183	0	52
BALEAGE WINTER - PUKEMUTU NON EFF	282	86	19	203	374	203	0	0
BALEAGE WINTER - WAIKIWI NON EFF	48	69	16	203	345	203	0	0
BALEAGE WINTER - WAIKIWI EFF	106	76	17	235	389	183	0	52
EAST BLOCK - PUKEMUTU	191	14	3	154	64	154	0	0
PUKEMUTU EFFLUENT	2479	50	11	235	254	183	0	52
PUKEMUTU NON EFFLUENT	4014	47	11	203	222	203	0	0
WAIKIWI EFFLUENT	1752	43	10	235	249	183	0	52
WAIKIWI NON EFFLUENT	740	39	9	203	210	203	0	0

Phosphorus summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	FERTILISER (KG/HA)	IRRIGATION (KG/HA)	EFFLUENT (KG/HA)
BALEAGE WINTER - PUKEMUTU EFF	1	0.8	0	0	3
BALEAGE WINTER - PUKEMUTU NON EFF	2	0.7	0	0	0
BALEAGE WINTER - WAIKIWI NON EFF	0	0.4	0	0	0
BALEAGE WINTER - WAIKIWI EFF	1	0.4	0	0	3
EAST BLOCK - PUKEMUTU	10	0.7	48	0	0
PUKEMUTU EFFLUENT	43	0.9	22	0	3
PUKEMUTU NON EFFLUENT	67	0.8	25	0	0
WAIKIWI EFFLUENT	18	0.4	22	0	3
WAIKIWI NON EFFLUENT	8	0.4	26	0	0

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File Note: T and J Driscoll Family Trust consent application

August 2019

Please find below a file note in relation to Overseer modelling completed for the T and J Driscoll Family Trust. This file note is intended to be read in conjunction alongside the previous Overseer modelling reports, dated 1st October 2018 and the previous file note "Further information: T And J Driscoll Family trust consent application," dated 18th December 2018. Both of these reports have been included in the appendices of this file note.

Purpose of this Report

The applicant (T and J Driscoll Family Trust) have instructed further modelling to be undertaken to reduce nutrient loss in the proposed dairy farm.

Previous Modelling Results

Overseer modelling was completed for the T and J Driscoll Trust in October 2018 using Overseer version 6.3.0. Summarised results from this modelling is shown in Table 1.

Table 1. Predicted nitrogen and phosphorus losses in the current and proposed systems (From modelling report dated 1st October 2018 – in appendices)

	Current system	Proposed system
Total Farm N Loss (kg)	11,503	11,345
N Loss/ha (kgN/ha/yr)	51	51
Total Farm P Loss (kg)	262	278
P loss/ha (kgP/ha/yr)	1.2	1.2

Following this modelling, Environment Southland raised concern that the predicted Phosphorus losses using Overseer are higher in the proposed than the current system. A file note was completed to quantify the impact of mitigations that are not accounted for in Overseer. Results including the phosphorus mitigations modelled outside of Overseer 6.3.0 are shown in table 2.

Report disclaimer:
The OverseerFM 6.3.1 model has been utilised to assess the nutrient losses from this property. Details of how the property is operated currently, and how the property will be operated going forward have been gathered from the farm owner. Where accurate data was unavailable, conservative assumptions have been made using professional judgement.

OverseerFM 6.3.1 predicted results have been extracted from the model on 22 August 2019

Table 2. Predicted nitrogen and phosphorus losses in the current and proposed systems, including phosphorus mitigations modelled outside of Overseer 6.3.0 (From "Further information: T and J Driscoll Family Trust consent application" - in appendices)

	Current system	Proposed system
Total Farm N Loss (kg)	11,503	11,345
N Loss/ha (kgN/ha/yr)	51	51
Total Farm P Loss (kg)	229 (including 33kg P mitigation modelled outside of Overseer)	226 (including 52kg P mitigation modelled outside of Overseer)
P loss/ha (kgP/ha/yr)	1.0	1.0

Using the Overseer 6.3.0 model and supporting phosphorus loss calculation outside of Overseer, it is predicted that losses of nitrogen will decrease by 1.4% and losses of phosphorus will decrease by 1.3%.

The key drivers of a decrease in nitrogen loss are shown below. In comparison to the current system, the proposed system has:

- Increased the area that effluent is applied to – reduced N application in effluent to this area
- Reduced nitrogen fertiliser use
- Increased cow numbers – increasing loss risk

The key driver of the decrease in phosphorus loss are shown below. In comparison to the current system the proposed has:

- Improved laneway sediment loss mitigations

Changes in Overseer since October 2018

Since October 2018 there have been two key changes in Overseer:

- Overseer moved to the OverseerFM platform. Please note that this was a change in the Overseer platform and working interface rather than a change to the mechanics of Overseer. This movement therefore created no change in predicted nitrogen and phosphorus losses.
- In February 2019 version 6.3.1 of OverseerFM was released. Version 6.3.1 made a change to the OverseerFM model relating to fodder crops. This has had a small impact on the results predicted for the T and J Driscoll Family Trust.

The Overseer files related to this consent application were reopened in OverseerFM version 6.3.1. Climate location and maintenance fertiliser inputs have been updated and the method is consistent between the current and proposed files. No other changes were made. Summary results from OverseerFM 6.3.1 are shown below with changes shown in red.

Table 3. Predicted nitrogen and phosphorus losses in the current system as modelled in OverseerFM 6.3.1

	Current Dairy Platform (3yr average)	East Block – Sheep (15-16 season)	East Block – Transition (16-17 season)	East Block – Dairy Support (17-18 season)	East block (average of 3yrs)	Current Total (averaged over 3 years)
Total Farm N Loss (kg)	11273	203	132	385	240	11513
N Loss/ha (kgN/ha/yr)	54	14	9	27	17	51
N Concentration in Drainage (ppm)	Pastoral – 10 to 13 Crops – 21 to 42	Pastoral – 3	Pastoral – 2	Pastoral - 6		
Total Farm P Loss (kg)	253	10	9	10	10	263
P loss/ha (kgP/ha/yr)	1.2	0.7	0.7	0.7	0.7	1.2
Overseer - predicted pasture grown (tDM/ha/yr)	16.2	11.8	11.8	11.9		

Table 4. Predicted nitrogen and phosphorus losses in the current and proposed systems, including phosphorus mitigations modelled outside of OverseerFM 6.3.1

	Current system	Proposed system
Total Farm N Loss (kg)	11513	11348
N Loss/ha (kgN/ha/yr)	51	51
N Concentration in Drainage (ppm)		Pastoral – 10 to 29
Total Farm P Loss (kg)	230 (including 33kg P mitigation modelled outside of Overseer)	226 (including 52kg P mitigation modelled outside of Overseer)
P loss/ha (kgP/ha/yr)	1.0	1.0
Overseer - predicted pasture grown (tDM/ha/yr)		16.2

Further Modelling

During conversations with Environment Southland and LandPro it has become clear that under the Proposed Water and Land Plan that the applicant needs to demonstrate a farm system (through modelling) that would contribute to a clear improvement to water quality.

Key changes from the original proposal are as follows (see appendices for detailed assumptions):

- Reduction in peak cows milked (from 700 to 680)
- Reduction in young stock numbers (aligned to reduction in cow numbers)

- Reduction in nitrogen applied as fertiliser overall
- Increased use of barley as a purchased in feed (lower protein feed)
- Increase in area utilised for baleage grass wintering
- A reduction in Olsen P to 30 on the milking platform (note the Olsen P on the East Block will increase from the current 20)

The East Block has been blocked separately and additional mitigation strategies have been implemented on this block (see appendices for detailed assumptions):

- No wintering on this block (June and July)
- No grazing of livestock in the months of May to August, requiring less pasture cover May to August and a subsequent reduction in fertiliser N applications, and consequently overall lower pasture grown on this block
- No supplements fed on block
- Baleage made on the East block due to distance from cowshed
- Low solubility P fertiliser is applied (assumed Reactive Phosphate Rock in the modelling, may also be serpentine super in practice)

The results of these mitigations are shown in Table 5.

Table 5. Predicted nitrogen and phosphorus losses in the current and proposed system before and after further mitigations were included, including phosphorus mitigations modelled outside of OverseerFM 6.3.1

	Current system	**Proposed system (before further mitigations applied)**	**Proposed system (following further mitigations)**
Total Farm N Loss (kg)	11513	11348	9908
N Loss/ha (kgN/ha/yr)	51	51	44
N Concentration in Drainage (ppm)		Pastoral – 10 to 29	Pastoral – 3 to 19
Total Farm P Loss (kg)	230 (including 33kg P mitigation modelled outside of Overseer)	226 (including 52kg P mitigation modelled outside of Overseer)	204 (including 52kg P mitigation modelled outside of Overseer)
P loss/ha (kgP/ha/yr)	1.0	1.0	0.9
OverseerFM - predicted pasture grown (tDM/ha/yr)		16.2	16.0 (excluding East Block) 15.6 (East Block)

Taking into account the further mitigations made to the proposed farm system, OverseerFM predicts that overall nitrogen will decrease by 14% and losses of phosphorus will decrease by 11%. The nutrient budget, nitrogen summary and phosphorus summary are shown for each system in the appendices.

Adjustments to nitrogen losses in the proposed system

Baleage grass wintering:

OverseerFM has estimated that the loss of nitrogen from the grass baleage system is 567kgN (or 81kgN/ha). Modelling of the grass baleage wintering system in OverseerFM is likely to underestimate nitrogen losses as OverseerFM is not able to adequately reflect the on-farm realities of this system. OverseerFM assumes that the pasture plants will regrow post grazing and take up urinary N from the wintering activity. However, in reality, due to the soil type and climate on the applicant's property, the plants are not viable following the winter grazing. As a result the area is cultivated and regrassed in spring.

I am unaware of any research that has quantified the impact of baleage grass wintering in terms of nitrate and phosphorus loss. I have therefore completed a desktop modelling exercise that attempts to more accurately estimate the nutrient losses from this system.

The following assumptions have been made:

- Same as the proposed system file
  - Soils / climatic conditions
  - Tile drains
  - Stock numbers
  - Imported / exported supplement
  - Fertiliser and nitrogen use

- Different from the proposed system file
  - Used kale instead of pasture to allow a defoliation event and regressing activity
  - Used kale as has a similar crude protein to average quality pasture
  - Reduced yield of kale to 3TDM/ha to reflect pasture accumulated for winter in practice
  - Regrassed the area in October in line with when the applicant would usually regrass following a grass baleage wintering event
  - Direct drilled kale (rather than conventional cultivation to minimise the impact of the mineralisation of N during cultivation)

Overseer predicted that the losses from the Kale block would be 99kgN/ha (total of 693kgN lost for the 7ha wintered on). Without comparative research, it is difficult to assess the accuracy of the above results. However, from a common sense perspective, losses from the baleage grass system are likely to be more comparable to a traditional fodder crop paddock than a permanent pasture paddock. Therefore, it is predicted that the losses from the grass baleage wintering system will be 126kgN higher than predicted in the Proposed scenario.

Table 6. Predicted nitrogen and phosphorus losses in the current and proposed system after further mitigations were included, including phosphorus mitigations modelled outside of OverseerFM 6.3.1

	Current system	Proposed system (following further mitigations)	Percentage change in losses
Total Farm N Loss (kg)	11513	10034 (including 126kgN adjustment modelled outside of Overseer)	12.8% reduction
N Loss/ha (kgN/ha/yr)	51	45	
N Concentration in Drainage (ppm)		Pastoral – 3 to 19	
Total Farm P Loss (kg)	230 (including 33kg P mitigation modelled outside of Overseer)	204 (including 52kg P mitigation modelled outside of Overseer)	11.3% reduction
P loss/ha (kgP/ha/yr)	1.0	0.9	
OverseerFM - predicted pasture grown (tDM/ha/yr)		16.0 (excluding East Block) 15.6 (East Block)	

Taking into account the further mitigations to the proposed farm system and the adjustment required for modelling the baleage grass wintering system, Overseer predicts that overall nitrogen will decrease by 13% and losses of phosphorus will decrease by 11.3%.

Off site effects of wintering:

No adjustment to nutrient losses to account for off site effects of wintering has been made as the number of animals wintered off farm (mixed age cows and R2 heifers) is the same in the current as the proposed. All additional stock in the proposed system will be wintered on farm and have therefore been accounted for in the modelling. The number of stock wintered on and off farm are described in detail in the appendices.

Off site effects of young stock:

As a result of the increased cow numbers on farm, there will also be an increase in the number of young stock reared for the property. These animals have been and will continue to be grazed off site with a third party grazier. The applicant does not have direct control over the management of these stock or the property that they are grazing. As agreed between Alex Erceg (ES) and Tanya Copeland (Landpro) in an email dated 21st February, the off site effects of these animals has not been included in the OverseerFM modelling. A copy of the relevant correspondence is available from Landpro upon request.

However, should quantification be required, I have made the following estimation of the scale of the effect of these extra young stock. The applicant rears 28% replacements (calves as a percentage of cows milked at peak). This is equivalent to 160 calves in the current system and 190 calves in the proposed system – an increase of 30 animals. Young stock are grazed off farm from weaning (1st

December), until their return as incalf heifers (1st Jun, 18months later). This system will continue to occur in the proposed scenario.

Rising 1 year old heifers have been traditionally wintered on fodder beet, although in the 2019 winter they were grazed on a baleage grass system. The off site effect of the extra young stock grazing can be estimated as follows:

- 30 rising 1 year olds, wintered on crop for 77days
- Require 5kgDM fodderbeet per head per day (the balance of the diet is made up of supplement as per standard practice)
- 5kgDM/head/day x 77days x 30animals = 11,550kgDM fodderbeet required
- At a 25,000tDM/ha yield of fodderbeet, the stock will require 0.5ha.
- It is assumed that the fodderbeet crop has losses of 225kg N/ha and 1.2kgP/ha. This is based on the losses modelled for the applicant under fodderbeet in the current scenario.

Therefore, it can be estimated that the off site effects of wintering the 30 increased rising 1 year olds is:

- 113kgN/year
- 0.6kgP/year

Please note that this estimate of nutrient losses during winter grazing is conservative, ie it is very likely to be overestimating the actual nutrient losses due to the winter feed type (fodder beet) and the intensity of the wintering (25tDM crop yield).

In addition to the winter grazing it is assumed that the additional 30 head of young stock are grass grazed when they aren't on winter crop. The 30 stock would require approximately 12ha of pasture. If this pasture has an N loss of 30kgN/ha and a p loss of 0.6kgP/ha, it can be estimated that the offsite effect of the young stock pasture grazing is:

- 360kgN/year
- 7.2kgP/year

Therefore, it can be estimated that the total offsite effect of the additional young stock is:

- 473kgN/year
- 7.8kgP/year

Note – the estimate above is intended to give an estimate of scale of effect, rather than to suggest any accuracy. There are too many variables that are unknown (including soil type, climate, stocking rate and fertiliser policy) to provide accuracy.

Table 7. Predicted nitrogen and phosphorus losses in the current and proposed system after further mitigations were included, including phosphorus mitigations modelled outside of OverseerFM 6.3.1

	Current system	Proposed system (following further mitigations)	Percentage change in losses
Total Farm N Loss (kg)	11513	10507 (including 126kgN grass baleage and 473kgN young stock adjustments modelled outside of Overseer)	8.7% reduction
N Loss/ha (kgN/ha/yr)	51	47	
N Concentration in Drainage (ppm)		Pastoral – 3 to 19	
Total Farm P Loss (kg)	230 (including 33kg P mitigation modelled outside of Overseer)	212 (including 52kg P laneway mitigation and 7.8kgP young stock adjustment modelled outside of Overseer)	7.8% reduction
P loss/ha (kgP/ha/yr)	1.0	0.9	
OverseerFM - predicted pasture grown (tDM/ha/yr)		16.0 (excluding East Block) 15.6 (East Block)	

Taking into account the further mitigations to the proposed farm system and the adjustment required for modelling the baleage grass wintering system, Overseer predicts that overall nitrogen will decrease by 8.7% and losses of phosphorus will decrease by 7.8%.

Conclusions from the modelling

Table 8. Predicted nitrogen and phosphorus losses in the current and proposed system after further mitigations were included, including phosphorus mitigations modelled outside of OverseerFM 6.3.1

	Current system	Proposed system (following further mitigations)	Percentage change in losses
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P loss/ha (kgP/ha/yr)	1.0	0.9	
OverseerFM - predicted pasture grown (tDM/ha/yr)		16.0 (excluding East Block) 15.6 (East Block)	

Taking into account the further mitigations to the proposed farm system and the adjustment required for modelling the baleage grass wintering system, Overseer predicts that overall nitrogen will decrease by 8.7% and losses of phosphorus will decrease by 7.8%.

The key drivers of a decrease in nitrogen loss are shown below. In comparison to the current system, the proposed system has:

- Increased the area that effluent is applied to – reduced N application in effluent to this area
- Reduced nitrogen fertiliser use
- Change in the farms culling policy to one of culling earlier
- Lower protein content supplementary feed (Barley)

The key driver of the decrease in phosphorus loss are shown below. In comparison to the current system the proposed has:

- Improved laneway sediment loss mitigations
- A reduction in the Olsen P on the current dairy platform area (although an increase in Olsen P on the East Block)
- Use of Reactive Phosphate Rock fertiliser on the East Block

Appendices:

Appendix 1: Updated detailed description of modelling inputs

Appendix 2: Nutrient budgets taken from OverseerFM

Appendix 3: Overseer modelling report for the purposes of as part of a consent application for expanded dairying, dated October 2018

Appendix 4: Further information: T and J Driscoll Family Trust consent application, December 2018

Appendix 5: T and J Driscoll Family Trust – Farm Maps

Appendix 1: Updated detailed description of modelling inputs

Blocks

The farm has been split into the following pastoral (effluent and non-effluent) and fodder crop blocks. Total farm area has been taken from the legal area (ex the rates demand). The area of each block has been determined using the measure function on Beacon. Soils on the property were assessed utilising the topoclimate information. OverseerFM soil settings were obtained from SMap for all soil types.

Changes from original modelling (dated October 2018) are shown in red. Original modelling inputs are shown in black

Block Name	Soil Type (from Beacon)	Smap Ref	Contour	Current Dairy Platform (ha)	East Block (ha)	Proposed Land Use (ha)
Effluent – Waikiwi	Edendale	Waiki_30a.1	Flat	**20.1**		**41.7 41.1**
Effluent – Pukemutu	Pukemutu	Pukem_6a.1	Flat	**41.9**		**49.9 49.2**
Non Effluent – Waikiwi	Edendale	Waiki_30a.1	Flat	**42.2**		**19.4 19.1**
Non Effluent – Pukemutu	Pukemutu	Pukem_6a.1	Flat	**98.4**		**101.5 86.2**
East Block - Pukemutu	Pukemutu	Pukem_6a.1	Flat		**13.9**	**13.9**
Baleage winter Eff Waikiwi	Edendale	Waiki_30a.1	Flat			**0.8 1.4**
Baleage winter Eff Pukemutu	Pukemutu	Pukem_6a.1	Flat			**0.9 1.6**
Baleage Winter Non Eff Waikiwi	Edendale	Waiki_30a.1	Flat			**0.4 0.7**
Baleage winter Non Eff Pukemutu	Pukemutu	Pukem_6a.1	Flat			**1.9 3.3**
	Effective Farm Area			**202.6**	**13.9**	**216.5**
	Non productive			8.0		8.0
	Total Farm Area			**210.6**	**13.9**	**224.5**
Rotating fodder crops						
Fodder beet				2.8		
Winter Turnips				1.0		

Climate Data

- The following climate information has been used from the OverseerFM climate station tool;
  - 1094mm of rainfall (updated to 1092mm – consistent across all nutrient budgets)
  - 10.1 degrees Celsius mean annual temperature
  - Annual PET of 711mm (updated to 710mm – consistent across all nutrient budgets)

Farm System

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
File name	CURRENT PLATFORM – AUG19	CURRENT – EAST SHEEP AUG19	CURRENT – EAST TRANSITION AUG19	CURRENT – EAST DAIRY SUPPORT AUG19	PROPOSED – AUG19 MITIGATED
Milk solids production	271,130 kg MS 473 kgMS/cow Median calving date – 20th August Drying off – 31st May				329,000kgMS 319,600 kg MS 470 kgMS/cow Median calving date – 20th August Drying off – 31st May
Cows on farm (Lactating and wintered)	Breed Fr J X Jul 140 Aug 599 Sep 593 Oct 573 Nov 573 Dec 573 Jan 573 Feb 573 Mar 573 Apr 530 May 487 Jun 83 Peak cows: 573 *Note: Some cows wintered off farm at a grazier's property* *June – 516* *June – 459*			Breed Fr J X Winter grazing for 100MA (July) and 125R2 cows (Jun and Jul)	Breed Fr J X Jul 273 252 Aug 732 711 Sep 724 702 Oct 700 680 Nov 700 680 Dec 700 680 Jan 700 680 Feb 700 650 Mar 700 620 Apr 647 590 May 595 570 Jun 216 195 Peak cows: 700 Peak cows: 680 *Note: Some cows wintered off farm at a grazier's property* *June – 516* *July – 459* *Note: change in culling policy*

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
Dairy replacements on farm	Calves are reared on farm until weaning (1-4months old) Aug - 135 Sep - 160 Oct - 160 Nov – 160		Grazing for R2 heifers May 125	Grazing for R2 heifers Jan 125 Feb 125	Calves are reared on farm until weaning (1-4months old) Aug - 152 160 Sep - 187 190 Oct - 187 190 Nov – 187 190 Note: error found in original modelling
Breeding bulls	Thirteen 2yr old Jersey bulls (Dec and Jan)				Fifteen 2yr old Jersey bulls (Dec and Jan)
Sheep		Wintered: 120 MA ewes 46replacements 3rams Coopworth 125% lambing percentage 20% replacement rate Mean lambing date of the 15th September. All non-replacement lambs sold by the end of May			
Relative productivity	No differences between blocks	No differences between blocks	No differences between blocks	No differences between blocks	No differences between blocks Relative productivity of East Block Pukemutu 0.97unit due to lower N useage. All other blocks have a relative productivity of 1.

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
Structures	Calving Pad Not modelled as used when ground conditions are saturated rather than for fixed time				Calving Pad Not modelled as used when ground conditions are saturated rather than for fixed time
In Shed Feeding	Management 100% of milkers fed Aug - May				Management 100% of milkers fed Aug – May
Rotating fodder crop management	2.8ha fodder beet Yield: 25tDM/ha Conventional cultivation October Fertiliser: 500kg/ha Winton Fodder Beet mix at sowing (delivering 50kg/ha N, 32kg/ha P, 75kg/ha K and 27kg/ha S) 100kg/ha Urea in December 100kg/ha Potassium Chloride in December 100kg/ha Urea in January Grazed by dairy cows May – Aug Resown in permanent pasture in September				Cows on farm in June/July are wintered on a baleage grass diet. 4ha 7ha Baleage/Grass wintering This area rotates around all blocks except the East Block Pukemutu the platform. This wintering system forms part of the property's regrassing strategy All feed required is imported (160tDM baleage) (150tDM baleage)
	1.0ha Turnips Yield: 8tDM/ha Conventional cultivation February				

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
	Fertiliser: 150kg/ha DAP and 150kg/ha super at sowing 100kg/ha Urea in March Grazed by dairy cows Jun – Aug Resown in permanent pasture in September				
Imported Supplements	In shed: 236t PKE 38t Barley (typo in original modelling) In paddock: 418tDM silage			In paddock: 65 tDM baleage	In shed: 300tDM PKE 40tDM PKE 100tDM barley 400tDM Barley 100tDM DDG In paddock: 850tDM silage (fed over entire platform) 500tDM silage (fed on all bocks except East Block) For wintering: 160tDM baleage 150tDM baleage Supplement harvested on the East block: 140tDM fed out on all blocks except East Block
Exported Supplements			130tDM baleage		
Soil Fertility	Olsen P 32 (soil test results June 2017) All other values entered at agronomic optimum	All soil test values entered at agronomic optimum (Olsen P of 20)	All soil test values entered at agronomic optimum (Olsen P of 20)	All soil test values entered at agronomic optimum (Olsen P of 20)	Olsen P 32 Olsen P 30 All other values entered at agronomic optimum

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
Fertiliser	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels Note: Phosphorus applied as RPR on the East Block
Pastoral Nitrogen Fertiliser	213 kgN/ha in split applications (Aug – April)				Non Effluent blocks (Excluding East Block) 218kgN/ha (203kgN/ha) in split applications (Aug – April) Effluent Blocks 197kgN/ha (183kgN/ha) in split applications (Aug – April) East Block 154kgN/ha in split applications (Sep – Mar)
Drainage	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained
Farm dairy effluent	Holding pond Solids aren't separated from the liquid Liquid effluent is applied at a depth of <12mm to the "effluent" blocks An effluent area of at least 31 ha is required to achieve a loading of less than 150 kg N / ha / year				Holding pond Solids aren't separated from the liquid Liquid effluent is applied at a depth of <12mm to the "effluent" blocks An effluent area of at least 34 (now 32) ha is required to achieve a loading of less than 150 kg N / ha / year

Appendix 2: Nutrient budgets taken from OverseerFM

Report disclaimer:

The OverseerFM 6.3.1 model has been utilised to assess the nutrient losses from this property. Details of how the property is operated currently, and how the property will be operated going forward have been gathered from the farm owner. Where accurate data was unavailable, conservative assumptions have been made using professional judgement.

OverseerFM 6.3.1 predicted results have been extracted from the model on 22 August 2019

Current system - Dairy Platform (File name - CURRENT PLATFORM - AUG19)

Table 9. Current system whole farm nutrient budget

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	11,273	54
Phosphorus	253	1.2

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	201	26	2	25	0	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	80	11	58	9	9	6	4
Rain/clover fixation	74	0	3	5	3	7	35
NUTRIENTS REMOVED (KG/HA/YR)	**N**	**P**	**K**	**S**	**CA**	**MG**	**NA**
Leached from root zone	54	1.2	12	38	61	6	20
As product	87	15	21	5	19	2	6
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	89	0	0	0	0	0	0
CHANGE IN POOLS (KG/HA/YR)	**N**	**P**	**K**	**S**	**CA**	**MG**	**NA**
Organic pool	125	19	11	-3	7	3	1
Inorganic mineral	0	2	-23	0	-2	-3	-3
Inorganic soil pool	1	0	43	0	-72	6	15

Table 10. Current system Nitrogen and Phosphorus summary reports

Nitrogen summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	N IN DRAINAGE (PPM)	N ADDED (KG/HA)	N SURPLUS (KG/HA)
PUKEMUTU EFFLUENT	2474	60	13	287	273
PUKEMUTU NON EFFLUENT	4850	50	11	211	220
WAIKIWI EFFLUENT	1007	51	12	287	265
WAIKIWI NON EFFLUENT	1793	43	10	211	213
FODDER BEET	630	225	42	142	21
TURNIPS	111	111	21	72	2

Phosphorus summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)
PUKEMUTU EFFLUENT	40	1
PUKEMUTU NON EFFLUENT	79	0.8
WAIKIWI EFFLUENT	9	0.5
WAIKIWI NON EFFLUENT	17	0.4
FODDER BEET	3	1.2
TURNIPS	1	1.1

Current system – East Block sheep (File name - CURRENT - EAST SHEEP AUG19)

Table 11. East Block – Sheep whole farm nutrient budget

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	203	14
Phosphorus	10	0.7

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	0	16	0	24	0	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	0	0	0	0	0	0	0
Rain/clover fixation	96	0	3	5	3	7	34

NUTRIENTS REMOVED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Leached from root zone	14	0.7	7	34	33	6	19
As product	20	3	1	3	5	0	1
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	37	0	0	0	0	0	0

CHANGE IN POOLS (KG/HA/YR)	N	P	K	S	CA	MG	NA
Organic pool	25	11	0	-8	0	0	0
Inorganic mineral	0	0	-25	0	-2	-3	-4
Inorganic soil pool	0	2	19	0	-33	4	18

Table 12. East Block - sheep nitrogen and phosphorus summary reports

Nitrogen summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	N IN DRAINAGE (PPM)	N ADDED (KG/HA)	N SURPLUS (KG/HA)
EAST BLOCK - PUKEMUTU	199	14	3	0	74

Phosphorus summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)
EAST BLOCK - PUKEMUTU	9	0.6

East Block – Transition (file name CURRENT - EAST TRANSITION AUG19)

Table 8. East Block – Transition whole farm nutrient budget

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	132	9
Phosphorus	9	0.7

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	0	36	203	33	0	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	0	0	0	0	0	0	0
Rain/clover fixation	150	0	3	5	3	7	34

NUTRIENTS REMOVED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Leached from root zone	9	0.7	15	29	29	6	19
As product	0	0	0	0	0	0	0
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	4	0	0	0	0	0	0

CHANGE IN POOLS (KG/HA/YR)	N	P	K	S	CA	MG	NA
Organic pool	-23	11	6	-8	1	0	0
Inorganic mineral	0	0	-22	0	-2	-3	-4
Inorganic soil pool	0	0	6	0	-71	-7	10

Table 9. East Block - transition nitrogen and Phosphorus summary reports

Nitrogen summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	N IN DRAINAGE (PPM)	N ADDED (KG/HA)	N SURPLUS (KG/HA)
EAST BLOCK - PUKEMUTU	132	9	2	0	-15

Phosphorus summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)
EAST BLOCK - PUKEMUTU	9	0.7

East Block – Dairy support (file name - CURRENT - EAST DAIRY SUPPORT AUG19)

Table 11. East Block – Dairy support whole farm nutrient budget

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	385	27
Phosphorus	10	0.7

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	0	1	0	11	0	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	0	0	0	0	0	0	0
Rain/clover fixation	80	0	3	5	3	7	34

NUTRIENTS REMOVED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Leached from root zone	27	0.7	9	33	43	6	19
As product	9	2	1	1	5	0	0
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	39	0	0	0	0	0	0

CHANGE IN POOLS (KG/HA/YR)	N	P	K	S	CA	MG	NA
Organic pool	78	12	4	-7	1	0	0
Inorganic mineral	0	0	-16	0	-2	-3	-4
Inorganic soil pool	0	0	98	0	-20	12	25

Table 12. East Block – Dairy support nitrogen and phosphorus summary reports

Nitrogen summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	N IN DRAINAGE (PPM)	N ADDED (KG/HA)	N SURPLUS (KG/HA)
EAST BLOCK - PUKEMUTU	381	27	6	0	139

Phosphorus summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)
EAST BLOCK - PUKEMUTU	8	0.6

Proposed system – (file name - PROPOSED - AUG19 MITIGATED)

Table 14. Proposed system whole farm nutrient budget

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	9,908	44
Phosphorus	256	1.1

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	185	22	15	25	8	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	104	14	71	9	15	7	5
Rain/clover fixation	71	0	3	5	3	7	35

NUTRIENTS REMOVED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Leached from root zone	44	1.1	13	39	54	6	20
As product	96	16	23	5	21	2	7
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	84	0	0	0	0	0	0

CHANGE IN POOLS (KG/HA/YR)	N	P	K	S	CA	MG	NA
Organic pool	136	18	13	-5	8	3	1
Inorganic mineral	0	2	-19	0	-2	-3	-3
Inorganic soil pool	0	0	58	0	-54	6	16

Table15. Proposed system nitrogen and phosphorus summary reports

Nitrogen summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	N IN DRAINAGE (PPM)	N ADDED (KG/HA)	N SURPLUS (KG/HA)
BALEAGE WINTER - PUKEMUTU EFF	140	88	19	234	396
BALEAGE WINTER - PUKEMUTU NON EFF	277	84	19	203	368
BALEAGE WINTER - WAIKIWI NON EFF	47	67	16	203	340
BALEAGE WINTER - WAIKIWI EFF	103	74	17	234	382
EAST BLOCK - PUKEMUTU	183	13	3	154	61
PUKEMUTU EFFLUENT	2408	49	11	234	249
PUKEMUTU NON EFFLUENT	3903	45	10	203	218
WAIKIWI EFFLUENT	1700	41	9	234	244
WAIKIWI NON EFFLUENT	719	38	9	203	205

Phosphorus summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)
BALEAGE WINTER - PUKEMUTU EFF	1	0.8
BALEAGE WINTER - PUKEMUTU NON EFF	2	0.7
BALEAGE WINTER - WAIKIWI NON EFF	0	0.4
BALEAGE WINTER - WAIKIWI EFF	1	0.4
EAST BLOCK - PUKEMUTU	10	0.7
PUKEMUTU EFFLUENT	43	0.9
PUKEMUTU NON EFFLUENT	67	0.8
WAIKIWI EFFLUENT	18	0.4
WAIKIWI NON EFFLUENT	8	0.4

Appendix 3: Overseer modelling report for the purposes of as part of a consent application for expanded dairying, dated October 2018

Report disclaimer:

The OverseerFM 6.3.1 model has been utilised to assess the nutrient losses from this property. Details of how the property is operated currently, and how the property will be operated going forward have been gathered from the farm owner. Where accurate data was unavailable, conservative assumptions have been made using professional judgement.

OverseerFM 6.3.1 predicted results have been extracted from the model on 22 August 2019

T & J Driscoll Family Trust

266 O'Shannessy Road, Winton

Overseer modelling report for the purposes of as part of a consent application for expanded dairying

Report prepared for:
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1 October 2018

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B.Agr.Sci

Executive Summary

T & J Driscoll Family Trust operate a high performance dairy farm near Winton, in Central Southland. The partially self-contained 210.6ha total property has a flat contour. There are two soil types on the property – Waikiwi and Pukemutu, separated by a small terrace. Calves are grazed on the platform until weaning and return to the platform as incalf heifers. Over the past three years, an average of 2.8ha of fodder beet and 1ha of winter turnips were planted. The farm has peak milked 573cows on average over the last three seasons.

In October 2016, Tim and Jocelyn purchased a neighbouring 13.9ha sheep grazing block – called the East Block. Following the purchase of the block, Tim and Jocelyn have transitioned the block into dairy support. It is proposed that the East Block (13.9ha) be converted to dairy and incorporated into the milking platform. In the proposed farm system, a portion of the herd will be wintered on 4ha with a baleage and grass diet. Young stock will continue to be grazed off farm from weaning to their return as incalf heifers.

Using Overseer (version 6.3.0) nutrient budgets have been constructed for the current land use and a proposed dairy unit nutrient budget to inform the consent application for expanded dairying. The nutrient budgets show the average nutrient losses for the last three years. Data inputs and methodology are explained in detail within this report.

A summary of the modelling output is given in Table 1. It shows a small decrease (loss than 5%) in the total Nitrogen loss from the property. Total Phosphorus loss from the property is predicted to increase (by less than 7%).

Table 13. Summary data from the Overseer analysis of the T & J Driscoll Family Trust Current and Proposed systems

	Current Total (averaged over 3 years)	Proposed system
Total Farm N Loss (kg)	11503	11345
N Loss/ha (kgN/ha/yr)	51	51
N Concentration in Drainage (ppm)		Pastoral – 9.8 – 29.3
Total Farm P Loss (kg)	262	278
P loss/ha (kgP/ha/yr)	1.2	1.2
Overseer - predicted pasture grown (tDM/ha/yr)		16.2

The key drivers of a decrease in nitrogen loss are shown below. In comparison to the current system, the proposed system has:

- Increased the area that effluent is applied to – reduced effluent N application to this area
- Reduced nitrogen fertiliser use on the effluent block
  Increased cow numbers – increasing loss risk

The key driver of the increase in phosphorus loss is an increase in losses from "other sources".

Overseer can model a range of good management practices. However, some farm specific good management practices cannot be modelled. Recommendations of further good management practices that cannot be modelled by Overseer are given within this report to further reduce the nutrient losses from this farm system.

Property legal description

Part Section 29 and 30 Block I Winton HUN

Section 1 and 2 SO 12000

Section 43, 44, 45 and 54 Block I Winton HUN

Lot 1 and 2 DP 449518

Report purpose

To quantify the losses of nitrogen and phosphorus from the current and the proposed farm systems being operated on this property. The report details the data inputs, the modelling outputs and areas of environmental risk within the system.

Disclaimer

The Overseer 6.3.0 model has been utilised to assess the nutrient losses from this property. Details of how the property is operated currently, and how the property will be operated going forward have been gathered from the farm owner. Where accurate data was unavailable, conservative assumptions have been made using professional judgement.

The proposal

Farm objectives

T & J Driscoll Family Trust operate their farm business with the following objectives:

- To refine the farm system to maximise farm profitability – targeting $2000/ha EBIT at a $5.00 milk price
- To operate in an environmentally sustainable manner with an emphasis on continual education and improvement
- Consolidate the business to ensure it is resilient
- "Farm for the future" – the property must remain flexible to deal with changes in market forces

Current System

Nutrient budgets have been constructed to determine the average actual nutrient losses over three years (June 2015 – May 2018).

Dairy platform

T & J Driscoll Family Trust operate a high performing dairy farm near Winton, in Central Southland. The farm is owned by the Driscoll trust (JP, CA, TJ and JA Driscoll), and is operated under a lease arrangement by T & J Driscoll Family Trust (Tim and Jocelyn Driscoll). The partially self-contained 210.6ha total property has a flat contour. There are two soil types on the property – Waikiwi and Pukemutu. Calves are grazed on the platform until weaning and return to the platform as incalf heifers.

Over the previous three seasons, the property has milked an average of 573cows at peak. There has been an average of 2.8ha fodder beet and 1ha turnips grown on farm for winter and early spring grazing. Nitrogen fertiliser has been applied at an average of 213kgN/ha in split applications from August to April over the whole milking platform. In the last three seasons, the majority of the herd has been wintered off farm at a graziers property. On average, 83 cows were wintered at home in June and July, while the remaining 516 were off farm. Early calving heifers and cows return to the platform in mid July. Bought in feed has been assumed to ensure that a feasible pasture growth rate is achieved in an average season.

East Block

In October 2016, Tim and Jocelyn purchased a neighbouring 13.9ha sheep grazing block – called the East Block. Following the purchase of the block, Tim and Jocelyn have transitioned the block into dairy support. In order to create accurate actual budgets for the previous three years, three separate budgets have been created for the East Block:

- Pre purchase use (15-16 season) – a sheep grazing block. Accurate stock numbers were not available. A conservative estimation of stocking rate and management practice has been made utilising Google Earth imaging and the Beef and Lamb farm monitoring data.
- Transition (16-17 season) – All feed grown on farm was cut as baleage. This was fed to incalf heifers or exported from the block.

- Dairy support (17-18 season) – 125incalf heifers and 100cows were wintered on a baleage/grass diet on the block. The block was grazed by heifers in January and February of 2018. All other feed grown was made into baleage.

Proposed system:

Through the development of the proposed system, a number of scenarios were run through Overseer. The proposed system detailed below was chosen as it was in line with the farm objectives, the farm system preferences and the proposed Water and Land Plan.

It is proposed that the East Block (13.9ha) be converted and incorporated into the milking platform. The total farm area would then be 224.5ha total and peak cow numbers would be increased to 700 cows. The property will winter 216cows on farm, and continue to winter the remaining 516cows off farm at a graziers property. The cows wintered on farm will be grazed of 4ha with a baleage grass diet. Young stock will continue to be grazed off farm from weaning to their return as incalf heifers. The effluent system will be extended to 93.3ha and fertiliser nitrogen applications will be targeted to 197kgN/ha on the effluent area and 218kgN/ha on the non-effluent area. Bought in feed has been assumed to ensure that a feasible pasture growth rate is achieved in an average season when consented cow numbers are being milked.

Modelling method

Nutrient losses have been estimated using the Overseer Version 6.3.0 model. Overseer is a software application that models nutrient movements within a farm system. Input data detailing the farm system is entered into the software and interpreted through the use of a series of sub-model that calculate the flow of seven major farm nutrients (Nitrogen, Phosphorus, Sulphur, Calcium, Magnesium and Sodium). Output data is reported for interpretation and to inform farm management practices. It currently requires an expert user to describe the physical and management details of a farm.

Overseer assumptions

Within the Overseer software, assumptions have been made of the farm management:

- Long term annual average model
  The model uses annual average input and produces annual average outputs
- Near equilibrium conditions
  Model assumes that that the farm is at a state where there is minimal change each year
- Actual and reasonable inputs
  It is assumed that input data is reasonable and a reflection of the actual farm system. If any parameter changes, it is assumed that all other parameters affected will also be changed.
- Good management practices are followed
  Overseer assumes the property is managed is line with accepted industry good management practice.

Overseer limitations

Key limitations of the Overseer model are:

- Overseer does not predict transformations, attenuation or dilution of nutrients between the root zone or farm boundary and the eventual receiving water body. A catchment model is needed to estimate the effects of the nutrient losses from farms on groundwater, river or lake water quality.
- Overseer does not calculate outcomes from extreme events (floods and droughts), but provides a typical years result based on a long-term average.
- Overseer does not calculate the impacts of a conversion process, rather it predicts the long-term annual average nutrient budgets for changed land use.
- Overseer is not spatially explicit beyond the level of defined blocks
- Not all management practices or activities that have an impact on nutrient losses are captured in the Overseer model
- Overseer does not represent all farm systems in New Zealand
- Components of Overseer have not been calibrated against measured data from every combination of farm systems and environment

Information on Overseer can be obtained from the following reports:

- Technical Description of OVERSEER for Regional Councils, September 2015
- Review of the phosphorus loss submodel in OVERSEER®, September 2016
- Using OVERSEER® in Regulation – Technical Resources and Guidance for Regional Councils, August 2016

Data input standards

Nutrient budgets have been constructed using the Overseer Version 6.3.0 model.

The nutrient budget have been developed in accordance with the Overseer data input protocols - “Overseer, Best Practice Data Input Standards, March 2018.” No deviations have been made from these protocols.

Modelling Inputs

To construct the nutrient budgets the following assumptions have been made;

Blocks

The farm has been split into the following pastoral (effluent and non-effluent) and fodder crop blocks. Total farm area has been taken from the legal area (ex the rates demand). The area of each block has been determined using the measure function on Beacon. Soils on the property were assessed utilising the topoclimate information. Overseer soil settings were obtained from SMap for all soil types.

Block Name	**Soil Type (from Beacon)**	**Smap Ref**	**Contour**	**Current Dairy Platform (ha)**	**East Block (ha)**	**Proposed Land Use (ha)**
Effluent – Waikiwi	Edendale	Waiki_30a.1	Flat	**20.1**		**41.7**
Effluent – Pukemutu	Pukemutu	Pukem_6a.1	Flat	**41.9**		**49.9**
Non Effluent – Waikiwi	Edendale	Waiki_30a.1	Flat	**42.2**		**19.4**
Non Effluent – Pukemutu	Pukemutu	Pukem_6a.1	Flat	**98.4**		**101.5**
East Block - Pukemutu	Pukemutu	Pukem_6a.1	Flat		**13.9**	
Baleage winter Eff Waikiwi	Edendale	Waiki_30a.1	Flat			**0.8**
Baleage winter Eff Pukemutu	Pukemutu	Pukem_6a.1	Flat			**0.9**
Baleage Winter Non Eff Waikiwi	Edendale	Waiki_30a.1	Flat			**0.4**
Baleage winter Non Eff Pukemutu	Pukemutu	Pukem_6a.1	Flat			**1.9**
	Effective Farm Area			**202.6**	**13.9**	**216.5**
	Non productive			8.0		8.0
	Total Farm Area			**210.6**	**13.9**	**224.5**
Rotating fodder crops						
Fodder beet				2.8		
Winter Turnips				1.0		

Climate Data

- Southland as the location setting
- The following climate information has been used from the Overseer climate station tool;
    - 1094mm of rainfall
    - 10.1 degrees Celsius mean annual temperature
    - Daily rainfall pattern setting of 731 to 1450mm, low
    - Mean annual PET of 711mm (moderate variation)

Farm System

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
Milk solids production	271,130 kg MS 473 kgMS/cow Median calving date – 20th August Drying off – 31st May				329,000 kg MS 470 kgMS/cow Median calving date – 20th August Drying off – 31st May
Cows on farm (Lactating and wintered)	Breed Fr J X Jul 140 Aug 599 Sep 593 Oct 573 Nov 573 Dec 573 Jan 573 Feb 573 Mar 573 Apr 530 May 487 Jun 83 Peak cows: 573			Breed Fr J X Winter grazing for 100MA and 125R2 cows (Jun and Jul)	Breed Fr J X Jul 273 Aug 732 Sep 724 Oct 700 Nov 700 Dec 700 Jan 700 Feb 700 Mar 700 Apr 647 May 595 Jun 216 Peak cows: 700
Dairy replacements on farm	Calves are reared on farm until weaning (1-4months old) Aug - 135 Sep - 160 Oct - 160 Nov – 160		Grazing for R2 heifers May 125	Grazing for R2 heifers Jan 125 Feb 125	Calves are reared on farm until weaning (1-4months old) Aug - 152 Sep - 187 Oct - 187 Nov – 187
Breeding bulls	Thirteen 2yr old Jersey bulls (Dec and Jan)				Fifteen 2yr old Jersey bulls (Dec and Jan)
Sheep		Wintered: 120 MA ewes 46replacements 3rams Coopworth 125% lambing percentage 20% replacement rate			

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
		Mean lambing date of the 15th September. All non-replacement lambs sold by the end of May			
Relative productivity	No differences between blocks	No differences between blocks	No differences between blocks	No differences between blocks	No differences between blocks
Structures	Calving Pad Not modelled as used when ground conditions are saturated rather than for fixed time				Calving Pad Not modelled as used when ground conditions are saturated rather than for fixed time
In Shed Feeding	Management 100% of milkers fed Aug - May				Management 100% of milkers fed Aug - May
Rotating fodder crop management	2.8ha fodder beet Yield: 25tDM/ha Conventional cultivation October Fertiliser: 500kg/ha Winton Fodder Beet mix at sowing (delivering 50kg/ha N, 32kg/ha P, 75kg/ha K and 27kg/ha S) 100kg/ha Urea in December 100kg/ha Potassium Chloride in December 100kg/ha Urea in January Grazed by dairy cows May – Aug				Cows on farm in June/July are wintered on a baleage grass diet. 4ha Baleage/Grass wintering This area rotates around the platform and is part of the property's regrassing strategy All feed required is imported (160tDM baleage)

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
	Resown in permanent pasture in September				
	1.0ha Turnips Yield: 8tDM/ha Conventional cultivation February Fertiliser: 150kg/ha DAP and 150kg/ha super at sowing 100kg/ha Urea in March Grazed by dairy cows Jun – Aug Resown in permanent pasture in September				
Imported Supplements	In shed: 236tDM PKE 33tDM Barley In paddock: 418tDM Silage			In paddock: 65 tDM baleage	In shed: 300tDM PKE 100tDM Barley 100tDM DDG In paddock: 850tDM baleage For wintering: 160tDM baleage
Exported Supplements			130tDM baleage		
Soil Fertility	Olsen P 32 (soil test results June 2017) All other values entered at agronomic optimum	All soil test values entered at agronomic optimum (Olsen P of 20)	All soil test values entered at agronomic optimum (Olsen P of 20)	All soil test values entered at agronomic optimum (Olsen P of 20)	Olsen P 32 (soil test results June 2017) All other values entered at agronomic optimum

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
Fertiliser	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels
Nitrogen Fertiliser	213 kgN/ha in split applications (Aug – April)				Non Effluent blocks 218kgN/ha in split applications (Aug – April) Effluent Blocks 197kgN/ha in split applications (Aug – April)
Drainage	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained
Farm dairy effluent	Holding pond Solids aren't separated from the liquid Liquid effluent is applied at a depth of <12mm to the "effluent" blocks An effluent area of at least 39 ha is required to achieve a loading of less than 150 kg N / ha / year				Holding pond Solids aren't separated from the liquid Liquid effluent is applied at a depth of <12mm to the "effluent" blocks An effluent area of at least 34 ha is required to achieve a loading of less than 150 kg N / ha / year

Predicted Overseer Results

Current land use

	Current Dairy Platform (3yr average)	East Block – Sheep (15-16 season)	East Block – Transition (16-17 season)	East Block – Dairy Support (17-18 season)	East block (average of 3yrs)	Current Total (averaged over 3 years)
Total Farm N Loss (kg)	11262	204	132	386	241	11503
N Loss/ha (kgN/ha/yr)	53	15	10	28	17	51

N Concentration in Drainage (ppm)	Pastoral – 9.9 to 12.8 Crops – 21.1 to 42.1	Pastoral – 3.2	Pastoral – 2.1	Pastoral - 6.1		
Total Farm P Loss (kg)	252	10	9	10	10	262
P loss/ha (kgP/ha/yr)	1.2	0.7	0.7	0.7	0.7	1.2
Overseer - predicted pasture grown (tDM/ha/yr)	16.2	11.8	11.8	11.9		

Proposed system

	Current Total (averaged over 3 years)	Proposed system
Total Farm N Loss (kg)	11503	11345
N Loss/ha (kgN/ha/yr)	51	51
N Concentration in Drainage (ppm)		Pastoral – 9.8 – 29.3
Total Farm P Loss (kg)	262	278
P loss/ha (kgP/ha/yr)	1.2	1.2
Overseer - predicted pasture grown (tDM/ha/yr)		16.2

Conclusions from the modelling

Nutrient budgets have been developed for Driscoll Dairy. These budgets compare the nutrient loss of the current farm system with the proposed farm system. Overseer has predicted that losses of nitrogen will decrease slightly (less than 5%) and losses of phosphorus will increase slightly (less than 7%).

The key drivers of a decrease in nitrogen loss are shown below. In comparison to the current system, the proposed system has:

- Increased the area that effluent is applied to – reduced N application in effluent to this area
- Reduced nitrogen fertiliser use on the effluent block
- Increased cow numbers – increasing loss risk
-

The key driver of the increase in phosphorus loss is an increase in losses from "other sources".

Please note: Losses from "other sources" include predicted losses from laneways, calving pads and yards. The increase in losses from other sources is a result of an increase in animal excretion onto laneways. Overseer estimates amount of excreta and assumes all P ends up in dung. Some of this dung is assumed to fall on laneways and 30% of that P is assumed to be lost from the farm. Furthermore, Overseer is not spatially explicit; so it does not take into account critical source area on farms. These critical source areas accumulate overland flow from adjacent areas and deliver overland flow to surface water bodies. On farms where there is not a direct connection (or a less connection) via critical source areas, or where management mitigates risk, Overseer cannot model the impact of these at an individual farm scale.

Recommendations:

Apart from the system changes outlined above, the following recommendations are given to reduce the nutrient losses from this farm system.

Overseer can model a range of good management practices. However, some farm specific good management practices cannot be modelled. It is recommended that the following good management practices are implemented on this property:

- Fertiliser is applied at the correct rate, and is not applied in close proximity to waterways
- Identify and manage critical source areas to reduce the risk of losses. These include loses from laneways, gateways and high traffic zones.
- Stand cows off on the calving pad during periods of high soil moisture content to minimise soil damage and leaching risk.
- Fertiliser applications are made during periods of plant growth.
- An effluent management plan is in place that takes into account soil moisture and temperature, and includes a fail safe system

The nutrient budgets within this report have been developed assuming that the Olsen P is 32 and all other soil fertility measures are at the agronomic optimum. It also assumes that fertiliser is applied at a maintenance rate. A soil testing regime should be implemented and fertiliser recommendations should be developed in line with these soil testing results.

The proposed Southland Water and Land Plan is currently in process. It will be important to stay up to date with developments in Environment Southland policy and rules, including the Limit Setting Process which will develop over the next few years

A farm environmental management plan detailing the recommendations within this report should be developed for the property.

Current system - Dairy Platform

Table 14. Current system whole farm nutrient budget

(kg/ha/yr)	N	P	K	S	Ca	Mg	Na
Nutrients added							
Fertiliser, lime & other	201	24	2	34	0	0	0
Rain/clover N fixation	74	0	3	5	3	7	35
Irrigation	0	0	0	0	0	0	0
Supplements	80	11	58	9	9	6	4
Nutrients removed							
As products	87	15	21	5	19	2	6
Exported effluent	0	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0
To atmosphere	89	0	0	0	0	0	0
To water	53	1.2	12	46	61	6	20
Change in farm pools							
Plant Material	0	0	-2	0	0	0	0
Organic pool	125	19	11	-3	7	3	1
Inorganic mineral	0	2	-23	0	-2	-3	-3
Inorganic soil pool	1	-2	43	0	-72	6	15

Table 15. Current system Nitrogen report

Block name	Total N lost kg N/yr	N lost to water kg N/ha/yr	N in drainage * ppm	N surplus kg N/ha/yr	Added N ** kg N/ha/yr
Waikiwi Effluent	1,003	51	**11.4**	264	285
Pukemutu Effluent	2,464	60	**12.8**	272	285
Waikiwi non effluent	1,793	43	9.9	213	211
Pukemutu non effluent	4,850	50	11.2	220	211
Fodder Beet	630	225	**42.1**	21	142
Turnips	111	111	**21.1**	2	72
Other sources	410				
Whole farm	11,262	53			
Less N removed in wetland	0				
Farm output	11,262	53			

Table 16. Current system Phosphorus report

Block name	Total P lost kg P/yr	P lost to water kg P/ha/yr	P loss categories		
			Soil	Fertiliser	Effluent
Waikiwi Effluent	9	0.5	Low	Low	Low
Pukemutu Effluent	39	0.9	Medium	Low	Medium
Waikiwi non effluent	17	0.4	Low	Low	N/A
Pukemutu non effluent	79	0.8	Medium	Low	N/A
Fodder Beet	3	1.2	N/A	N/A	N/A
Turnips	1	1.1	N/A	N/A	N/A
Other sources	104				
Whole farm	252	1.2			

East Block – Sheep

Table 17. East Block – Sheep whole farm nutrient budget

(kg/ha/yr)	N	P	K	S	Ca	Mg	Na
Nutrients added							
Fertiliser, lime & other	0	16	0	24	0	0	0
Rain/clover N fixation	97	0	3	5	3	7	35
Irrigation	0	0	0	0	0	0	0
Nutrients removed							
As products	20	3	1	3	5	0	1
Exported effluent	0	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0
To atmosphere	37	0	0	0	0	0	0
To water	15	0.7	7	35	33	6	19
Change in farm pools							
Plant Material	0	0	0	0	0	0	0
Organic pool	25	11	0	-8	0	0	0
Inorganic mineral	0	0	-25	0	-2	-3	-4
Inorganic soil pool	0	2	19	0	-33	4	18

Table 18. East Block - sheep nitrogen report

Block name	Total N lost kg N/yr	N lost to water kg N/ha/yr	N in drainage * ppm	N surplus kg N/ha/yr	Added N ** kg N/ha/yr
East block - Pukemutu	200	14	3.2	74	0
Other sources	4				
Whole farm	204	15			
Less N removed in wetland	0				
Farm output	204	15			

Table 19. East Block - Sheep phosphorus report

Block name	Total P lost kg P/yr	P lost to water kg P/ha/yr	P loss categories		
			Soil	Fertiliser	Effluent
East block - Pukemutu	9	0.6	Low	Low	N/A
Other sources	1				
Whole farm	10	0.7			

East Block – Transition

Table 8. East Block – Transition whole farm nutrient budget

(kg/ha/yr)	N	P	K	S	Ca	Mg	Na
Nutrients added							
Fertiliser, lime & other	0	36	204	33	0	0	0
Rain/clover N fixation	152	0	3	5	3	7	35
Irrigation	0	0	0	0	0	0	0
Nutrients removed							
As products	0	0	0	0	0	0	0
Exported effluent	0	0	0	0	0	0	0
As supplements and crop residues	162	24	203	17	46	11	9
To atmosphere	4	0	0	0	0	0	0
To water	10	0.7	15	30	29	6	19
Change in farm pools							
Plant Material	0	0	0	0	0	0	0
Organic pool	-24	12	6	-8	1	0	0
Inorganic mineral	0	0	-22	0	-2	-3	-4
Inorganic soil pool	0	0	5	0	-72	-7	10

Table 9. East Block - transition nitrogen report

Block name	Total N lost kg N/yr	N lost to water kg N/ha/yr	N in drainage * ppm	N surplus kg N/ha/yr	Added N ** kg N/ha/yr
East block - Pukemutu	132	9	2.1	-15	0
Other sources	1				
Whole farm	132	10			
Less N removed in wetland	0				
Farm output	132	10			

Table 10. East Block - Transition phosphorus report

Block name	Total P lost kg P/yr	P lost to water kg P/ha/yr	P loss categories		
			Soil	Fertiliser	Effluent
East block - Pukemutu	9	0.7	Low	Low	N/A
Other sources	0				
Whole farm	9	0.7			

East Block – Dairy support

Table 11. East Block – Dairy support whole farm nutrient budget

(kg/ha/yr)	N	P	K	S	Ca	Mg	Na
Nutrients added							
Fertiliser, lime & other	0	0	0	8	0	0	0
Rain/clover N fixation	81	0	3	5	3	7	35
Irrigation	0	0	0	0	0	0	0
Nutrients removed							
As products	9	2	1	1	5	0	0
Exported effluent	0	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0
To atmosphere	40	0	0	0	0	0	0
To water	28	0.7	9	30	43	6	19
Change in farm pools							
Plant Material	-75	-14	-94	-11	-23	-8	-7
Organic pool	79	12	4	-7	1	0	0
Inorganic mineral	0	0	-16	0	-2	-3	-4
Inorganic soil pool	0	-1	98	0	-21	12	25

Table 12. East Block – Dairy support nitrogen report

Block name	Total N lost kg N/yr	N lost to water kg N/ha/yr	N in drainage * ppm	N surplus kg N/ha/yr	Added N ** kg N/ha/yr
East block - Pukemutu	381	27	6.1	139	0
Other sources	5				
Whole farm	386	28			
Less N removed in wetland	0				
Farm output	386	28			

Table 13. East Block – Dairy support phosphorus report

Block name	Total P lost kg P/yr	P lost to water kg P/ha/yr	P loss categories		
			Soil	Fertiliser	Effluent
East block - Pukemutu	8	0.6	Low	N/A	N/A
Other sources	2				
Whole farm	10	0.7			

Proposed system

Table 14. Proposed system whole farm nutrient budget

(kg/ha/yr)	N	P	K	S	Ca	Mg	Na
Nutrients added							
Fertiliser, lime & other	199	21	0	30	0	0	0
Rain/clover N fixation	73	0	3	5	3	7	35
Irrigation	0	0	0	0	0	0	0
Supplements	103	21	97	16	22	11	7
Nutrients removed							
As products	99	17	24	5	21	2	7
Exported effluent	0	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0
To atmosphere	87	0	0	0	0	0	0
To water	51	1.2	13	49	59	6	20
Change in farm pools							
Plant Material	0	0	0	0	0	0	0
Organic pool	138	20	15	-3	8	4	1
Inorganic mineral	0	2	-19	0	-2	-3	-3
Inorganic soil pool	0	2	67	0	-62	9	17

Table15. Proposed system nitrogen report

Block name	Total N lost kg N/yr	N lost to water kg N/ha/yr	N in drainage * ppm	N surplus kg N/ha/yr	Added N ** kg N/ha/yr
Waikiwi Effluent	1,887	45	10.2	241	249
Pukemutu Effluent	2,662	53	**11.5**	249	249
Waikiwi non effluent	830	43	9.8	210	215
Pukemutu non effluent	5,030	50	11.1	217	215
Baleage winter - waikiwi Eff	88	111	**25.2**	506	249
Baleage winter - Pukemutu Eff	120	133	**29.3**	530	249
Baleage winter - Waikiwi Non Eff	40	99	**22.6**	451	215
Baleage winter - Pukemutu Non Eff	240	126	**28.3**	498	215
Other sources	449				
Whole farm	11,345	51			
Less N removed in wetland	0				
Farm output	11,345	51			

Table 20. Proposed system phosphorus report

Block name	Total P lost	P lost to water	P loss categories		
	kg P/yr	kg P/ha/yr	Soil	Fertiliser	Effluent
Waikiwi Effluent	19	0.5	Low	Low	Low
Pukemutu Effluent	46	0.9	Medium	Low	Medium
Waikiwi non effluent	8	0.4	Low	Low	N/A
Pukemutu non effluent	82	0.8	Medium	Low	N/A
Baleage winter - waikiwi Eff	0	0.5	Low	Low	Low
Baleage winter - Pukemutu Eff	1	0.9	Medium	Low	Medium
Baleage winter - Waikiwi Non Eff	0	0.4	Low	Low	N/A
Baleage winter - Pukemutu Non Eff	2	0.8	Medium	Low	N/A
Other sources	121				
Whole farm	278	1.2			

Farm Map

Figure 1. Driscolls farm map showing the current and proposed effluent areas

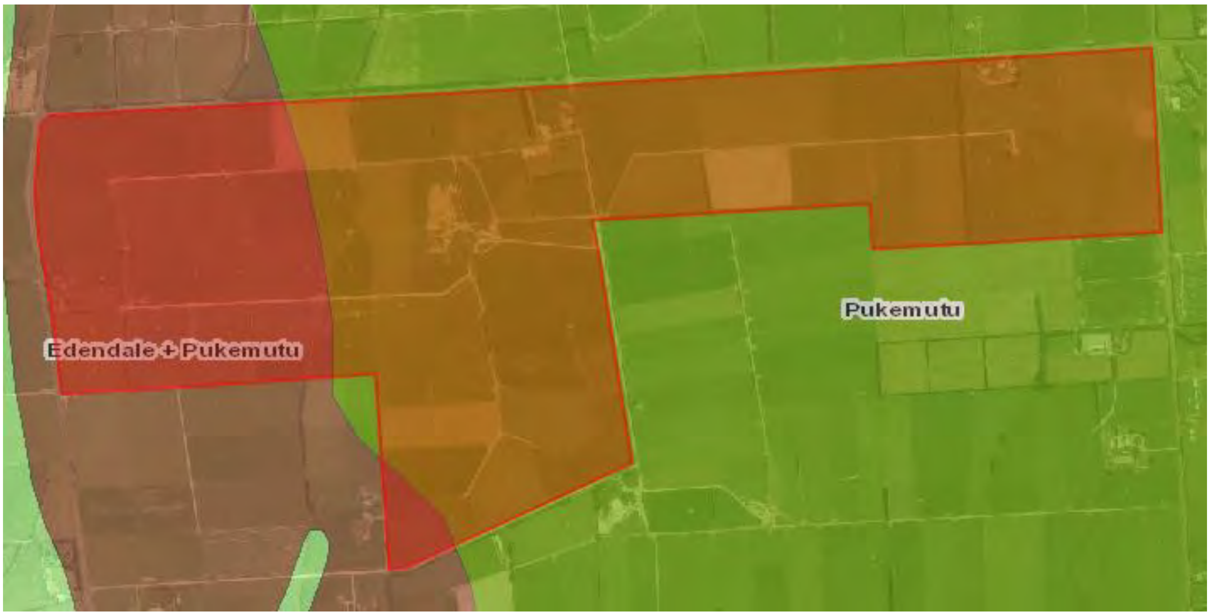

Figure 2. Driscolls farm map showing the soil types on farm

Report disclaimer:
The OverseerFM 6.3.1 model has been utilised to assess the nutrient losses from this property. Details of how the property is operated currently, and how the property will be operated going forward have been gathered from the farm owner. Where accurate data was unavailable, conservative assumptions have been made using professional judgement.

OverseerFM 6.3.1 predicted results have been extracted from the model on 22 August 2019

Appendix 4: Further information: T and J Driscoll Family Trust consent application, December 2018

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Further information: T and J Driscoll Family Trust consent application

Please find below a file note in relation to Overseer modelling completed for the T and J Driscoll Family Trust. This file note is intended to be read alongside the Overseer Modelling Report, dated 1st October, 2018.

Executive summary

An application for consent to use land for dairying was made by the T and J Driscoll Family Trust in October 2018. This application utilised Overseer data to quantify predicted losses of nitrogen and phosphorus from the current and proposed systems. Environment Southland has raised concern that the predicted P losses using Overseer are higher in the proposed system than the current system. However, there are a range of P loss mitigations that are not accounted for, or are not fully accounted for, in Overseer. This file note seeks to quantitatively estimate the difference in P loss between the current and proposed systems using both Overseer and the results of recent New Zealand research.

Overseer has predicted the following total P loss:

Current situation	262 kg P/yr
Proposed situation	278 kg P/yr
Difference	**16 kg P/yr increase**

The Overseer model has a reasonable degree of calibration and evaluation/validation within the nitrogen leaching sub-model. However, the P loss sub-model has been developed using a less extensive calibration and evaluation/validation base. The model is not spatially explicit and as such it uses a number of assumptions to make estimates of both N and P loss. It is important to appreciate that there are significant uncertainties associated with Overseer nutrient loss estimates and Overseer currently only provides for a very limited range of mitigation options to be incorporated.

We have considered the current mitigations in place to reduce nutrient loss from laneways and further mitigations planned. These are described in the report. Revised Overseer P loss estimates have been calculated, taking into account the effect of the laneway mitigations for the current and proposed systems:

	Overseer P loss estimate	– estimated P loss mitigated	= revised P loss
Current system	262 kg P/yr	- 33kg P	= 229kgP
Proposed system	278 kg P/yr – 19.1kgP	- 52kg P	= 226kgP
Difference			**= 3kg P/yr decrease**

Further mitigations that may be implemented in the future are to apply 50% of the phosphorus fertiliser in a low solubility form and to lower the Olsen P to 30. Overseer predicts that these mitigations would reduce P loss from the pastoral areas by a further 10 kg P.

Report disclaimer:
The OverseerFM 6.3.1 model has been utilised to assess the nutrient losses from this property. Details of how the property is operated currently, and how the property will be operated going forward have been gathered from the farm owner. Where accurate data was unavailable, conservative assumptions have been made using professional judgement.

OverseerFM 6.3.1 predicted results have been extracted from the model on 22 August 2019

P runoff from laneways

Overseer has a built in assumption that 30% of phosphorus deposited on laneways as dung is lost. This is accounted for in the "other sources" losses within the Phosphorus report (shown in the appendices of the consent application). Research has shown that a dairy cow consuming 15.5kgDM/day on a pasture diet will consume 0.4 kg P/week, of which 66% will be deposited in dung (shown in the table below, source: Massey University). Assuming that the farm has a lactation season of 270 days, each cow will ingest 15.4 kg P/cow, and **10.2kgP/animal would be deposited as dung.** A study by Ledgard *et al.* (1999) reported that **5% of cow excreta was deposited on laneways.** We have assumed that Overseer incorporates this information. Overseer then assumes that for phosphorus deposited on laneways in dung, **30% is lost from the system to water.**

Table 1.4 The fate of minerals ingested by a lactating dairy cow (ingesting 15.5 kg DM/day) (adapted from During 1984).

Element	Consumption	Percentage in			
	Kg /week	Faeces	Urine	Milk	Retained
N	5.1	26	53	17	4
P	0.4	66	-	26	8
K	2.9	11	81	5	3
Mg	0.2	80	12	3	5
Ca	0.4	77	3	11	9
Na	0.4	30	56	8	6

There is opportunity to mitigate the losses from laneways through careful management of bridges/culverts, buffer zone planting, laneway cambering and siting laneways away from waterways. These mitigations all reduce P loss by ensuring laneway runoff is filtered through a vegetated buffer strip. Research has shown that vegetated buffer strips can reduce P losses by 38-59% (figure 1). None of these mitigation strategies are provided for in Overseer.

As described in the application for consent, this property has already implemented some mitigations to reduce phosphorus loss from laneways. These include kickboards on the two bridges (see pictures in consent application) and having some cut outs from the lane that direct runoff into paddocks rather than into waterways. The process of applying for consent has identified areas where further mitigations could be implemented. This includes improving the kickboards on the bridges, and improving the camber and increasing the size of the buffer on the laneway south of the cowshed which runs alongside an open drain. Water flow will be redirected through vegetated areas to allow for filtering. These areas of laneway are considered critical source areas – small areas that contribute a relatively high proportion of nutrient/phosphorus losses.

These improvements in laneway management will further mitigate losses of P. A study in the Mangakino stream by McDowell et al. (2006) found that the majority (c. 80%) of P losses were occurring from a small tributary that contributed less than 20% of the flow. Investigation of the tributary found that there was a heavily used, poorly managed dairy farm stream crossing less than 200m upstream from the confluence. Management of these high risk areas of laneway can therefore have significant positive effects on Predicted losses.

Given the evidence above, it has been assumed that the Driscoll property is currently mitigating at the low end of the range of reported mitigation, i.e., 38% of the losses from laneways assumed by Overseer, for the current 573 cows.

P loss mitigated	= Cows	x P in dung	x Excreted on lanes	x assumed losses	x current mitigations	
Current system	= 573	x 10.2kg P	x 5%	x 30%	x 38%	
	= 33 kg P/yr					

Revised Overseer estimated P loss (current system) = 262 kg P – 33kg P = 229 kg P

Going forward, as a result of this consent application, the Driscolls will make further mitigations to reduce laneway losses through increased use of vegetated buffers, as described above. We consider that these improvements can reduce annual P loss from laneways to the midpoint of the range of reported mitigation, i.e., 49% of the losses assumed by Overseer, for the proposed 700cows.

P loss mitigated	= Cows	x P in dung	x Excreted on lanes	x assumed losses	x extra mitigations	
Proposed system	= 700	x 10.2kgP	x 5%	x 30%	x 49%	
	= 52 kg P/yr					

Revised Overseer estimated P loss (proposed system) = 278 kg P – 52kg P = 226 kg P

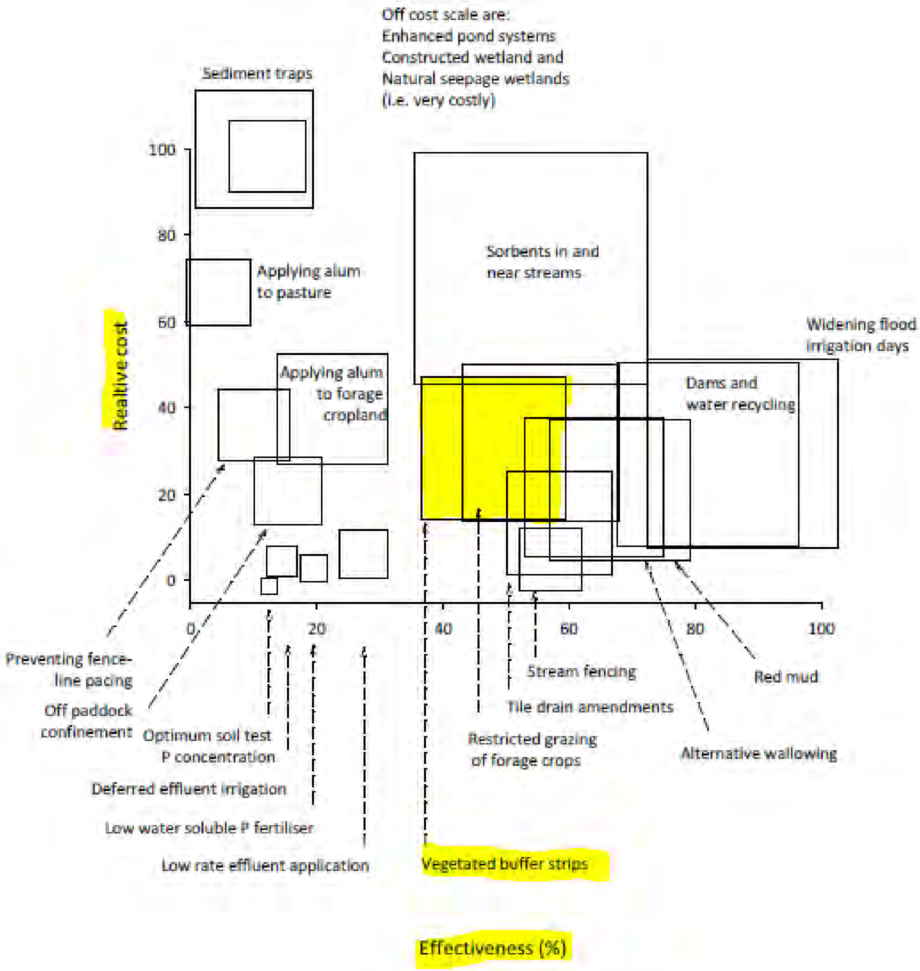

Figure 3. Diagram of the cost and effectiveness of strategies to mitigate phosphorus losses to water at the farm-scale. Cost is shown as the cost per kg of P mitigated relative to the most expensive strategy - sediment traps at $360 per kg P retained/ha/yr. From McDowell et al (2013)

Further future mitigation options:

Lower solubility Phosphorus fertilisers

The modelling completed assumed that fertiliser P would be applied as super phosphate – the most commonly used P fertiliser in New Zealand. This assumption was made in order to show a conservative estimate of losses, and to ensure that the systems were compared fairly. Going forward, the Driscolls have indicated that they are considering using RPR/serpentine super instead of super phosphate. This was not shown in the modelling as a transition to RPR/serpentine super should be untaken over a number of years in order to maintain pasture production.

Super phosphate fertiliser is 100% water soluble. In comparison, serpentine super and Reactive Phosphate Rock (RPR) have lower water solubility - 2.9% and 0% respectively (McNaught et al, 1968). As a result, the risk of P loss is higher in situations where super phosphate has been applied compared to RPR or serpentine super.

To show the effectiveness of this as a mitigation, I have modelled applying a maintenance application of P as 50% super phosphate and 50% RPR instead of 100% super phosphate. Please note

that the amount of P, in kg P per ha, has not changed, but the form of the fertiliser has. Overseer assumes that serpentine super has the same solubility as superphosphate (Wheeler and Watkins, 2016), and therefore the same fertiliser runoff risk profile. However, due to it's similar water solubility, serpentine super is expected to have similar losses of P as RPR. **This change in fertiliser form has resulted in a reduction in predicted P loss by 4kgP**. The Overseer P loss reports are shown in the appendices.

Soil Olsen P

Olsen P is a commonly used measure of plant available soil P. From an agronomic perspective, the optimum Olsen P level is 30. The Driscolls have an average Olsen P of 32. In the modelling completed for the Driscoll's it was assumed that maintenance fertiliser would be applied going forward, and that the Olsen P would therefore remain the same.

The consent application process has highlighted the environmental risk of a higher Olsen P to Tim and Jocelyn. As a result Tim and Jocelyn are considering reducing their Olsen P. **Overseer predicts that a reduction in Olsen P from 32 to 30 is expected to reduce P loss by 6kgP**. The Overseer P loss reports are shown in the appendices.

Conclusions:

Overseer has predicted the following total P loss:

Current situation	262 kg P/yr
Proposed situation	278 kg P/yr
Difference	**16 kg P/yr increase**

We have considered the current mitigations in place to reduce nutrient loss from laneways and further mitigations planned. These are described in the report. Revised Overseer estimates have been calculated, taking into account the effect of the laneway mitigations for the current and proposed systems:

	Overseer P loss estimate	– estimated P loss mitigated	= revised P loss
Current system	262 kg P/yr	- 33kg P	= 229kgP
Proposed system	278 kg P/yr – 19.1kgP	- 52kg P	= 226kgP
Difference			**= 3kg P/yr decrease**

Further mitigations that may be implemented in the future are to apply 50% of the phosphorus fertiliser in a low solubility form and to lower the Olsen P to 30. Overseer predicts that these mitigations would reduce P loss from the pastoral areas by 10 kg P.

References

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Wheeler, D., & Watkins, N. (2016). *Overseer Technical Manual: Characteristics of Fertilisers.* AgResearch.

Appendices:

Table 21. Block P loss table, as estimated by overseer for the Proposed system (same as in the consent application)

Farm name: Driscolls Proposed FINAL 1Oct

Block Phosphorus

Block name	Total P lost (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Waikiwi Effluent	19	0.5	Low	Low	Low
Pukemutu Effluent	46	0.9	Medium	Low	Medium
Waikiwi non effluent	8	0.4	Low	Low	n/a
Pukemutu non effluent	82	0.8	Medium	Low	n/a
Baleage winter - waikiwi Eff	0	0.5	Low	Low	Low
Baleage winter - Pukemutu Eff	1	0.9	Medium	Low	Medium
Baleage winter - Waikiwi Non Eff	0	0.4	Low	Low	n/a
Baleage winter - Pukemutu Non Eff	2	0.8	Medium	Low	n/a
Other farm sources	121				
Whole farm	278	1.2			

Table 22 Block P loss table, as estimated by overseer for the Proposed system – after applying 50% of the phosphorus fertiliser in a lower solubility form.

Farm name: Driscolls Proposed FINAL 1Oct - 50% RPR

Block Phosphorus

Block name	Total P lost (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Waikiwi Effluent	19	0.4	Low	Low	Low
Pukemutu Effluent	45	0.9	Medium	Low	Medium
Waikiwi non effluent	8	0.4	Low	Low	n/a
Pukemutu non effluent	79	0.8	Medium	Low	n/a
Baleage winter - waikiwi Eff	0	0.4	Low	Low	Low
Baleage winter - Pukemutu Eff	1	0.9	Medium	Low	Medium
Baleage winter - Waikiwi Non Eff	0	0.4	Low	Low	n/a
Baleage winter - Pukemutu Non Eff	1	0.8	Medium	Low	n/a
Other farm sources	121				
Whole farm	274	1.2			

Table 23. Block P loss table, as estimated by overseer for the Proposed system – after reducing Olsen P to 30.

Farm name: Driscolls Proposed FINAL 1Oct - Olsen P 30

Block Phosphorus

Block name	Total P lost (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Waikiwi Effluent	19	0.4	Low	Low	Low
Pukemutu Effluent	44	0.9	Medium	Low	Medium
Waikiwi non effluent	8	0.4	Low	Low	n/a
Pukemutu non effluent	79	0.8	Medium	Low	n/a
Baleage winter - waikiwi Eff	0	0.4	Low	Low	Low
Baleage winter - Pukemutu Eff	1	0.9	Medium	Low	Medium
Baleage winter - Waikiwi Non Eff	0	0.4	Low	Low	n/a
Baleage winter - Pukemutu Non Eff	2	0.8	Medium	Low	n/a
Other farm sources	120				
Whole farm	272	1.2			

Appendix 5: T and J Driscoll Family Trust – Farm Maps

Farm Map

Figure 4. Driscolls farm map showing the current and proposed effluent areas, and the East Block.

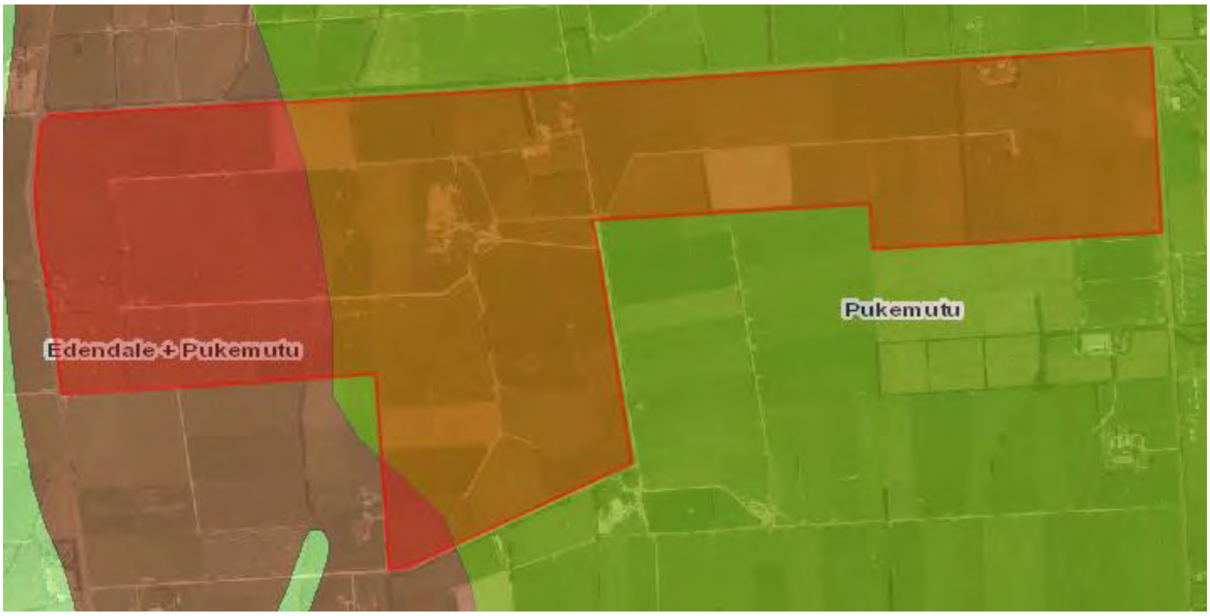

Figure 5. Driscolls farm map showing the soil types on farm

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Further information: T and J Driscoll Family Trust consent application

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Current situation	262 kg P/yr
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Difference	**16 kg P/yr increase**

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Difference			**= 3kg P/yr decrease**

Further mitigations that may be implemented in the future are to apply 50% of the phosphorus fertiliser in a low solubility form and to lower the Olsen P to 30. Overseer predicts that these mitigations would reduce P loss from the pastoral areas by a further 10 kg P.

P runoff from laneways

Overseer has a built in assumption that 30% of phosphorus deposited on laneways as dung is lost. This is accounted for in the "other sources" losses within the Phosphorus report (shown in the appendices of the consent application). Research has shown that a dairy cow consuming 15.5kgDM/day on a pasture diet will consume 0.4 kg P/week, of which 66% will be deposited in dung (shown in the table below, source: Massey University). Assuming that the farm has a lactation season of 270 days, each cow will ingest 15.4 kg P/cow, and **10.2kgP/animal would be deposited as dung.** A study by Ledgard *et al.* (1999) reported that **5% of cow excreta was deposited on laneways.** We have assumed that Overseer incorporates this information. Overseer then assumes that for phosphorus deposited on laneways in dung, **30% is lost from the system to water.**

Table 1.4 The fate of minerals ingested by a lactating dairy cow (ingesting 15.5 kg DM/day) (adapted from During 1984).

Element	Consumption	Percentage in			
	Kg /week	Faeces	Urine	Milk	Retained
N	5.1	26	53	17	4
P	0.4	66	-	26	8
K	2.9	11	81	5	3
Mg	0.2	80	12	3	5
Ca	0.4	77	3	11	9
Na	0.4	30	56	8	6

There is opportunity to mitigate the losses from laneways through careful management of bridges/culverts, buffer zone planting, laneway cambering and siting laneways away from waterways. These mitigations all reduce P loss by ensuring laneway runoff is filtered through a vegetated buffer strip. Research has shown that vegetated buffer strips can reduce P losses by 38-59% (figure 1). None of these mitigation strategies are provided for in Overseer.

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P loss mitigated	= Cows x	P in dung	x	Excreted on lanes x	assumed losses x	current mitigations
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Going forward, as a result of this consent application, the Driscolls will make further mitigations to reduce laneway losses through increased use of vegetated buffers, as described above. We consider that these improvements can reduce annual P loss from laneways to the midpoint of the range of reported mitigation, i.e., 49% of the losses assumed by Overseer, for the proposed 700cows.

P loss mitigated	= Cows x	P in dung	x	Excreted on lanes	x	assumed losses	x	extra mitigations
Proposed system	= 700 x	10.2kgP	x	5%	x	30%	x	49%
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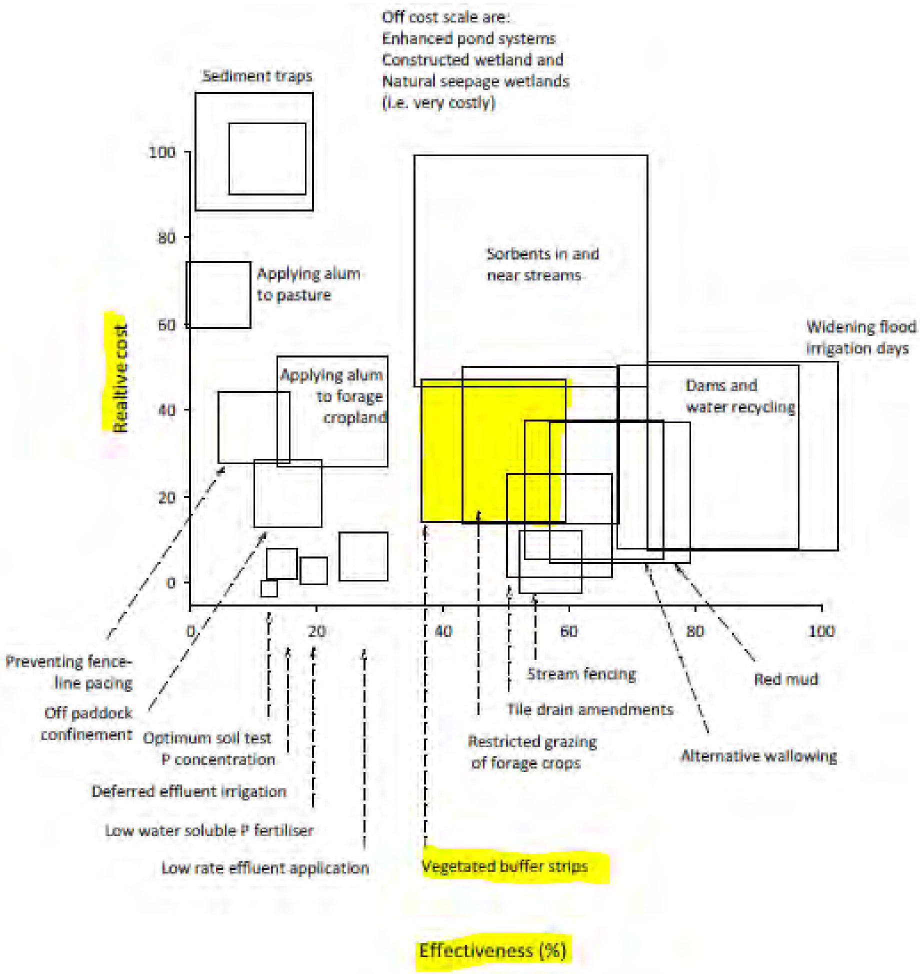

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Appendices:

Table 1. Block P loss table, as estimated by overseer for the Proposed system (same as in the consent application)

Farm name: Driscolls Proposed FINAL 1Oct

Block Phosphorus

Block name	Total P lost (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Waikiwi Effluent	19	0.5	Low	Low	Low
Pukemutu Effluent	46	0.9	Medium	Low	Medium
Waikiwi non effluent	8	0.4	Low	Low	n/a
Pukemutu non effluent	82	0.8	Medium	Low	n/a
Baleage winter - waikiwi Eff	0	0.5	Low	Low	Low
Baleage winter - Pukemutu Eff	1	0.9	Medium	Low	Medium
Baleage winter - Waikiwi Non Eff	0	0.4	Low	Low	n/a
Baleage winter - Pukemutu Non Eff	2	0.8	Medium	Low	n/a
Other farm sources	121				
Whole farm	278	1.2			

Table 2 Block P loss table, as estimated by overseer for the Proposed system – after applying 50% of the phosphorus fertiliser in a lower solubility form.

Farm name: Driscolls Proposed FINAL 1Oct - 50% RPR

Block Phosphorus

Block name	Total P lost (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Waikiwi Effluent	19	0.4	Low	Low	Low
Pukemutu Effluent	45	0.9	Medium	Low	Medium
Waikiwi non effluent	8	0.4	Low	Low	n/a
Pukemutu non effluent	79	0.8	Medium	Low	n/a
Baleage winter - waikiwi Eff	0	0.4	Low	Low	Low
Baleage winter - Pukemutu Eff	1	0.9	Medium	Low	Medium
Baleage winter - Waikiwi Non Eff	0	0.4	Low	Low	n/a
Baleage winter - Pukemutu Non Eff	1	0.8	Medium	Low	n/a
Other farm sources	121				
Whole farm	274	1.2			

Table 3. Block P loss table, as estimated by overseer for the Proposed system – after reducing Olsen P to 30.

Farm name: Driscolls Proposed FINAL 1Oct - Olsen P 30

Block Phosphorus

Block name	Total P lost (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Waikiwi Effluent	19	0.4	Low	Low	Low
Pukemutu Effluent	44	0.9	Medium	Low	Medium
Waikiwi non effluent	8	0.4	Low	Low	n/a
Pukemutu non effluent	79	0.8	Medium	Low	n/a
Baleage winter - waikiwi Eff	0	0.4	Low	Low	Low
Baleage winter - Pukemutu Eff	1	0.9	Medium	Low	Medium
Baleage winter - Waikiwi Non Eff	0	0.4	Low	Low	n/a
Baleage winter - Pukemutu Non Eff	2	0.8	Medium	Low	n/a
Other farm sources	120				
Whole farm	272	1.2			

FarmWise

T & J Driscoll Family Trust

266 O'Shannessy Road, Winton

Overseer modelling report for the purposes of as part of a consent application for expanded dairying

Report prepared for:
Tim and Jocelyn Driscoll
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1 October 2018

Executive Summary

T & J Driscoll Family Trust operate a high performance dairy farm near Winton, in Central Southland. The partially self-contained 210.6ha total property has a flat contour. There are two soil types on the property – Waikiwi and Pukemutu, separated by a small terrace. Calves are grazed on the platform until weaning and return to the platform as incalf heifers. Over the past three years, an average of 2.8ha of fodder beet and 1ha of winter turnips were planted. The farm has peak milked 573cows on average over the last three seasons.

In October 2016, Tim and Jocelyn purchased a neighbouring 13.9ha sheep grazing block – called the East Block. Following the purchase of the block, Tim and Jocelyn have transitioned the block into dairy support. It is proposed that the East Block (13.9ha) be converted to dairy and incorporated into the milking platform. In the proposed farm system, a portion of the herd will be wintered on 4ha with a baleage and grass diet. Young stock will continue to be grazed off farm from weaning to their return as incalf heifers.

Using Overseer (version 6.3.0) nutrient budgets have been constructed for the current land use and a proposed dairy unit nutrient budget to inform the consent application for expanded dairying. The nutrient budgets show the average nutrient losses for the last three years. Data inputs and methodology are explained in detail within this report.

A summary of the modelling output is given in Table 1. It shows a small decrease (loss than 5%) in the total Nitrogen loss from the property. Total Phosphorus loss from the property is predicted to increase (by less than 7%).

Table 1. Summary data from the Overseer analysis of the T & J Driscoll Family Trust Current and Proposed systems

	Current Total (averaged over 3 years)	Proposed system
Total Farm N Loss (kg)	11503	11345
N Loss/ha (kgN/ha/yr)	51	51
N Concentration in Drainage (ppm)		Pastoral – 9.8 – 29.3
Total Farm P Loss (kg)	262	278
P loss/ha (kgP/ha/yr)	1.2	1.2
Overseer - predicted pasture grown (tDM/ha/yr)		16.2

The key drivers of a decrease in nitrogen loss are shown below. In comparison to the current system, the proposed system has:

- Increased the area that effluent is applied to – reduced effluent N application to this area
- Reduced nitrogen fertiliser use on the effluent block
  Increased cow numbers – increasing loss risk

The key driver of the increase in phosphorus loss is an increase in losses from "other sources".

Overseer can model a range of good management practices. However, some farm specific good management practices cannot be modelled. Recommendations of further good management practices that cannot be modelled by Overseer are given within this report to further reduce the nutrient losses from this farm system.

Property legal description

Part Section 29 and 30 Block I Winton HUN

Section 1 and 2 SO 12000

Section 43, 44, 45 and 54 Block I Winton HUN

Lot 1 and 2 DP 449518

Report purpose

To quantify the losses of nitrogen and phosphorus from the current and the proposed farm systems being operated on this property. The report details the data inputs, the modelling outputs and areas of environmental risk within the system.

Disclaimer

The Overseer 6.3.0 model has been utilised to assess the nutrient losses from this property. Details of how the property is operated currently, and how the property will be operated going forward have been gathered from the farm owner. Where accurate data was unavailable, conservative assumptions have been made using professional judgement.

The proposal

Farm objectives

T & J Driscoll Family Trust operate their farm business with the following objectives:

- To refine the farm system to maximise farm profitability – targeting $2000/ha EBIT at a $5.00 milk price
- To operate in an environmentally sustainable manner with an emphasis on continual education and improvement
- Consolidate the business to ensure it is resilient
- "Farm for the future" – the property must remain flexible to deal with changes in market forces

Current System

Nutrient budgets have been constructed to determine the average actual nutrient losses over three years (June 2015 – May 2018).

Dairy platform

T & J Driscoll Family Trust operate a high performing dairy farm near Winton, in Central Southland. The farm is owned by the Driscoll trust (JP, CA, TJ and JA Driscoll), and is operated under a lease arrangement by T & J Driscoll Family Trust (Tim and Jocelyn Driscoll). The partially self-contained 210.6ha total property has a flat contour. There are two soil types on the property – Waikiwi and Pukemutu. Calves are grazed on the platform until weaning and return to the platform as incalf heifers.

Over the previous three seasons, the property has milked an average of 573cows at peak. There has been an average of 2.8ha fodder beet and 1ha turnips grown on farm for winter and early spring grazing. Nitrogen fertiliser has been applied at an average of 213kgN/ha in split applications from August to April over the whole milking platform. In the last three seasons, the majority of the herd has been wintered off farm at a graziers property. On average, 83 cows were wintered at home in June and July, while the remaining 516 were off farm. Early calving heifers and cows return to the platform in mid July. Bought in feed has been assumed to ensure that a feasible pasture growth rate is achieved in an average season.

East Block

In October 2016, Tim and Jocelyn purchased a neighbouring 13.9ha sheep grazing block – called the East Block. Following the purchase of the block, Tim and Jocelyn have transitioned the block into dairy support. In order to create accurate actual budgets for the previous three years, three separate budgets have been created for the East Block:

- Pre purchase use (15-16 season) – a sheep grazing block. Accurate stock numbers were not available. A conservative estimation of stocking rate and management practice has been made utilising Google Earth imaging and the Beef and Lamb farm monitoring data.

- Transition (16-17 season) – All feed grown on farm was cut as baleage. This was fed to incalf heifers or exported from the block.
- Dairy support (17-18 season) – 125incalf heifers and 100cows were wintered on a baleage/grass diet on the block. The block was grazed by heifers in January and February of 2018. All other feed grown was made into baleage.

Proposed system:

Through the development of the proposed system, a number of scenarios were run through Overseer. The proposed system detailed below was chosen as it was in line with the farm objectives, the farm system preferences and the proposed Water and Land Plan.

It is proposed that the East Block (13.9ha) be converted and incorporated into the milking platform. The total farm area would then be 224.5ha total and peak cow numbers would be increased to 700 cows. The property will winter 216cows on farm, and continue to winter the remaining 516cows off farm at a graziers property. The cows wintered on farm will be grazed of 4ha with a baleage grass diet. Young stock will continue to be grazed off farm from weaning to their return as incalf heifers. The effluent system will be extended to 93.3ha and fertiliser nitrogen applications will be targeted to 197kgN/ha on the effluent area and 218kgN/ha on the non-effluent area. Bought in feed has been assumed to ensure that a feasible pasture growth rate is achieved in an average season when consented cow numbers are being milked.

Modelling method

Nutrient losses have been estimated using the Overseer Version 6.3.0 model. Overseer is a software application that models nutrient movements within a farm system. Input data detailing the farm system is entered into the software and interpreted through the use of a series of sub-model that calculate the flow of seven major farm nutrients (Nitrogen, Phosphorus, Sulphur, Calcium, Magnesium and Sodium). Output data is reported for interpretation and to inform farm management practices. It currently requires an expert user to describe the physical and management details of a farm.

Overseer assumptions

Within the Overseer software, assumptions have been made of the farm management:

- Long term annual average model
  The model uses annual average input and produces annual average outputs
- Near equilibrium conditions
  Model assumes that that the farm is at a state where there is minimal change each year
- Actual and reasonable inputs
  It is assumed that input data is reasonable and a reflection of the actual farm system. If any parameter changes, it is assumed that all other parameters affected will also be changed.
- Good management practices are followed
  Overseer assumes the property is managed is line with accepted industry good management practice.

Overseer limitations

Key limitations of the Overseer model are:

- Overseer does not predict transformations, attenuation or dilution of nutrients between the root zone or farm boundary and the eventual receiving water body. A catchment model is needed to estimate the effects of the nutrient losses from farms on groundwater, river or lake water quality.
- Overseer does not calculate outcomes from extreme events (floods and droughts), but provides a typical years result based on a long-term average.
- Overseer does not calculate the impacts of a conversion process, rather it predicts the long-term annual average nutrient budgets for changed land use.
- Overseer is not spatially explicit beyond the level of defined blocks
- Not all management practices or activities that have an impact on nutrient losses are captured in the Overseer model
- Overseer does not represent all farm systems in New Zealand
- Components of Overseer have not been calibrated against measured data from every combination of farm systems and environment

Information on Overseer can be obtained from the following reports:

- Technical Description of OVERSEER for Regional Councils, September 2015
- Review of the phosphorus loss submodel in OVERSEER®, September 2016
- Using OVERSEER® in Regulation – Technical Resources and Guidance for Regional Councils, August 2016

Data input standards

Nutrient budgets have been constructed using the Overseer Version 6.3.0 model.

The nutrient budget have been developed in accordance with the Overseer data input protocols - “Overseer, Best Practice Data Input Standards, March 2018.” No deviations have been made from these protocols.

Modelling Inputs

To construct the nutrient budgets the following assumptions have been made;

Blocks

The farm has been split into the following pastoral (effluent and non-effluent) and fodder crop blocks. Total farm area has been taken from the legal area (ex the rates demand). The area of each block has been determined using the measure function on Beacon. Soils on the property were assessed utilising the topoclimate information. Overseer soil settings were obtained from SMap for all soil types.

Block Name	Soil Type (from Beacon)	Smap Ref	Contour	Current Dairy Platform (ha)	East Block (ha)	Proposed Land Use (ha)
Effluent – Waikiwi	Edendale	Waiki_30a.1	Flat	**20.1**		**41.7**
Effluent – Pukemutu	Pukemutu	Pukem_6a.1	Flat	**41.9**		**49.9**
Non Effluent – Waikiwi	Edendale	Waiki_30a.1	Flat	**42.2**		**19.4**
Non Effluent – Pukemutu	Pukemutu	Pukem_6a.1	Flat	**98.4**		**101.5**
East Block - Pukemutu	Pukemutu	Pukem_6a.1	Flat		**13.9**	
Baleage winter Eff Waikiwi	Edendale	Waiki_30a.1	Flat			**0.8**
Baleage winter Eff Pukemutu	Pukemutu	Pukem_6a.1	Flat			**0.9**
Baleage Winter Non Eff Waikiwi	Edendale	Waiki_30a.1	Flat			**0.4**
Baleage winter Non Eff Pukemutu	Pukemutu	Pukem_6a.1	Flat			**1.9**
	Effective Farm Area			**202.6**	**13.9**	**216.5**
	Non productive			8.0		8.0
	Total Farm Area			**210.6**	**13.9**	**224.5**
Rotating fodder crops						
Fodder beet				2.8		
Winter Turnips				1.0		

Climate Data

- Southland as the location setting
- The following climate information has been used from the Overseer climate station tool;
  - 1094mm of rainfall
  - 10.1 degrees Celsius mean annual temperature
  - Daily rainfall pattern setting of 731 to 1450mm, low
  - Mean annual PET of 711mm (moderate variation)

Farm System

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
Milk solids production	271,130 kg MS 473 kgMS/cow Median calving date – 20th August Drying off – 31st May				329,000 kg MS 470 kgMS/cow Median calving date – 20th August Drying off – 31st May
Cows on farm (Lactating and wintered)	Breed Fr J X Jul 140 Aug 599 Sep 593 Oct 573 Nov 573 Dec 573 Jan 573 Feb 573 Mar 573 Apr 530 May 487 Jun 83 Peak cows: 573			Breed Fr J X Winter grazing for 100MA and 125R2 cows (Jun and Jul)	Breed Fr J X Jul 273 Aug 732 Sep 724 Oct 700 Nov 700 Dec 700 Jan 700 Feb 700 Mar 700 Apr 647 May 595 Jun 216 Peak cows: 700
Dairy replacements on farm	Calves are reared on farm until weaning (1-4months old) Aug - 135 Sep - 160 Oct - 160 Nov – 160		Grazing for R2 heifers May 125	Grazing for R2 heifers Jan 125 Feb 125	Calves are reared on farm until weaning (1-4months old) Aug - 152 Sep - 187 Oct - 187 Nov – 187
Breeding bulls	Thirteen 2yr old Jersey bulls (Dec and Jan)				Fifteen 2yr old Jersey bulls (Dec and Jan)
Sheep		Wintered: 120 MA ewes 46replacements 3rams Coopworth			

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
		125% lambing percentage 20% replacement rate Mean lambing date of the 15th September. All non-replacement lambs sold by the end of May			
Relative productivity	No differences between blocks	No differences between blocks	No differences between blocks	No differences between blocks	No differences between blocks
Structures	<u>Calving Pad</u> Not modelled as used when ground conditions are saturated rather than for fixed time				<u>Calving Pad</u> Not modelled as used when ground conditions are saturated rather than for fixed time
In Shed Feeding	Management 100% of milkers fed Aug - May				Management 100% of milkers fed Aug - May
Rotating fodder crop management	<u>2.8ha fodder beet</u> Yield: 25tDM/ha Conventional cultivation October Fertiliser: 500kg/ha Winton Fodder Beet mix at sowing (delivering 50kg/ha N, 32kg/ha P, 75kg/ha K and 27kg/ha S) 100kg/ha Urea in December 100kg/ha Potassium				Cows on farm in June/July are wintered on a baleage grass diet. <u>4ha Baleage/Grass wintering</u> This area rotates around the platform and is part of the property's regrassing strategy All feed required is imported (160tDM baleage)

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
	Chloride in December 100kg/ha Urea in January Grazed by dairy cows May – Aug Resown in permanent pasture in September				
	1.0ha Turnips Yield: 8tDM/ha Conventional cultivation February Fertiliser: 150kg/ha DAP and 150kg/ha super at sowing 100kg/ha Urea in March Grazed by dairy cows Jun – Aug Resown in permanent pasture in September				
Imported Supplements	In shed: 236tDM PKE 33tDM Barley In paddock: 418tDM Silage			In paddock: 65 tDM baleage	In shed: 300tDM PKE 100tDM Barley 100tDM DDG In paddock: 850tDM baleage For wintering: 160tDM baleage

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
Exported Supplements			130tDM baleage		
Soil Fertility	Olsen P 32 (soil test results June 2017) All other values entered at agronomic optimum	All soil test values entered at agronomic optimum (Olsen P of 20)	All soil test values entered at agronomic optimum (Olsen P of 20)	All soil test values entered at agronomic optimum (Olsen P of 20)	Olsen P 32 (soil test results June 2017) All other values entered at agronomic optimum
Fertiliser	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels
Nitrogen Fertiliser	213 kgN/ha in split applications (Aug – April)				<u>Non Effluent blocks</u> 218kgN/ha in split applications (Aug – April) <u>Effluent Blocks</u> 197kgN/ha in split applications (Aug – April)
Drainage	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained
Farm dairy effluent	Holding pond Solids aren't separated from the liquid Liquid effluent is applied at a depth of <12mm to the "effluent" blocks An effluent area of at least 39 ha is required to achieve a loading of less than 150 kg N / ha / year				Holding pond Solids aren't separated from the liquid Liquid effluent is applied at a depth of <12mm to the "effluent" blocks An effluent area of at least 34 ha is required to achieve a loading of less than 150 kg N / ha / year

Predicted Overseer Results

Current land use

	Current Dairy Platform (3yr average)	East Block – Sheep (15-16 season)	East Block – Transition (16-17 season)	East Block – Dairy Support (17-18 season)	East block (average of 3yrs)	Current Total (averaged over 3 years)
Total Farm N Loss (kg)	11262	204	132	386	241	11503
N Loss/ha (kgN/ha/yr)	53	15	10	28	17	51
N Concentration in Drainage (ppm)	Pastoral – 9.9 to 12.8 Crops – 21.1 to 42.1	Pastoral – 3.2	Pastoral – 2.1	Pastoral - 6.1		
Total Farm P Loss (kg)	252	10	9	10	10	262
P loss/ha (kgP/ha/yr)	1.2	0.7	0.7	0.7	0.7	1.2
Overseer - predicted pasture grown (tDM/ha/yr)	16.2	11.8	11.8	11.9		

Proposed system

	Current Total (averaged over 3 years)	Proposed system
Total Farm N Loss (kg)	11503	11345
N Loss/ha (kgN/ha/yr)	51	51
N Concentration in Drainage (ppm)		Pastoral – 9.8 – 29.3
Total Farm P Loss (kg)	262	278
P loss/ha (kgP/ha/yr)	1.2	1.2
Overseer - predicted pasture grown (tDM/ha/yr)		16.2

Conclusions from the modelling

Nutrient budgets have been developed for Driscoll Dairy. These budgets compare the nutrient loss of the current farm system with the proposed farm system. Overseer has predicted that losses of nitrogen will decrease slightly (less than 5%) and losses of phosphorus will increase slightly (less than 7%).

The key drivers of a decrease in nitrogen loss are shown below. In comparison to the current system, the proposed system has:

- Increased the area that effluent is applied to – reduced N application in effluent to this area
- Reduced nitrogen fertiliser use on the effluent block
- Increased cow numbers – increasing loss risk
-

The key driver of the increase in phosphorus loss is an increase in losses from "other sources".

Please note: Losses from "other sources" include predicted losses from laneways, calving pads and yards. The increase in losses from other sources is a result of an increase in animal excretion onto laneways. Overseer estimates amount of excreta and assumes all P ends up in dung. Some of this dung is assumed to fall on laneways and 30% of that P is assumed to be lost from the farm. Furthermore, Overseer is not spatially explicit; so it does not take into account critical source area on farms. These critical source areas accumulate overland flow from adjacent areas and deliver overland flow to surface water bodies. On farms where there is not a direct connection (or a less connection) via critical source areas, or where management mitigates risk, Overseer cannot model the impact of these at an individual farm scale.

Recommendations:

Apart from the system changes outlined above, the following recommendations are given to reduce the nutrient losses from this farm system.

Overseer can model a range of good management practices. However, some farm specific good management practices cannot be modelled. It is recommended that the following good management practices are implemented on this property:

- Fertiliser is applied at the correct rate, and is not applied in close proximity to waterways
- Identify and manage critical source areas to reduce the risk of losses. These include loses from laneways, gateways and high traffic zones.
- Stand cows off on the calving pad during periods of high soil moisture content to minimise soil damage and leaching risk.
- Fertiliser applications are made during periods of plant growth.
- An effluent management plan is in place that takes into account soil moisture and temperature, and includes a fail safe system

The nutrient budgets within this report have been developed assuming that the Olsen P is 32 and all other soil fertility measures are at the agronomic optimum. It also assumes that fertiliser is applied at a maintenance rate. A soil testing regime should be implemented and fertiliser recommendations should be developed in line with these soil testing results.

The proposed Southland Water and Land Plan is currently in process. It will be important to stay up to date with developments in Environment Southland policy and rules, including the Limit Setting Process which will develop over the next few years

A farm environmental management plan detailing the recommendations within this report should be developed for the property.

Current system - Dairy Platform

Table 2. Current system whole farm nutrient budget

(kg/ha/yr)	N	P	K	S	Ca	Mg	Na
Nutrients added							
Fertiliser, lime & other	201	24	2	34	0	0	0
Rain/clover N fixation	74	0	3	5	3	7	35
Irrigation	0	0	0	0	0	0	0
Supplements	80	11	58	9	9	6	4
Nutrients removed							
As products	87	15	21	5	19	2	6
Exported effluent	0	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0
To atmosphere	89	0	0	0	0	0	0
To water	53	1.2	12	46	61	6	20
Change in farm pools							
Plant Material	0	0	-2	0	0	0	0
Organic pool	125	19	11	-3	7	3	1
Inorganic mineral	0	2	-23	0	-2	-3	-3
Inorganic soil pool	1	-2	43	0	-72	6	15

Table 3. Current system Nitrogen report

Block name	Total N lost	N lost to water	N in drainage *	N surplus	Added N **
	kg N/yr	kg N/ha/yr	ppm	kg N/ha/yr	kg N/ha/yr
Waikiwi Effluent	1,003	51	**11.4**	264	285
Pukemutu Effluent	2,464	60	**12.8**	272	285
Waikiwi non effluent	1,793	43	9.9	213	211
Pukemutu non effluent	4,850	50	11.2	220	211
Fodder Beet	630	225	**42.1**	21	142
Turnips	111	111	**21.1**	2	72
Other sources	410				
Whole farm	11,262	53			
Less N removed in wetland	0				
Farm output	11,262	53			

Table 4. Current system Phosphorus report

Block name	Total P lost	P lost to water	P loss categories		
	kg P/yr	kg P/ha/yr	Soil	Fertiliser	Effluent
Waikiwi Effluent	9	0.5	Low	Low	Low
Pukemutu Effluent	39	0.9	Medium	Low	Medium
Waikiwi non effluent	17	0.4	Low	Low	N/A
Pukemutu non effluent	79	0.8	Medium	Low	N/A
Fodder Beet	3	1.2	N/A	N/A	N/A
Turnips	1	1.1	N/A	N/A	N/A
Other sources	104				
Whole farm	252	1.2			

East Block – Sheep

Table 5. East Block – Sheep whole farm nutrient budget

(kg/ha/yr)	N	P	K	S	Ca	Mg	Na
Nutrients added							
Fertiliser, lime & other	0	16	0	24	0	0	0
Rain/clover N fixation	97	0	3	5	3	7	35
Irrigation	0	0	0	0	0	0	0
Nutrients removed							
As products	20	3	1	3	5	0	1
Exported effluent	0	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0
To atmosphere	37	0	0	0	0	0	0
To water	15	0.7	7	35	33	6	19
Change in farm pools							
Plant Material	0	0	0	0	0	0	0
Organic pool	25	11	0	-8	0	0	0
Inorganic mineral	0	0	-25	0	-2	-3	-4
Inorganic soil pool	0	2	19	0	-33	4	18

Table 6. East Block - sheep nitrogen report

Block name	Total N lost kg N/yr	N lost to water kg N/ha/yr	N in drainage * ppm	N surplus kg N/ha/yr	Added N ** kg N/ha/yr
East block - Pukemutu	200	14	3.2	74	0
Other sources	4				
Whole farm	204	15			
Less N removed in wetland	0				
Farm output	204	15			

Table 7. East Block - Sheep phosphorus report

Block name	Total P lost kg P/yr	P lost to water kg P/ha/yr	P loss categories		
			Soil	Fertiliser	Effluent
East block - Pukemutu	9	0.6	Low	Low	N/A
Other sources	1				
Whole farm	10	0.7			

East Block – Transition

Table 8. East Block – Transition whole farm nutrient budget

(kg/ha/yr)	N	P	K	S	Ca	Mg	Na
Nutrients added							
Fertiliser, lime & other	0	36	204	33	0	0	0
Rain/clover N fixation	152	0	3	5	3	7	35
Irrigation	0	0	0	0	0	0	0
Nutrients removed							
As products	0	0	0	0	0	0	0
Exported effluent	0	0	0	0	0	0	0
As supplements and crop residues	162	24	203	17	46	11	9
To atmosphere	4	0	0	0	0	0	0
To water	10	0.7	15	30	29	6	19
Change in farm pools							
Plant Material	0	0	0	0	0	0	0
Organic pool	-24	12	6	-8	1	0	0
Inorganic mineral	0	0	-22	0	-2	-3	-4
Inorganic soil pool	0	0	5	0	-72	-7	10

Table 9. East Block - transition nitrogen report

Block name	Total N lost kg N/yr	N lost to water kg N/ha/yr	N in drainage * ppm	N surplus kg N/ha/yr	Added N ** kg N/ha/yr
East block - Pukemutu	132	9	2.1	-15	0
Other sources	1				
Whole farm	132	10			
Less N removed in wetland	0				
Farm output	132	10			

Table 10. East Block - Transition phosphorus report

Block name	Total P lost kg P/yr	P lost to water kg P/ha/yr	P loss categories		
			Soil	Fertiliser	Effluent
East block - Pukemutu	9	0.7	Low	Low	N/A
Other sources	0				
Whole farm	9	0.7			

East Block – Dairy support

Table 11. East Block – Dairy support whole farm nutrient budget

(kg/ha/yr)	N	P	K	S	Ca	Mg	Na
Nutrients added							
Fertiliser, lime & other	0	0	0	8	0	0	0
Rain/clover N fixation	81	0	3	5	3	7	35
Irrigation	0	0	0	0	0	0	0
Nutrients removed							
As products	9	2	1	1	5	0	0
Exported effluent	0	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0
To atmosphere	40	0	0	0	0	0	0
To water	28	0.7	9	30	43	6	19
Change in farm pools							
Plant Material	-75	-14	-94	-11	-23	-8	-7
Organic pool	79	12	4	-7	1	0	0
Inorganic mineral	0	0	-16	0	-2	-3	-4
Inorganic soil pool	0	-1	98	0	-21	12	25

Table 12. East Block – Dairy support nitrogen report

Block name	Total N lost kg N/yr	N lost to water kg N/ha/yr	N in drainage * ppm	N surplus kg N/ha/yr	Added N ** kg N/ha/yr
East block - Pukemutu	381	27	6.1	139	0
Other sources	5				
Whole farm	386	28			
Less N removed in wetland	0				
Farm output	386	28			

Table 13. East Block – Dairy support phosphorus report

Block name	Total P lost kg P/yr	P lost to water kg P/ha/yr	P loss categories		
			Soil	Fertiliser	Effluent
East block - Pukemutu	8	0.6	Low	N/A	N/A
Other sources	2				
Whole farm	10	0.7			

Proposed system

Table 14. Proposed system whole farm nutrient budget

(kg/ha/yr)	N	P	K	S	Ca	Mg	Na
Nutrients added							
Fertiliser, lime & other	199	21	0	30	0	0	0
Rain/clover N fixation	73	0	3	5	3	7	35
Irrigation	0	0	0	0	0	0	0
Supplements	103	21	97	16	22	11	7
Nutrients removed							
As products	99	17	24	5	21	2	7
Exported effluent	0	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0
To atmosphere	87	0	0	0	0	0	0
To water	51	1.2	13	49	59	6	20
Change in farm pools							
Plant Material	0	0	0	0	0	0	0
Organic pool	138	20	15	-3	8	4	1
Inorganic mineral	0	2	-19	0	-2	-3	-3
Inorganic soil pool	0	2	67	0	-62	9	17

Table15. Proposed system nitrogen report

Block name	Total N lost kg N/yr	N lost to water kg N/ha/yr	N in drainage * ppm	N surplus kg N/ha/yr	Added N ** kg N/ha/yr
Waikiwi Effluent	1,887	45	10.2	241	249
Pukemutu Effluent	2,662	53	**11.5**	249	249
Waikiwi non effluent	830	43	9.8	210	215
Pukemutu non effluent	5,030	50	11.1	217	215
Baleage winter - waikiwi Eff	88	111	**25.2**	506	249
Baleage winter - Pukemutu Eff	120	133	**29.3**	530	249
Baleage winter - Waikiwi Non Eff	40	99	**22.6**	451	215
Baleage winter - Pukemutu Non Eff	240	126	**28.3**	498	215
Other sources	449				
Whole farm	11,345	51			
Less N removed in wetland	0				
Farm output	11,345	51			

Table 8. Proposed system phosphorus report

Block name	Total P lost	P lost to water	P loss categories		
	kg P/yr	kg P/ha/yr	Soil	Fertiliser	Effluent
Waikiwi Effluent	19	0.5	Low	Low	Low
Pukemutu Effluent	46	0.9	Medium	Low	Medium
Waikiwi non effluent	8	0.4	Low	Low	N/A
Pukemutu non effluent	82	0.8	Medium	Low	N/A
Baleage winter - waikiwi Eff	0	0.5	Low	Low	Low
Baleage winter - Pukemutu Eff	1	0.9	Medium	Low	Medium
Baleage winter - Waikiwi Non Eff	0	0.4	Low	Low	N/A
Baleage winter - Pukemutu Non Eff	2	0.8	Medium	Low	N/A
Other sources	121				
Whole farm	278	1.2			

Farm Map

Figure 1. Driscolls farm map showing the current and proposed effluent areas

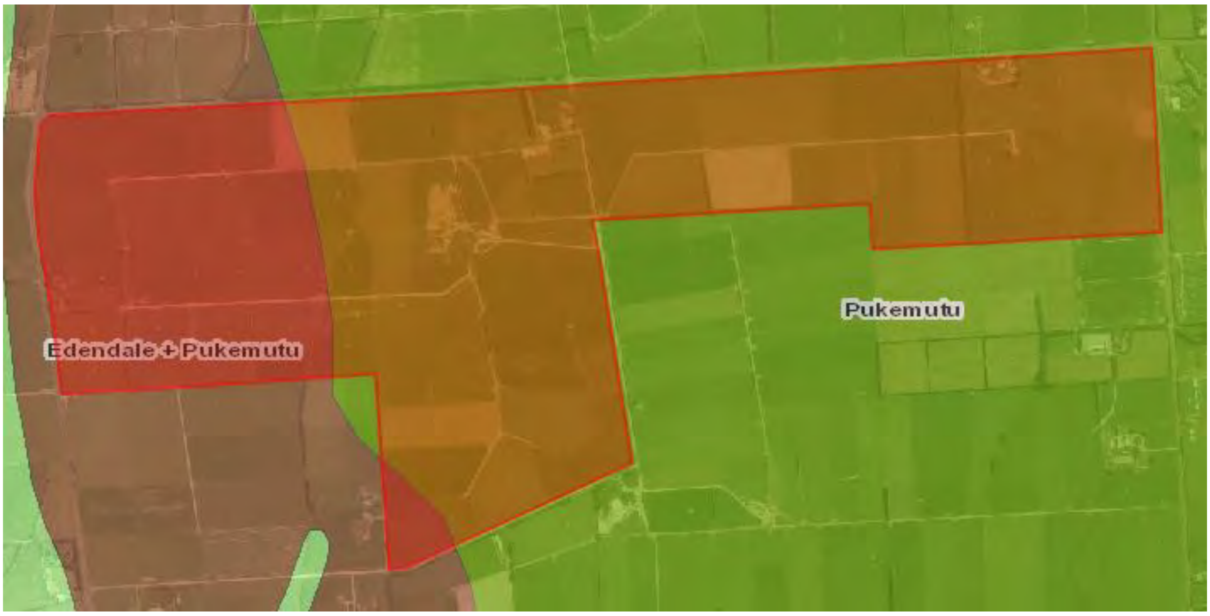

Figure 2. Driscolls farm map showing the soil types on farm

Appendix 6: T and J Driscoll Family Trust Farm Maps

Map showing current and proposed effluent areas, and the East Block

Figure 1. Driscolls farm map showing the current and proposed effluent areas, and the East Block.

Soil type map

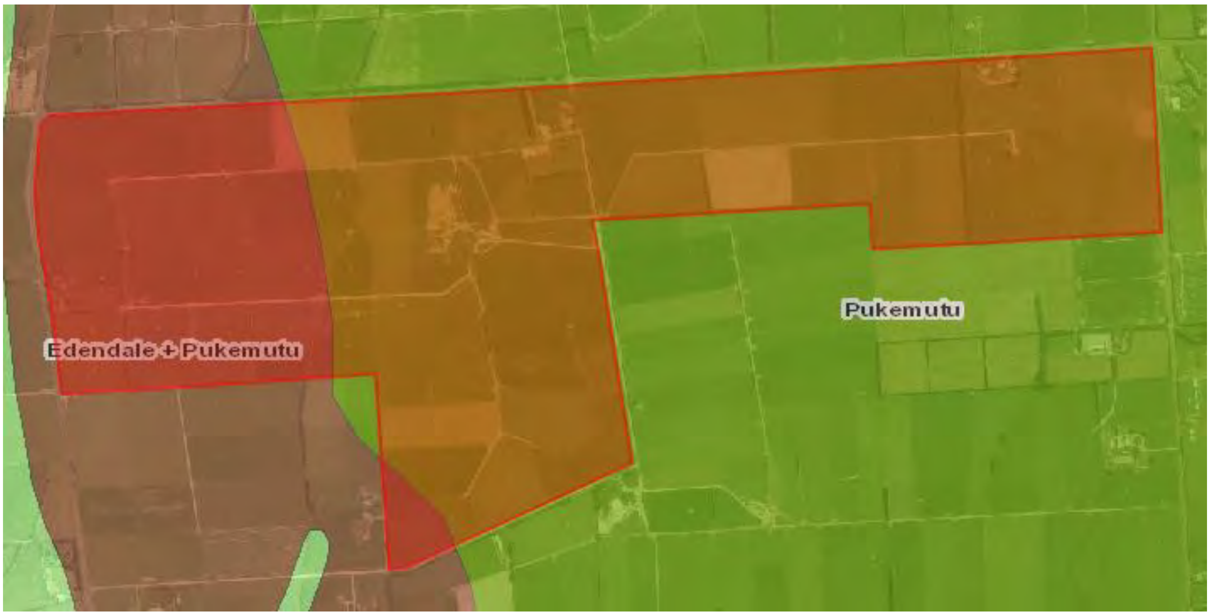

Figure 2. Driscolls farm map showing the soil types on far

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File Note: T and J Driscoll Family Trust consent application – updated budgets including the 18-19 season

December 2019

1.0 Supporting information to this report:

This file note is not a standalone report. It is intended to be read in conjunction with:

- The Overseer modelling reports, dated 1st October 2018
- The file note "Further information: T and J Driscoll Family trust consent application," dated 18th December 2018
- The file note "File Note: T and J Driscoll Family Trust consent application" dated 22 Aug 2019

These reports and file notes have been including in the appendices of this file note.

2.0 Previous reports and modelling:

Three key reports have been completed on behalf of the T and J Driscoll Family Trust. Briefly, the reports were written for the following purpose:

- The original modelling was completed in Oct 2018 under Overseer version 6.3.0.
- In Dec 2018, a file note was written to quantify the impact of Phosphorus loss mitigations not accounted for in Overseer version 6.3.0
- In Aug 2019, further mitigations were modelled in OverseerFM version 6.3.1 to show that a clear reduction in losses between the current and proposed would be achieved.

3.0 Purpose of this Report

The applicant (T and J Driscoll Family Trust) has asked for further modelling to be undertaken so that actual data from the most recent season (the 18-19 season) is included. As a result, the "current" scenario will reflect the actual average of the previous four seasons (June 2015 – June 2019).

Throughout the previous modelling described in the reports above, the "current" scenario modelled the three years from mid-2015 to mid-2018. In a recent hearing, it was requested that the applicant

Report disclaimer:
The OverseerFM 6.3.2 model has been utilised to assess the nutrient losses from this property. Details of how the property is operated currently, and how the property will be operated going forward have been gathered from the farm owner. Where accurate data was unavailable, conservative assumptions have been made using professional judgement.

OverseerFM 6.3.2 predicted results have been extracted from the model on 11 December 2019 model the most recent year as part of the "current" scenario. The applicant and Landpro have requested that this modelling be updated to include the most recent season (the 18-19 season).

4.0 Previous Modelling Results

4.1 Original modelling under Overseer version 6.3.0 (October 2018)

Overseer modelling was completed for the T and J Driscoll Trust in October 2018 using Overseer version 6.3.0. Summarised results from this modelling is shown in Table 1. The full report is included in the appendices of this report including a detailed summary of the input data.

Table 1. Predicted nitrogen and phosphorus losses in the current and proposed systems under Overseer version 6.3.0 (From modelling report dated 1st October 2018 – in appendices)

	Current system	Proposed system
Total Farm N Loss (kg)	11,503	11,345
N Loss/ha (kgN/ha/yr)	51	51
Total Farm P Loss (kg)	262	278
P loss/ha (kgP/ha/yr)	1.2	1.2

4.2 Quantification of predicted P loss using calculations outside of Overseer 6.3.0 (Dec 2018)

Following the original modelling (Oct 2018), concerns were raised that the predicted Phosphorus losses using Overseer were higher in the proposed system than the current system. A file note was completed to quantify the impact of mitigations that are not accounted for in Overseer. Results including the phosphorus mitigations modelled outside of Overseer 6.3.0 are shown in table 2. Red figures indicate a number that has changed compared to the previous modelling. The complete report is attached in the appendices.

Table 2. Predicted nitrogen and phosphorus losses in the current and proposed systems, including phosphorus mitigations modelled outside of Overseer 6.3.0 (From "Further information: T and J Driscoll Family Trust consent application" dated Dec2018 - in appendices)

	Current system	Proposed system
Total Farm N Loss (kg)	11,503	11,345
N Loss/ha (kgN/ha/yr)	51	51
Total Farm P Loss (kg)	229 (262 minus 33kg P mitigation modelled outside of Overseer)	226 (278 minus 52kg P mitigation modelled outside of Overseer)
P loss/ha (kgP/ha/yr)	1.0	1.0

4.3 Further modelling of the proposed system to show clear reductions in nutrient loss completed in OverseerFM version 6.3.1 (Aug 2019)

In August 2019, following a recent hearing, the applicant instructed that further mitigation be modelled for the proposed dairy system. A file note was completed to quantify the impact of implementing these further mitigations on the property. Adjustments were also calculated outside of OverseerFM to quantify:

- Off-site nutrient loss of young stock grazing
- Baleage grass wintering on the platform
- Laneway mitigations to reduce phosphorus loss

The results of this modelling is shown in the table below. Red figures indicate a number that has changed compared to the previous modelling. A detailed description of the input data including the mitigations and an explanation of how the adjustments were calculated is given the previous file note dated August 2019. This is included in the appendices.

Please note, due an Overseer version change (6.3.0 to 6.3.1) between Dec 2018 and Aug 2019, there is a small change in predicted losses from the current system. Again, Red figures indicate a number that has changed compared to the previous modelling.

Table 3. Predicted nitrogen and phosphorus losses in the current and proposed system after further mitigations were included, including phosphorus and nitrogen mitigations modelled outside of OverseerFM 6.3.1 (adjustments for mitigations calculated outside of Overseer are described in detail in the file note dated Aug 2019 – in appendices).

	Current system	**Proposed system (following further mitigations)**	**Percentage change in losses**
Total Farm N Loss (kg)	11513	10507 (9908kgN plus 126kgN grass baleage plus 473kgN young stock adjustments modelled outside of Overseer)	8.7% reduction
N Loss/ha (kgN/ha/yr)	51	47	
N Concentration in Drainage (ppm)		Pastoral – 3 to 19	
Total Farm P Loss (kg)	230 (263kgP minus 33kg P mitigation modelled outside of Overseer)	212 (256kgP minus 52kg P laneway mitigation plus 7.8kgP young stock adjustment modelled outside of Overseer)	7.8% reduction
P loss/ha (kgP/ha/yr)	1.0	0.9	
OverseerFM - predicted pasture grown (tDM/ha/yr)		16.0 (excluding East Block) 15.6 (East Block)	

Considering the further mitigations to the proposed farm system and the adjustments made to predicted nutrient losses, Overseer predicts that overall nitrogen will decrease by 8.7% and losses of phosphorus will decrease by 7.8%.

The key drivers of a decrease in nitrogen loss are shown below. In comparison to the current system, the proposed system has:

- Increased the area that effluent is applied to – reduced N application in effluent to this area
- Reduced nitrogen fertiliser use
- Change in the farms culling policy to one of culling earlier
- Lower protein content supplementary feed (Barley)

The key driver of the decrease in phosphorus loss are shown below. In comparison to the current system the proposed has:

- Improved laneway sediment loss mitigations
- A reduction in the Olsen P on the current dairy platform area (although an increase in Olsen P on the East Block)
- Use of Reactive Phosphate Rock fertiliser on the East Block

5.0 Updating the “current” scenario modelling – Dec 2019:

The applicant (T and J Driscoll Family Trust) has asked for further modelling to be undertaken so that actual data from the most recent season (the 18-19 season) is included. This data has ben collected from the applicant. As a result, the “current” scenario will reflect the previous four seasons (June 2015 – June 2019).

Throughout all of the modelling described in previous reports, the “current” scenario modelled actual data for the three years from mid-2015 to mid-2018. In a recent hearing, it was requested that the applicant model the most recent year as part of the “current” scenario. The applicant and Landpro have requested that this modelling be updated to include actual data from the most recent season (the 18-19 season).

5.1 Changes in OverseerFM since August 2019:

Since August 2019 a new version of OverseerFM has been released – version 6.3.2. The updated Overseer version (version 6.3.2) has predicted slightly higher nutrient losses for dairy farms than the previous version due to changes in two areas – increased animal energy requirements and a change to how nitrous oxide losses are calculated.

The OverseerFM files related to this consent application were reopened in OverseerFM version 6.3.2. Maintenance fertiliser inputs have been updated. No other changes were made. Summary results from OverseerFM 6.3.2 are shown below with changes shown in red.

Table 4. Predicted nitrogen and phosphorus losses in the current and proposed system as modelled by OverseerFM 6.3.2 including adjustments calculated in the file note dated August 2019 (in appendices)

	Current system	Proposed system	Percentage change in losses
Total Farm N Loss (kg)	11759	10792 (10193kgN plus 126kgN grass baleage and 473kgN young stock adjustments modelled outside of Overseer)	8.2% reduction
N Loss/ha (kgN/ha/yr)	52	48	
N Concentration in Drainage (ppm)		Pastoral – 3 to 20	
Total Farm P Loss (kg)	232 (265kgP minus 33kg P mitigation modelled outside of Overseer)	216 (260kgP minus 52kg P laneway mitigation plus 7.8kgP young stock adjustment modelled outside of Overseer)	6.9% reduction
P loss/ha (kgP/ha/yr)	1.0	1.0	
OverseerFM - predicted pasture grown (tDM/ha/yr)		16.4 (excluding East Block) 16.0 (East Block)	

The "current" scenario modelling results given above (and in all previous modelling) reflect how the land was actually operated in the three years from mid-2015 to mid-2018. It is made up of four individual nutrient budgets:

- The "current dairy platform" – one nutrient budget modelling the dairy operation over the three seasons mid 2015 to mid-2018.
- The "East Block, sheep (15-16season)" – the pre purchase system operating by the previous landowner.
- The "East Block, transition (16-17season)" – the season where the property was purchased by the Driscoll Family Trust and transitioned into their management.
- The "East Block, dairy support (17-18season)" – the management system imposed by the Driscoll's.

The table below shows the summary results from OverseerFM version 6.3.2 for each of the budgets described. Red figures show where the output predicted by OverseerFM version 6.3.2 is different to that predicted by the previous version (OverseerFM 6.3.0).

To determine the average total annual nutrient losses from the Dairy Platform and the East Block for the period mid 2015 – mid 2018, an average of the losses from the East Block nutrient budgets was calculated ("East Block average of 3yrs" – highlighted in green) and this was added to the "current dairy platform 3yr average" – also highlighted in green) to give the "current total 3yr average" (highlighted in blue). These "current total 3yr average" figures are taken directly from OverseerFM version 6.3.2 and do not include any of the adjustments made outside of OverseerFM.

Table 5. Predicted nitrogen and phosphorus losses in the current system as modelled in OverseerFM 6.3.2 for the years mid 2015 – mid 2018.

	Current Dairy Platform (3yr average)	East Block – Sheep (15-16 season)	East Block – Transition (16-17 season)	East Block – Dairy Support (17-18 season)	East block (average of 3yrs)	Current Total (averaged over 3 years)
Total Farm N Loss (kg)	11510	203	138	405	249	11759
N Loss/ha (kgN/ha/yr)	55	14	10	29	18	52
N Concentration in Drainage (ppm)	Pastoral – 10 to 13 Crops – 21 to 43	Pastoral – 3	Pastoral – 2	Pastoral - 7		
Total Farm P Loss (kg)	255	10	9	10	10	265
P loss/ha (kgP/ha/yr)	1.2	0.7	0.7	0.7	0.7	1.2
Overseer - predicted pasture grown (tDM/ha/yr)	16.6	11.7	11.9	12.6		

5.2 Modelling of the 18-19 season to update the "current scenario":

A new budget was created for each of the dairy platform and the East Block (named "Dairy farm 18-19" and "East Block 18-19" respectively). A detailed description of the input data as supplied by the applicant is given in the appendices.

In the 18-19 season, the dairy farm:

- Milked 599 cows at peak producing 513kgMS/cow
- Applied 184kgN/ha in split applications from August to April
- Imported Palm Kernel Extract (200tDM), Dried Distillers Grains (149tDM), Baleage (275tDM) and silage (40tDM) into the system for milking and wintering.
- Wintered 75 cows on farm on a baleage grass diet

In the 18-19 season, the East Block was operated in a conservative manner. It:

- Exported 154tDM of Baleage
- Grazed 100calves in November
- Applied 185kgN/ha in split applications from August to April

The results of this modelling are shown in ***bold and italics*** in the table below. The nutrient budget, nitrogen summary and phosphorus summary are shown for each system in the appendices.

To determine the average total annual nutrient losses from the Dairy Platform and the East Block for the period mid 2015 – mid 2019 ("current total average 4yrs"):

- An average of the losses from the East Block nutrient budgets was calculated ("East Block average of 4yrs" – highlighted in green)
- An average of the losses for the dairy platform ("current dairy platform 4yr average – also highlighted in green) was calculated.

The average dairy farm losses were then added to the average East Block losses to give the total average annual nutrient loss from the landholding in the period mid-2015 to mid-2019 ("current total 4yr average" – highlighted in blue). Red figures show where the output predicted by OverseerFM version 6.3.2 is different to that predicted by the previous version (OverseerFM 6.3.0).

Please note: These figures are taken directly from OverseerFM version 6.3.2 and do not include any of the adjustments made outside of OverseerFM.

Table 6. Predicted nitrogen and phosphorus losses in the current system as modelled in OverseerFM 6.3.2

	Current Dairy Platform (3yr average)	*Current Dairy Platform (18-19 season)*	Current Dairy Platform (average of 4yrs)	East Block – Sheep (15-16 season)	East Block – Transition (16-17 season)	East Block – Dairy Support (17-18 season)	*East Block – (18-19 season)*	East block (average of 4yrs)	Current Total (averaged over 4 years)
Total Farm N Loss (kg)	11510	***11201***	11433	203	138	405	***70***	204	11637
N Loss/ha (kgN/ha/yr)	55	***53***	54	14	10	29	***5***	15	52
N Concentration in Drainage (ppm)	Pastoral – 10 to 13 Crops – 21 to 43	***Pastoral – 10 to 20***		Pastoral – 3	Pastoral – 2	Pastoral - 7	***Pastoral – 1***		
Total Farm P Loss (kg)	255	***250***	254	10	9	10	***9***	10	264
P loss/ha (kgP/ha/yr)	1.2	***1.2***	1.2	0.7	0.7	0.7	***0.7***	0.7	1.2
Overseer - predicted pasture grown (tDM/ha/yr)	16.6	***16.6***		11.7	11.9	12.6	***11.8***		

Note: as per the methodology used in previous modelling, in the nutrient budgets for the 18-19 season, imported feed has been assumed to ensure a feasible pasture grown rate is achieved in an average season, and maintenance fertiliser has been assumed for P, K and S rather than the actual application rates. If actual inputs of supplements and fertiliser had been used for the 18-19 season modelling, nitrogen and phosphorus losses from the system would be have been higher so this is a conservative approach.

The table below summarises the results following the modelling of the 18-19 season. The "current system" results are taken from Table 6, while the "proposed system" results are taken from Table 4. Red figures show which results have changed as a result of adding in the 18-19 season modelling (ie. Results in red are different to those presented in Table 4).

Table 7. Predicted nitrogen and phosphorus losses in the current and proposed system after modelling of the 18-19 season was included, including phosphorus and nitrogen mitigations modelled outside of OverseerFM 6.3.2. Modelling to support adjustments made outside of OverseerFM are discussed in detail in previous file notes (in appendices)

	Current system	Proposed system	Percentage change in losses
Total Farm N Loss (kg)	11637	10792 (10193kgN plus 126kgN grass baleage and 473kgN young stock adjustments modelled outside of Overseer)	7.3% reduction
N Loss/ha (kgN/ha/yr)	52	48	
N Concentration in Drainage (ppm)		Pastoral – 3 to 20	
Total Farm P Loss (kg)	231 (264kgP minus 33kg P mitigation modelled outside of Overseer)	216 (260kgP minus 52kg P laneway mitigation plus 7.8kgP young stock adjustment modelled outside of Overseer)	6.5% reduction
P loss/ha (kgP/ha/yr)	1.0	1.0	
OverseerFM - predicted pasture grown (tDM/ha/yr)		16.4 (excluding East Block) 16.0 (East Block)	

5.3 Adjustments to nitrogen and phosphorus losses calculated outside of OverseerFM

In the previous file note (dated Aug 2019), adjustments to predicted nitrogen losses have been calculated outside of OverseerFM. Adjustments were made to the results predicted by OverseerFM to account for the following areas:

- A limitation within OverseerFM that means that the baleage wintering system underestimates actual nutrient losses
- The offsite effect of rearing and therefore grazing off more young stock in the proposed system
- A limitation within OverseerFM that means that phosphorus losses from the system are overestimated

The adjustments to nitrogen and phosphorus losses have been recalculated in light of the updated current scenario budgets. The methodology of the calculations is the same as that described in the file note, dated August 2019.

Although the offsite effect of wintering cows is lower in the proposed system than the current system, no adjustment has been made. This is a conservative approach as including the adjustment would reduce the predicted losses in the proposed system.

5.3.1 Baleage grass wintering:

As discussed in the previous file note, OverseerFM is likely to underestimate nitrogen losses under a baleage grass wintering system as it is not able to adequately reflect the on-farm realities of this system. To my knowledge there has been no research completed to determine the actual nutrient losses under a baleage grass wintering system. Therefore, a desktop modelling exercise was completed which assumed that losses under a baleage grass wintering system would be more comparable to a traditional fodder crop paddock than a permanent pasture paddock.

As described in this report already, since writing the August 19 file note, there has been a new version of Overseer released (version 6.3.2), and I have included data from the 18-19 season which includes baleage grass wintering on the dairy platform. As a result, this adjustment has been recalculated.

The table below shows the area in the baleage grass wintering system (on average for the last four years), and the nitrogen losses predicted by OverseerFM version 6.3.2 for the baleage grass wintering blocks.

Table 8. Area of baleage grass wintering in the current and proposed systems and the expected nitrogen loss compared to that modelled using a desktop methodology.

	Area in baleage grass wintering (ha)	Modelled nitrogen loss (kgN/ha) in the baleage grass wintering paddocks
Current system (average of 4yrs)	3	80
Proposed system	7	83

In comparison, the desktop modelling, as per the assumptions detailed in the Aug 2019 file note, predicted losses of 99kgN/ha. As these losses are greater than those modelled in both the current and proposed system, an adjustment to both scenarios is required. The adjustment is calculated by finding the difference in nitrogen loss predicted and multiplying by the number of hectares in the baleage grass system.

	Desktop N loss/ha	-	System N loss/ha	x	Area in baleage grass	=	Adjustment
Current system:	99	-	80	x	3	=	↑ 57kgN
Proposed system:	99	-	83	x	7	=	↑112kgN

The table below shows the effect of updating the adjustment calculated for the baleage grass wintering system. Red figures show which results have changed as a result of updated the adjustment for baleage grass wintering (ie. Results in red are different to those presented in Table 7).

Table 9. Predicted nitrogen and phosphorus losses in the current and proposed system after modelling of the 18-19 season was included, including phosphorus and nitrogen mitigations modelled outside of OverseerFM 6.3.2. Modelling to support adjustments made outside of Overseer are discussed in detail in previous file notes (in appendices)

	Current system	Proposed system	Percentage change in losses
Total Farm N Loss (kg)	11694 (11637 plus 57kgN grass baleage adjustments modelled outside of Overseer)	10778 (10193kgN plus 112kgN grass baleage plus 473kgN young stock adjustments modelled outside of Overseer)	7.8% reduction
N Loss/ha (kgN/ha/yr)	52	48	
N Concentration in Drainage (ppm)		Pastoral – 3 to 20	
Total Farm P Loss (kg)	231 (264kgP minus 33kg P mitigation modelled outside of Overseer)	216 (260kgP minus 52kg P laneway mitigation plus 7.8kgP young stock adjustment modelled outside of Overseer)	6.5% reduction
P loss/ha (kgP/ha/yr)	1.0	1.0	
OverseerFM - predicted pasture grown (tDM/ha/yr)		16.4 (excluding East Block) 16.0 (East Block)	

5.3.2 Offsite effects of wintering:

No adjustment has been made to nutrient losses to account for the reduced off-site effect of wintering fewer cows at a third-party grazier. The number of cows wintered off in the current scenario was 526 and 483 in June and July respectively compared to 516 and 459 in June and July respectively in the proposed system.

This is a conservative approach as including this adjustment would result in a reduction in predicted losses under the proposed system.

5.3.3 Off-site effects of young stock:

As discussed in the previous file note (dated Aug19), there will be an increase in the number of young stock reared for the property as a result of the increased cow numbers on farm. Therefore, the offsite nutrient loss of the young stock in the proposed system will be higher than the current system. These animals have been and will continue to be grazed off site with a third-party grazier. In an email, dated 21st February, between Alex Erceg (ES) and Tanya Copeland (Landpro) it was agreed that the off-site effects of these animals did not need to be quantified or taken into account in the OverseerFM modelling. A copy of the relevant correspondence is available from Landpro upon request.

However, for completeness, in the file note dated August 2019, the scale of off-site nutrient loss due to the extra young stock was estimated. The calculation was intended to give an estimate of scale of nutrient loss, rather than to suggest accuracy. There were too many variables that are unknown (including soil type, climate, stocking rate and fertiliser policy) to provide accuracy. The assumptions and calculations are described in detail in the file note dated August 2019. The calculations estimated that each extra heifer grazed off farm would have the following offsite effect:

- 15.8kgN/year
- 0.26kgP/year

In the previous modelling, the average number of heifers grazed off farm for the years mid 2015 to mid 2018 ("the current scenario") was 160. This is compared to 190 heifers being grazed off farm in the proposed scenario – 30 more than the current scenario. With the inclusion of the 18-19 season in the current modelling, the average number of heifers grazed off farm for the years mid 2015 to mid 2019 has increased to 170 – a difference of 20 heifers when compared to the proposed system.

Therefore, it is expected that the offsite nutrient loss of these extra young stock is:

- 315kgN/year (20 heifers x 15.8kgN/heifer/yr)
- 5.2kgP/year (20 heifers x 0.26kgP/heifer/yr)

The table below shows the predicted losses following the updated adjustment for offsite young stock grazing. Red figures show which results have changed as a result of updating the adjustment (ie. Results in red are different to those presented in Table 9).

Table 10. Predicted nitrogen and phosphorus losses in the current and proposed system after modelling of the 18-19 season was included, including phosphorus and nitrogen mitigations modelled outside of OverseerFM 6.3.2. Modelling to support adjustments made outside of Overseer are discussed in detail in previous file notes (in appendices)

	Current system	Proposed system	Percentage change in losses
Total Farm N Loss (kg)	11694 (11637 plus 57kgN grass baleage adjustments modelled outside of Overseer)	10620 (10193kgN plus 112kgN grass baleage and 315kgN young stock adjustments modelled outside of Overseer)	9.2% reduction
N Loss/ha (kgN/ha/yr)	52	47	
N Concentration in Drainage (ppm)		Pastoral – 3 to 20	
Total Farm P Loss (kg)	231 (264kgP minus 33kg P mitigation modelled outside of Overseer)	213 (260kgP minus 52kg P laneway mitigation plus 5.2kgP young stock adjustment modelled outside of Overseer)	7.8% reduction
P loss/ha (kgP/ha/yr)	1.0	0.9	
OverseerFM - predicted pasture grown (tDM/ha/yr)		16.4 (excluding East Block) 16.0 (East Block)	

5.3.4 Laneway phosphorus loss mitigations:

Overseer has a built-in assumption that 30% of phosphorus deposited on laneways as dung is lost. This is calculated on a "per cow" basis and is accounted for in the "other sources" losses within the Phosphorus report (shown in the appendices of this file note). There is opportunity to mitigate the losses from laneways through careful management of bridges/culverts, buffer zone planting, laneway cambering and siting laneways away from waterways. These mitigations all reduce P loss by ensuring laneway runoff is filtered through a vegetated buffer strip. None of these mitigation strategies are provided for in OverseerFM.

The applicant has currently implemented some of these mitigation strategies and has plans to implement more in the near future. Details of these further mitigations are described in detail in the applicants Farm Environmental Management Plan and in the file note Dec 2018. As a result of the OverseerFM assumption, P losses estimated by OverseerFM are higher than expected, and an adjustment is required.

The peak number of cows milked was higher in the 18-19 season than the average of the three seasons prior to that. The adjustment in laneway phosphorus loss was recalculated using the same methodology as that described in the December 2018 file note. It is predicted that laneway phosphorus losses are 34kgP lower than that estimated by OverseerFM in the current scenario.

The table below shows the predicted losses following the updated adjustment for laneway phosphorus losses. Red figures show which results have changed as a result of updating the adjustment (ie. Results in red are different to those presented in Table 10).

Table 11. Predicted nitrogen and phosphorus losses in the current and proposed system after modelling of the 18-19 season was included, including phosphorus and nitrogen mitigations modelled outside of OverseerFM 6.3.2. Modelling to support adjustments made outside of Overseer are discussed in detail in previous file notes (in appendices)

	Current system	**Proposed system**	**Percentage change in losses**
Total Farm N Loss (kg)	11694 (including 57kgN grass baleage adjustments modelled outside of Overseer)	10620 (including 112kgN grass baleage and 315kgN young stock adjustments modelled outside of Overseer)	9.2% reduction
N Loss/ha (kgN/ha/yr)	52	47	
N Concentration in Drainage (ppm)		Pastoral – 3 to 20	
Total Farm P Loss (kg)	230 (264kgP minus 34kg P mitigation modelled outside of Overseer)	213 (including 52kg P laneway mitigation and 5.2kgP young stock adjustment modelled outside of Overseer)	7.4% reduction
P loss/ha (kgP/ha/yr)	1.0	0.9	
OverseerFM - predicted pasture grown (tDM/ha/yr)		16.4 (excluding East Block) 16.0 (East Block)	

6.0 Conclusions from the modelling

Table 12. Predicted nitrogen and phosphorus losses in the current and proposed system after modelling of the 18-19 season was included, including phosphorus and nitrogen mitigations modelled outside of OverseerFM 6.3.2. Modelling to support adjustments made outside of Overseer are discussed in detail in previous file notes (in appendices)

	Current system	Proposed system	Percentage change in losses
Total Farm N Loss (kg)	11694 (including 57kgN grass baleage adjustments modelled outside of Overseer)	10620 (including 112kgN grass baleage and 315kgN young stock adjustments modelled outside of Overseer)	9.2% reduction
N Loss/ha (kgN/ha/yr)	52	47	
N Concentration in Drainage (ppm)		Pastoral – 3 to 20	
Total Farm P Loss (kg)	230 (264kgP minus 34kg P mitigation modelled outside of Overseer)	213 (including 52kg P laneway mitigation and 5.2kgP young stock adjustment modelled outside of Overseer)	7.4% reduction
P loss/ha (kgP/ha/yr)	1.0	0.9	
OverseerFM - predicted pasture grown (tDM/ha/yr)		16.4 (excluding East Block) 16.0 (East Block)	

This file note has updated the current scenario modelling to include the 18-19 season. Following this inclusion, nutrient loss adjustments were recalculated, and appropriate changes were made to the OverseerFM predicted nutrient losses. The modelling predicts that overall nitrogen will decrease by 9.2% and losses of phosphorus will decrease by 7.4%.

Please note that the reductions in N and P loss presented above are conservative figures. It is expected that a greater reduction will occur than what has been modelled due to:

- Fewer cows being wintered off farm in the proposed scenario (ie lower offsite effects than modelled) – an adjustment for this was not calculated
- An adjustment for greater off-site nutrient loss in the proposed system due to more young stock being grazed off farm was taken into account and included in the losses presented in table 12 – even though an agreement was reached between Environment Southland and Landpro that this was out of scope.
- Assumed imported supplement to create a feasible long-term pasture grown figure (the 18-19 season had exceptional pasture growth in the Winton area which is not representative of the average season. This higher pasture grown estimate would result in higher predicted losses in the 18-19 season)
- Assumed maintenance fertiliser applied (in the 18-19 season, some paddocks received extra fertiliser as they had missed their maintenance application in the 17-18 season. The

use of actual fertiliser application rates would have resulted in higher phosphorus losses predicted in the 18-19 season)

The key drivers of a decrease in nitrogen loss are shown below. In comparison to the current system, the proposed system has:

- Increased the area that effluent is applied to – reduced N application in effluent to this area
- Reduced nitrogen fertiliser use
- Change in the farms culling policy to one of culling earlier
- Lower protein content supplementary feed (Barley)

The key driver of the decrease in phosphorus loss are shown below. In comparison to the current system the proposed has:

- Improved laneway sediment loss mitigations (as detailed in the applicants Farm Environmental Management Plan)
- A reduction in the Olsen P on the current dairy platform area (although an increase in Olsen P on the East Block)
- Use of Reactive Phosphate Rock fertiliser on the East Block

Appendices:

Appendix 1: Detailed Nutrient Budget Assumptions

Appendix 2: Nutrient budgets taken from OverseerFM Dec2019

Appendix 3: File note - Aug 2019

Appendix 4: Further information: T and J Driscoll Family Trust consent application, December 2018

Appendix 5: Overseer modelling report for the purposes of as part of a consent application for expanded dairying, dated October 2018

Appendix 6: Farm Maps

Technical Report

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Review of Resource Consent Application by T.J. and J.A. Driscoll

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Earth & Environmental Science Report 2019/06

December, 2019

Prepared for Environment Southland Regional Council

Quality control record

Title:	Review of Resource Consent Application by T.J. and J.A. Driscoll
Client:	Environment Southland Regional Council
Version:	FINAL
Issue date:	13.12.2019
Job number:	190009
File location:	Projects\EnvironmentSouthland\ResourceConsents\Driscoll \Reporting

Review

Technical:	Jens Rekker
Organisation:	JH Rekker Consulting Ltd.
Date:	13.12.2019

Document details

Author:	Abigail Lovett
Reference:	Lovett, A., 2019. Review of Resource Consent Application by T.J. and J.A. Driscoll. Earth & Environmental Science Report 2019/06, prepared for Environment Southland Regional Council. 27p.

Approved for release by:

ABIGAIL LOVETT 13/12/2019

Contents

Executive summary

Environment Southland requested that Earth & Environmental Science Ltd. review a resource consent application submitted by T.J. and J.A. Driscoll. The application proposes an increase in area of the dairy platform at 266 O'Shannessy Road, Winton and associated consents for land use for dairy farming (including an increase in cows from 599 – 680), effluent discharge, and groundwater abstraction. The review included assessment of information provided in the application to address potential effects on freshwater resources in the receiving environment as a result of the proposed activities. Where required, additional information to support an assessment of effects from the proposed activities was presented.

Surface water

Surface water bodies that drain the local catchment include Oreti River, Makarewa River, and Tussock Creek – all of which are located within the Oreti Freshwater Management Unit. Surface water quality information showed that land use in the catchment has had an impact on the water quality of the Tussock Creek, Makarewa River, and Oreti River including increased nutrient, bacterial, and sediment contamination. The most likely source of bacterial contamination and increased nutrients is land use change and intensification in the catchment. Furthermore, New River Estuary is exhibiting significant issues associated with excessive macroalgal growth and likely represents the largest impact of this type to have occurred in this type of estuary in New Zealand. Studies indicate that unless nutrient inputs to the estuary are reduced significantly, it is expected that there will be a continuation of these difficult to reverse adverse impacts within the estuary.

Groundwater

The dairy platform is predominantly located within the Lower Oreti Groundwater Management Zone with the eastern area of the farm within the Makarewa Groundwater Management Zone. Groundwater levels showed strong seasonal signals due to the influence of rainfall, land surface recharge, and abstraction. There was no evidence of a long-term decline in groundwater level over time. Since the aquifers are predominantly recharged via rainfall, they are particularly vulnerable to the influence of land surface processes on water quality. Results of limited groundwater quality monitoring datasets indicated that the Makarewa and Lower Oreti groundwater systems had been impacted from land use processes, including elevated nutrient concentrations and increased bacterial contamination.

Drinking water supplies

Land use on Driscoll Farm has the potential to affect the Lochiel School groundwater supply due the close proximity and inferred groundwater flow direction. A brief assessment of this drinking water supply was undertaken in the application and no assessment of additional downstream sites has been undertaken, including Alliance Makarewa and Alliance Lorneville supply sites.

Soils

Soil types on the property include Pukemutu and Edendale. Soil moisture datasets indicate that drainage is likely to occur during the period May – October, with differences in weather promoting earlier or later onset of land surface recharge. Soil moisture is a controlling factor in the timing and rate of effluent irrigation, since application of effluent can lead to leaching of nutrient and bacteria to groundwater and discharge of contaminants (including sediment) to surface water. A high level of effluent management is required to limit the adverse effects on surface water and groundwater. The proposed application of (an average of) 67 kg/N/ha/yr is approximately 44% of the recommended maximum areal rate of 150 kg/N/ha/yr. Regardless, some adverse effects of effluent application, including bacterial and sediment contamination of surface water is likely to occur due to shallow drainage and overland flow processes.

Overseer

Overseer modelling showed a decrease in nutrient loss under the proposed consent activities (10,507 kg/N/yr; 212 kg/P/yr), when compared to the current activities (11,513 kg/N/yr; 230 kg/P/yr). This is equivalent to a 9% reduction in nitrogen loss and an 8% reduction in phosphorus loss. Primary drivers for the decrease in nitrogen and phosphorus loading included: a reduction in winter crop area and fertilizer use; an increase in effluent discharge area resulting in a reduction of effluent application depth; and increased use of barley and baleage grass wintering. It is suggested that this modelled reduction in nutrient loss could likely occur on-farm, however it is continually overstated in the application as being "*a significant reduction*" when more appropriate terminology should have been used in the application.

Even under the reduced nutrient loadings, the proposed activities have the potential to adversely affect surface water, groundwater, and estuarine environments. Any instance of mitigation measures proposed in the Farm Environment Plan or Overseer are not followed will result in an increased risk of nutrient, sediment, and/or bacterial loss to the receiving environment.

Summary

The description of the receiving environment provided in the application is relatively basic and relies on limited data sources, which have been supplemented by additional information in this report. Overall, the data presented in the application clearly indicates that surface water, groundwater, and estuarine environments have been impacted by land use in the Oreti Catchment, in particular the New River Estuary. The modelled reduction in nutrients from the current scenario to the proposed scenario indicates that a reduction in nitrogen and phosphorus loss is likely. The potential impacts on bacterial contamination and sediment are more uncertain, since these contaminants cannot be modelled in Overseer and since the potential for Pukemutu Soils to undergo bypass (preferential) flow is not well considered. Furthermore, it must be considered that the reduction in nutrient loss relies heavily on the mitigation measures proposed in the Farm Environment Plan and Overseer being implemented and operating successfully.

The following aspects of the application are not adequately described (or have been contradicted in the application) and should be addressed:

- Whether increased abstraction from bore E46/1067 is proposed, and if so, why an (desktop) assessment of the effects for the increased abstraction has not been undertaken; and
- A description of how soil moisture management is actually implemented or how relevant soil moisture data is used to determine current soil conditions to ensure effects of FDE application are minimised, has not been provided.

1.0 Introduction

Environment Southland requested Earth & Environmental Science Ltd (E&E Science) undertake a review of Resource Consent Application for T.J. and J.A. Driscoll (Driscoll) prepared on behalf of the applicant by Landpro (2019). The scope of the review included: assessment of information provided in the consent application with regards to addressing potential effects on groundwater and surface water quality and quantity in the receiving environment and provision of information required for determining the effects of the proposed activities on surface water and groundwater environments. The proposed consent activities have the potential to impact water quality and quantity of groundwater and surface water receiving environments. The proposed activities relevant include a 13.5% increase in the number of dairy cows (+ 81 cows); increased effluent discharge (e.g., changes to volume, rate, timing, and methods); and an increase in groundwater abstraction. The effects of the proposed activities will be assessed in terms of the entirety of the land use activity and intensification of current land use on the receiving environment.

1.1 Consent application summary

All information provided in this section was obtained from the consent application document (Landpro, 2019). The applicant currently operates a dairy farm at 266 O'Shannessy Road, Winton including which consists of dairy platform with associated Effluent Discharge and Water Permits that expire in 2021 (Table 1). The application proposes an increase in area of the dairy platform and associated consents for land use for dairy farming, effluent discharge, and groundwater abstraction (Table 1).

Table 1.1: Summary of current and proposed consents for Driscoll.

Current consents	Proposed consents
Dairy Platform (210.6 Ha) • Effluent Discharge permit (599 cows) • Water permit (60 m^3/day)	Dairy Platform (224.5 Ha) • Land use consent for dairy farming (224.5 Ha) • Effluent Discharge permit (680 cows) • Water permit (84 m^3/day)

The applicant currently holds the following permits (consents):

- AUTH-301043: Effluent Discharge Permit (2017 - 2027)
  - 599-cow herd
  - Method: not specified
  - Farm Dairy Effluent (FDE) discharge
- AUTH-301044: Water Permit (2017 - 2027)
  - Bore E45/0071
  - Groundwater abstraction up to a maximum of 60 m^3/day (equivalent to 100 L/cow/day)

The applicant has proposed that the following new consents be granted, including the following changes:

- Land use consent for dairy farming
  - Increase the dairy platform by 13.9 ha (from 210.6 ha to 224.5 ha)
  - Equivalent to a 6.6% increase in land area on the platform
- Effluent discharge Permit (replace AUTH-301043) [93.3 ha]
  - Increase cow numbers from 599 cows to 680 (81 additional cows; equivalent to 13.5% increase)
  - Discharge of agricultural effluent (50 bale rotary dairy shed, vat stand, tanker apron) to land via:
    - Slurry tanker when desludging pond (maximum 5 mm depth); and
    - RX plastic maxi Pods (10 mm/hr and 25 mm per application).
- Water Use (replace AUTH-301044)
  - Increase groundwater abstraction from 60 m^3/day to (up to) 82 m^3/day in summer (40% increase)
    - Bore E46/1067 (currently used), <1 L/s
    - Bore E46/1089 (not currently used)
  - 120 L/cow/day for 680 cows over summer (82 m^3/day), 70 L/cow/day for 86 cows over winter (6 m^3/day)
  - Located within the Lower Oreti Groundwater Management Zone

2.0 Geographic setting

2.1 Location

The applicant's property is located on relatively flat topography approximately 5 km south of Winton at 266 O'Shannessy Road (Figure 2.1). The dairy platform is predominantly located within the Lower Oreti Groundwater Management Zone (GMZ) with the eastern area of the farm within the Makarewa GMZ (Figure 2.2). Surface water bodies that drain the local catchment include Oreti River, Makarewa River, and Tussock Creek – all of which are located within the Oreti Freshwater Management Unit (FMU) (Figure 2.3). The property is predominantly located within the Lower Oreti Soil types on the property include Pukemutu and Edendale, with several local soil profiles available (Figure 2.4). The property is located within both Oxidising and Gleyed physiographic zones. Approximately 78.5% of land in the Oreti FMU is developed, of which predominant land use includes sheep and beef farming (46%), dairy farming (30%), forestry (6%), and urban (5%) (Figure 2.5).

Table 2.1: Summary of freshwater management unit (pSWLP, 2018), groundwater management zone (pSWLP, 2018), physiographic zones, and main soil types for Driscoll Farm.

Freshwater management unit (FMU)	Groundwater Management Zone (GMZ)	Physiographic Zone	Soil type
Oreti	Lower Oreti Makarewa	Oxidising Gleyed	Pukemutu Edendale

Figure 2.1: Location of applicant's property boundary and existing groundwater abstraction (blue water droplets) and farm dairy effluent discharge consents (brown cows) (Environment Southland, 2019). Bore E46/1067 is located at the house (northern bore) and currently used for groundwater supply, whereas bore E46/1089 is located at the dairy shed and not currently used.

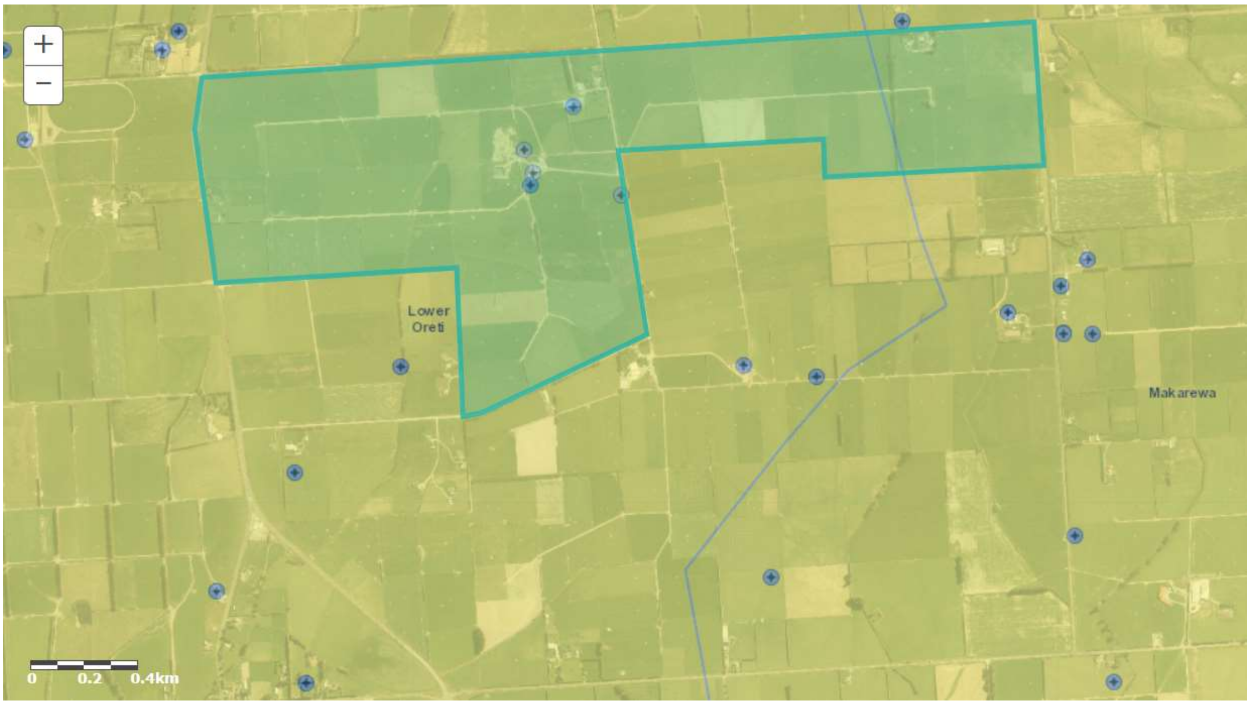

Figure 2.2: Location of applicant's property boundary within Lower Oreti (western) and Makarewa (eastern) groundwater management zones, including location of bores in the local area (Environment Southland, 2019).

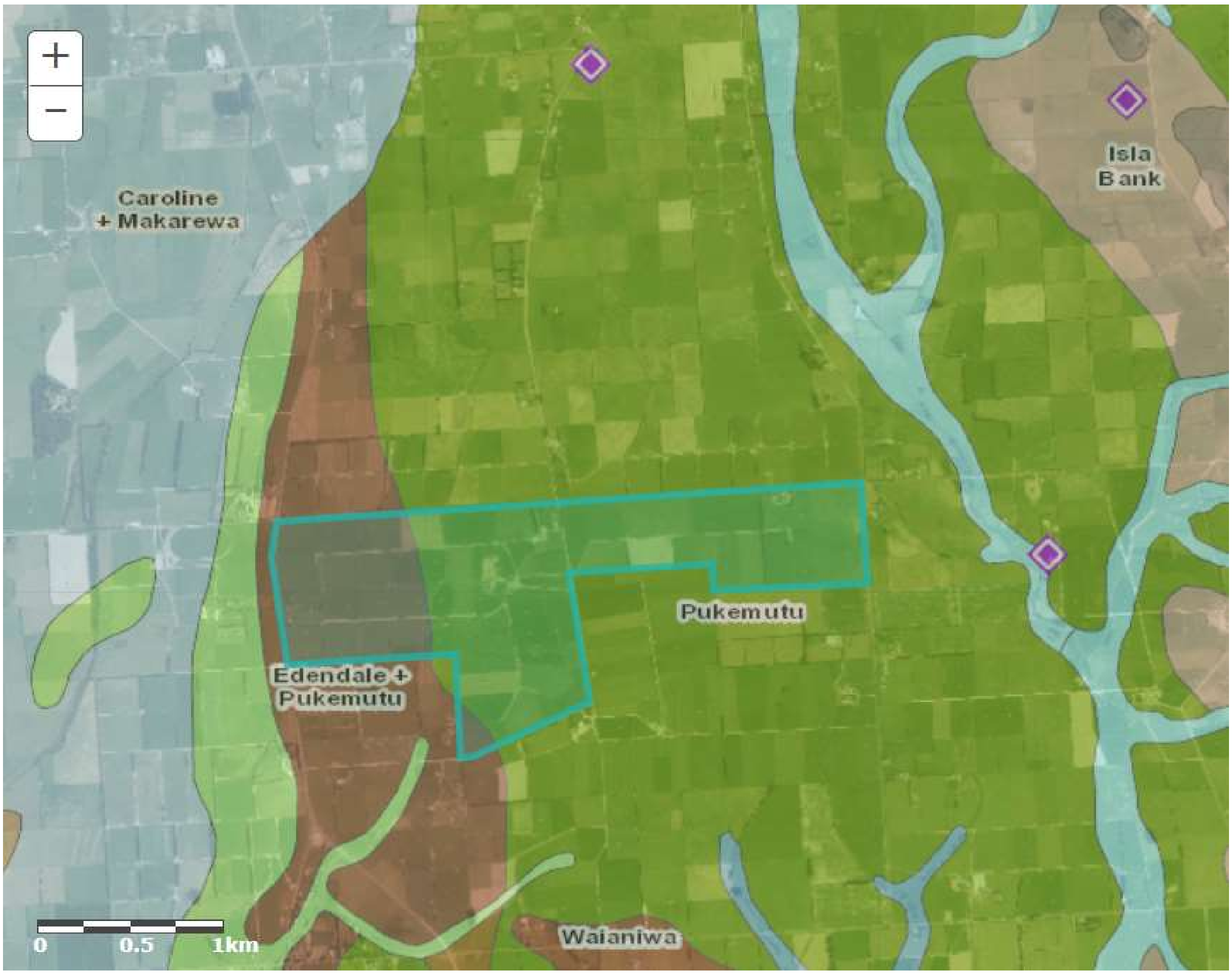

Figure 2.3: Location of applicant's boundary, soil types, and locations of soil profiles (purple diamonds) (Environment Southland, 2019).

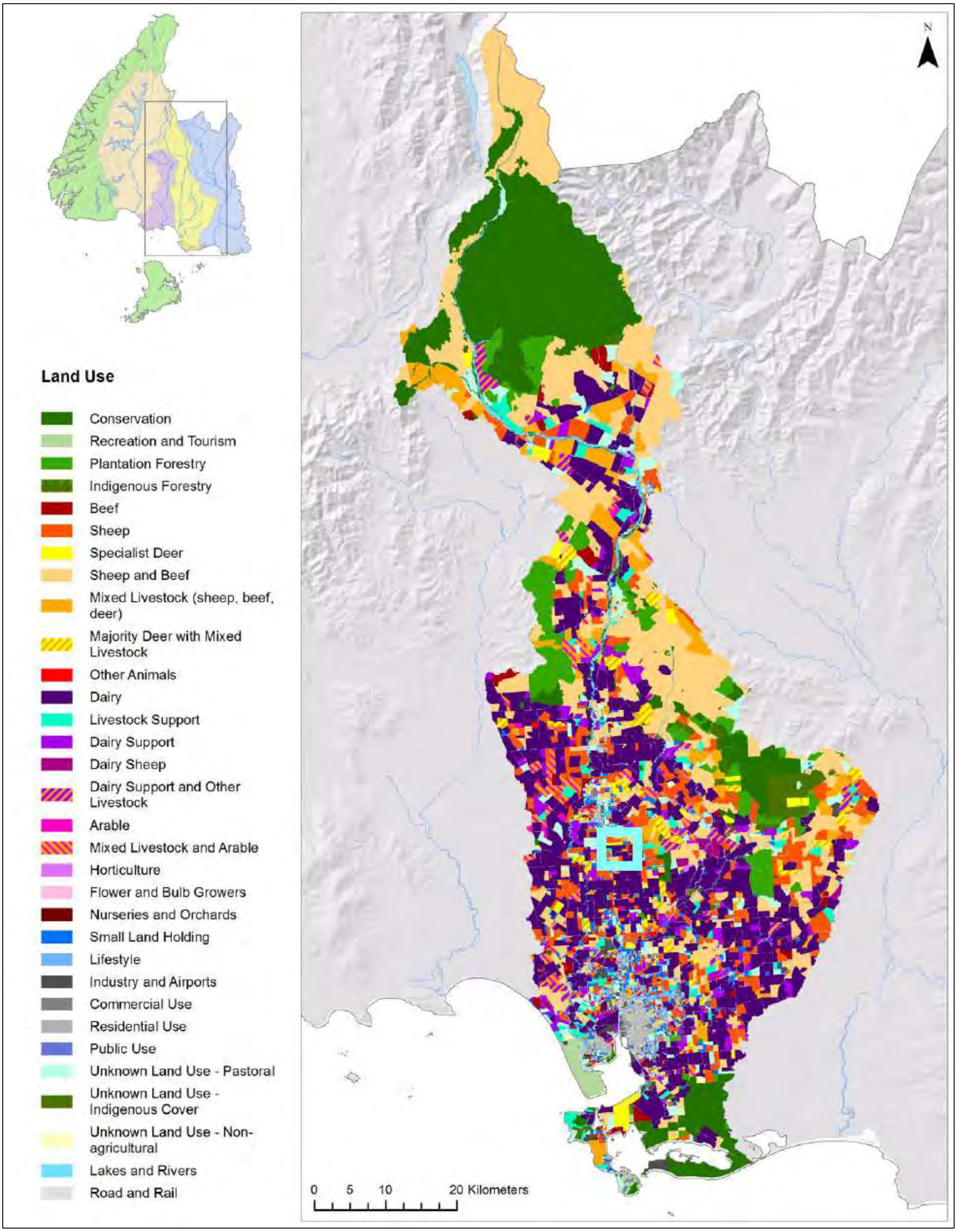

Figure 2.4: Approximate location of the applicant's property (blue box), in the context of the Oreti FMU in the context of land use within the Oreti Catchment. Modified from Nicol and Robertson (2018).

3.0 Water resources management

Continued use of freshwater resources in the Southland Region is dependent on availability of the resource at sufficient quality and quantity. Current pressures on the water resources include an increasing demand for surface and groundwater, a trend which is expected to continue as population growth and land use intensification continue to rise. Meanwhile, groundwater plays an important role in environmental, social, and cultural resources both in terms of maintaining stream and spring flow, sustaining flow for aquatic habitat, and supporting recreational and cultural activities. Further stress on freshwater resources are likely to be driven by long-term changes to regional climate such as observed decreases in precipitation in summer (Beyer, 2017; NIWA, 2017; MfE, 2016). The combination of recent and projected changes in climate (e.g., reduced recharge rates) with conjunction with increases in surface and groundwater abstraction and intensification of land use, mean that appropriate management of freshwater resources in the region is essential.

The FMU concept is used to plan and manage freshwater resources, and can be defined as "*the water body, multiple water bodies or any part of a water body determined by the regional council as the appropriate spatial scale for setting freshwater objectives and limits and for freshwater accounting and management purposes*" (Ministry for the Environment, 2016). Five FMUs have been set for the Southland Region, in accordance with the National Policy Statement for Freshwater Management 2014 (NPSFM, 2017). The Southland region FMU's include Aparima, Fiordland and Islands, Mataura, Oreti, and Waiau.

The framework for groundwater management in Southland heavily relies on the confinement status of the aquifer systems, so aquifers have been identified as confined or unconfined (Environment Southland, 2019). Confined aquifers are separated from the land surface, usually through a layer of impermeable material (e.g., rock or sediment) that separates the groundwater from the surface above. The confining layer acts as a barrier to groundwater and prevents vertical movement in or out of the aquifer. Unconfined aquifers are fed by rainwater (e.g., land surface recharge) or inflow surface waters (e.g., wetlands, lakes, streams). Many unconfined aquifers in Southland are located very close to the land surface (e.g., < 5 m below ground level (BGL)). Due to the high level of connection with the land surface, shallow unconfined aquifers can be heavily influenced by land use including bacterial and nutrient enrichment. To assist with groundwater management in Southland, unconfined aquifers have been subdivided into 26 groundwater management zones. These zones have been delineated based on areas of similar hydrogeological characteristics. Confined aquifers are managed separately as they respond differently to abstraction and recharge so are therefore more difficult to quantify.

3.1 Hydrological parameters and water quality indicators

The following hydrological parameters are regularly used to describe and benchmark the quality of surface waters in New Zealand (Davies-Colley, 2013):

- fine sediment (causing reduced water clarity and sedimentation of river beds and downstream water bodies);
- major nutrients of nitrogen and phosphorus (promoting aquatic plant, particularly nuisance algae, growth; and
- faecal microbes (representing a hazard to human users of water or consumers of contaminated shellfish).

Due to the comparatively high cost of directly measuring suspended sediment concentration of water quality samples, optical variables of visual clarity and turbidity are often measured (Davies-Colley, 2013). These variables both relate to light scattering by particles and neither is an absolute measurement of sediment concentration. Turbidity is a measurement of the amount of light that is scattered by material in water when a light is shined through the water sample (e.g., higher intensity of scattered light relates to a higher turbidity). Materials increasing turbidity (and reducing visual clarity) can include: clay, silt, inorganic and organic matter, algae, dissolved colored organic compounds, plankton, and other microscopic organisms. Turbidity provides a useful check on (non-repeatable) visual clarity measured in the field.

Nitrogen (N) is found in several different forms in terrestrial and aquatic ecosystems, including ammonia (NH_3-N), organic and particulate nitrogen, nitrate (NO_3-N), and nitrite (NO_2-N). Phosphorus is also found in a variety of different forms, and most commonly water quality results state Total Phosphorus (TP), which is a measure of all forms of phosphorus that are found in a sample, including dissolved and particulate, organic, and inorganic. Dissolved Reactive Phosphorus (DRP) is reported as a measure of the dissolved (soluble) phosphorus compounds that are readily available for use by plants and algae. N and P are essential plant nutrients and commonly applied in various forms as fertiliser to promote plant growth.

However, in excess, these nutrients can cause significant water quality issues such as eutrophication, increase in nuisance aquatic plant growth and algal blooms, and a decrease in macroinvertebrate community. Natural levels of NH_3-N and NO_3-N in surface waters are typically low (e.g., < 1.0 mg/L), as are natural levels of P in waterways (e.g., < 0.002 mg/L). Therefore, N and P concentrations are commonly used an indicator of the effects from land use processes (e.g., agricultural runoff, leaching, industry, waste water urban). Primary sources of nutrients include runoff from agricultural land and animal manure storage areas, wastewater treatment plants, and industrial discharge. New Zealand Drinking Water Standards (NZDWS) maximum acceptable value (MAV) for NO_3-N is 11.3 mg/L. The National Objectives Framework (NOF) prescribes a national bottom line of 6.9 mg/L of NO_3-N in surface water (nitrate toxicity to fish) (MfE, 2016). For all parameters, units for water quality presented in mg/L and g/m^3 can be used interchangeably (e.g., 1.0 mg/L and 1.0 g/m^3 are equivalent).

Faecal microbial pollution from livestock pasture is generally indicated in waterways by presence of *E. coli* as a result of animal waste from contributing areas (e.g., soil compacted by livestock trampling; cattle directly entering channels) (Davies-Colley, 2013). *E. coli* is used as a primary indicator of the risk of getting sick from contact with surface waters, as high levels of *E. coli* can make people and animals sick. Primary contact involves activities such as swimming and water skiing whereas secondary contact includes activities such as boating and fishing. The compulsory national bottom line for secondary contact is 1,000 cfu/100 mL of *E. coli*, however limits for primary contact have not yet been established. In addition, faecal coliforms and total coliforms are additional parameters commonly used for reporting of water quality.

Soil moisture in Southland is reported as percentage of "Water Filled Pores" which indicates pore space (e.g., gaps in the soils structure) that are filled with water or as a (calibrated) percentage soil moisture. A completely saturated soil has 100% water filled pores. When a soil is above field holding capacity, rapid drainage to the shallow groundwater system and/or surface water runoff and drainage are likely occur. Environment Southland currently monitor soil moisture at 22 sites throughout the region. These monitoring sites can be used by landowners to determine appropriate rates and timing for irrigation and application of Farm Dairy Effluent (FDE).

Groundwater level measurements provide an indication of changes in groundwater level over time. Observed changes are likely to be driven by a combination of natural and anthropogenic factors. Natural drivers include seasonal, annual, or long-term changes in rainfall, which effects the volume of surface water and/or land surface recharge to the groundwater system. Anthropogenic factors include abstraction from surface waters (which are the source of recharge) and/or groundwater abstraction from the aquifer. Changes in groundwater levels can be observed at a local, catchment, or regional scale. Although groundwater level measurements should ideally be undertaken under static water level conditions (e.g., where there is little or no impact on the water level from pumping in that monitoring well or from nearby), this is not always possible. Therefore, interference effects are a key limitation on the accuracy of groundwater level data.

3.0 Hydrological setting of the receiving environment

Receiving freshwater environments that are potentially affected by the proposed consent activities include the Oreti Freshwater Management Unit (FMU), and the Makarewa and Lower Oreti Groundwater Management Zones (pSWLP, 2018). In this section, a hydrological summary is presented to describe the current state of the freshwater resources, and where sufficient data is available, to describe any trends in hydrological parameters (e.g., water quality). Information provided in this section is supplementary to that presented in the application (Landpro, 2019), and provides a wider context to more appropriately determine the effects of the proposed activity on the receiving environment.

3.1 Oreti Freshwater Management Unit

The Oreti Catchment is bounded in the north by the Thomson Mountains. Water flows in a southward direction and discharges into the ocean via the New River Estuary adjacent to Invercargill. The upper catchment of the Oreti River maintains much of its natural qualities whereas the mid and lower reaches of the catchment have been modified via drainage, flood control, and channel clearance work. Impacts on water quality in the Oreti River are likely due to tile drain and non-point source discharges, stock access to waterways, drainage maintenance and gravel extraction activities. SOE water quality monitoring sites in the Oreti River Catchment include Bog Burn d/s Hundred Line Road and Oreti River at Wallacetown (Table 3.1). Water quality monitoring is also undertaken at the Branxholme water supply, located *c.* 4.5 km upstream of the Wallacetown site (Table 3.1). Tributaries of the Oreti River (e.g., Winton Stream, Waikiwi Stream, Makarewa River) are subject to point-source discharges of effluent from industry and municipal sewage treatment and confluence with the Oreti River downstream of the Wallacetown monitoring site. Monitoring sites on the Makarewa River include Makarewa at Counsell Rd and Makarewa at Wallacetown, and the higher order Tussock Creek at Cooper Road (Table 3.2)

*Table 3.1: Summary of key water quality parameters for the Oreti River and tributaries (Environment Southland, 2019). *numbers in brackets indicate the number of sample results below the detection level for the analysis method.*

	Parameter	*E. coli*	Faecal Coliform	Nitrate	Nitrite	Dissolved Reactive Phosphorus	TP	Suspended Sediment
	Unit	cfu/100 mL	cfu/100 mL	mg/L	mg/L	mg/L	mg/L	mg/L
Bog Burn d/s Hundred Line Rd	Min	40	40	0.083	0.003	0.005	0.019	-
	Max	21,000	22,000	6.30	0.035	0.210	0.490	-
	Mean	1,544	1,809	1.18	0.009	0.027	0.062	-
	Median	800	900	0.91	0.008	0.023	0.051	-
	Count	213 (1)	192 (1)	82	81	207	206	-
Oreti River (Branxholme)	Min	10	10	0.36	0.002	0.004	0.004	11
	Max	5,000	7,000	3.10	0.020	0.13	0.58	4400
	Mean	432	523	1.11	0.002	0.02	0.14	206
	Median	130	160	0.96	0.007	0.01	0.08	136
	Count	52	52	274	258 (16)*	207 (67)*	273 (1)*	175 (66)*
Oreti River (Wallacetown)	Min	6	6	0.34	0.002	0.004	0.004	10
	Max	24,000	24,000	2.5	0.01	0.04	0.32	144
	Mean	592	661	1.1	0.004	0.008	0.028	36
	Median	150	190	0.94	0.003	0.007	0.012	13
	Count	240 (3)*	242 (3)*	75	69 (6)*	50 (26)*	73 (3)*	7 (42)*

Bog Burn is a considerable distance upgradient of the applicant's property and shows moderate to high impacts of land use on water quality, particularly bacterial indicators. *E. coli* concentration ranged from <10 – 21,000 cfu/100 mL and faecal coliform concentration ranged from 40 – 22,000 cfu/100 mL (Table 3.1, Figure 3.1). Bacterial presence was confirmed in almost 100% of the sampling events (e.g., 213 of 214 samples) (Table 3.1). Nutrient concentrations for Bog Burn ranged from 0.083 – 6.3 mg/L for NO_3-N and 0.003 – 0.035 mg/L for NO_2-N, whereas TP concentration was 0.02 – 0.49 mg/L (Figure 3.2). Water quality results clearly indicate impacts from land use in the immediate catchment, likely as a result of soil drainage and/or runoff events from intensive agriculture.

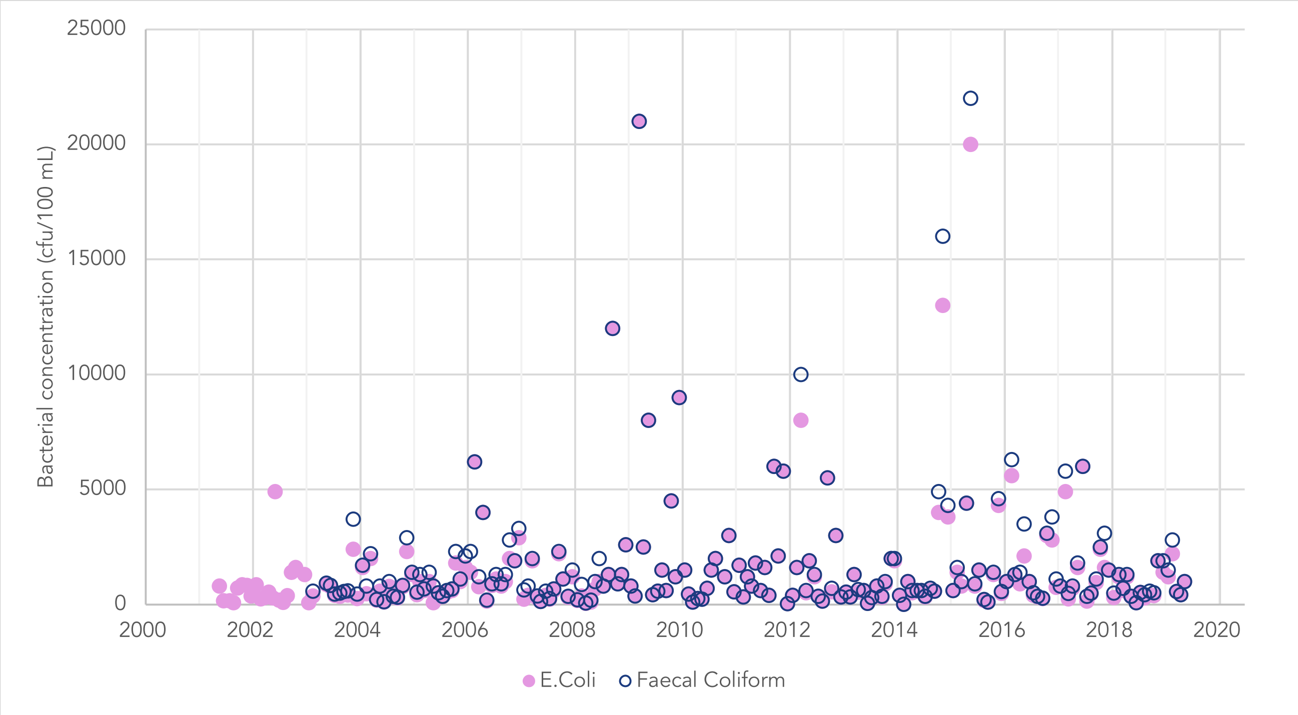

Figure 3.1: Summary of bacterial concentration at the Bog Burn monitoring site (Environment Southland, 2019).

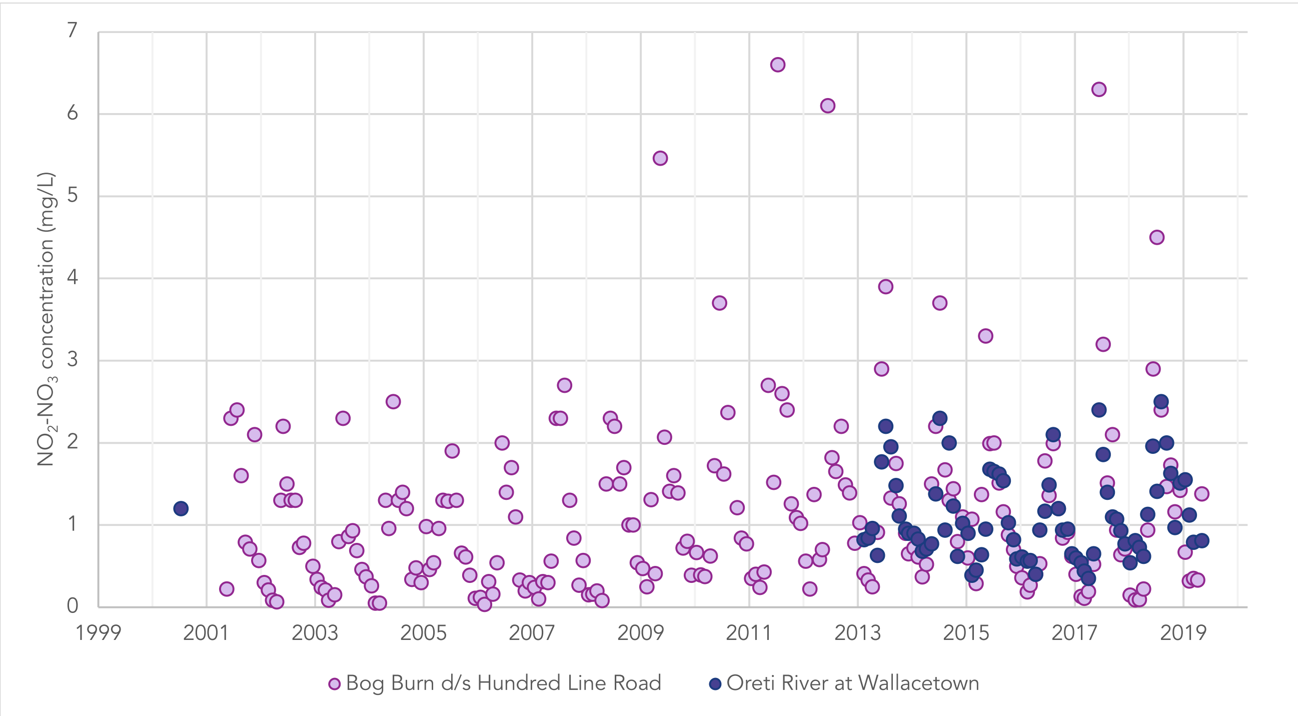

Figure 3.2: Nutrient concentrations for Bog Burn d/s Hundred Line Road and Wallacetown monitoring sites (Environment Southland, 2019).

A considerable dataset for surface water quality existed for the Invercargill Water Supply (Branxholme). Results showed high variability in bacterial concentration, including 10 – 5,000 cfu/100 mL for *E. coli* and 10 – 7,000 cfu/100 mL for faecal coliforms (Table 3.1). Nutrient concentration ranged from 0.36 – 3.10 mg/L NO_3-N and 0.53 – 4.8 mg/L for total nitrogen (Table 3.1). Bacterial concentrations are higher for the Wallacetown site, potentially since a greater number of sampling events have been captured at this location. Overall, water quality in the Oreti River shows impacts from land use in the catchment, and in particular shows highly elevated incidences of bacterial contamination.

Likewise, water quality results for the Makarewa River at Counsell Road and Wallacetown shows bacterial contamination (70 – 190,000 cfu/100 mL) and elevated concentrations of nutrients including nitrate (average 1 mg/L), nitrite (average 0.009 mg/L), DRP (average 0.018), and TP (average 0.08 mg/L) (Table 3.2). Overall, the Makarewa at Wallacetown monitoring site shows similar, albeit slight reduced, bacterial contamination and slightly higher concentrations of nutrients (e.g., average nitrate = 1.22 mg/L; average DRP = 0.27 mg/L) (Table 3.2). Water quality results clearly indicate impacts from land use in the immediate catchment, likely as a result of soil drainage and/or runoff events from intensive agriculture. There is potential for surface water to flow towards the Tussock Creek Catchment, and so results of water quality monitoring have been included here for completeness.

*Table 3.2: Summary of key water quality parameters for the Makarewa River Catchment (Environment Southland, 2019). *numbers in brackets indicate the number of sample results below the detection level for the analysis method.*

	Parameter	*E. coli*	Faecal Coliform	Nitrate	Nitrite	Dissolved Reactive Phosphorus	TP
	Unit	cfu/100 mL	cfu/100 mL	mg/L	mg/L	mg/L	mg/L
Makarewa (Counsell Rd)	Min	70	70	0.01	0.002	0.006	0.03
	Max	190,000	190,000	3.40	0.032	0.112	0.42
	Mean	7,713	8,184	0.94	0.009	0.018	0.08
	Median	445	510	0.93	0.008	0.015	0.05
	Count	78	78	129 (2)	108 (5)	129 (1)	133
Makarewa (Wallacetown)	Min	30	30	0.11	0.005	0.005	0.017
	Max	140,000	140,000	4.60	0.030	0.230	0.680
	Mean	3,506	3,771	1.22	0.012	0.027	0.091
	Median	360	470	1.14	0.010	0.018	0.053
	Count	238	240	134	97	245 (4)	249
Tussock Creek (Cooper Rd)	Min	50	70	0.02		0.004	0.01
	Max	98,000	100,000	8.90		0.25	1.05
	Mean	4,279	4,609	1.66		0.03	0.09
	Median	970	1,100	1.60		0.03	0.06
	Count	211	214	221		206 (5)	211

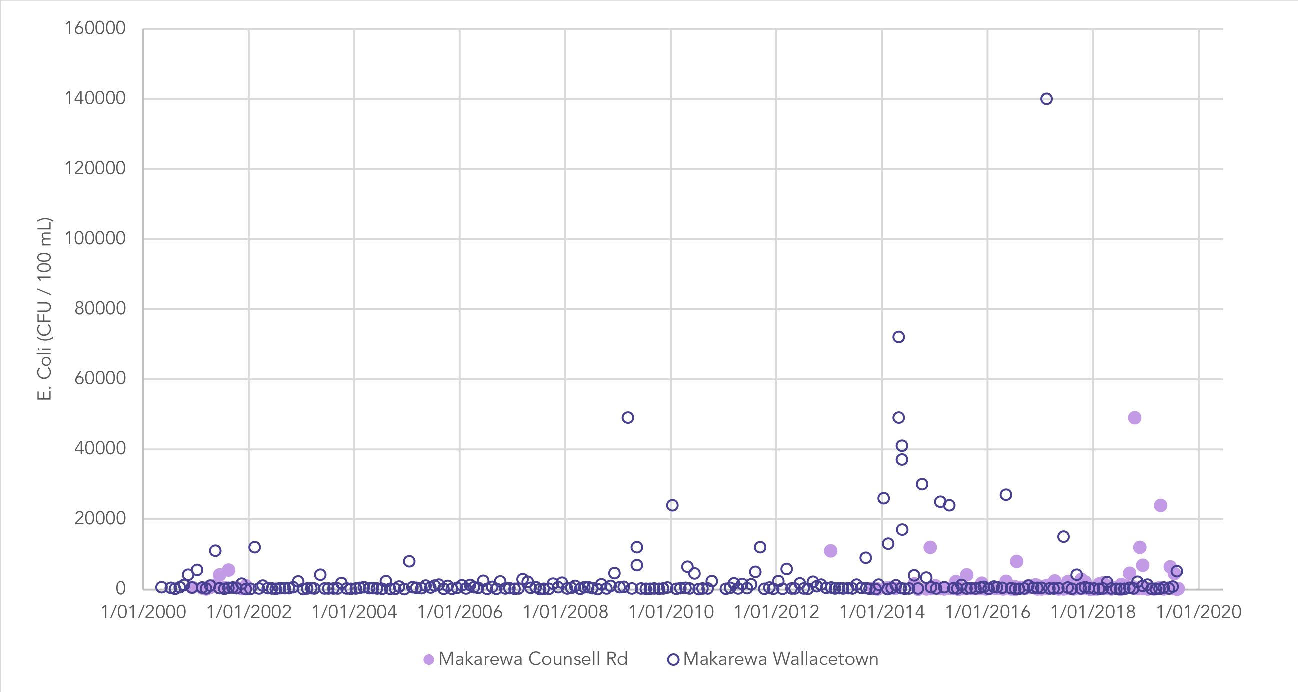

Figure 3.3: E.coli concentrations for Makarewa River at Counsell Road and Wallacetown monitoring sites (Environment Southland, 2019).

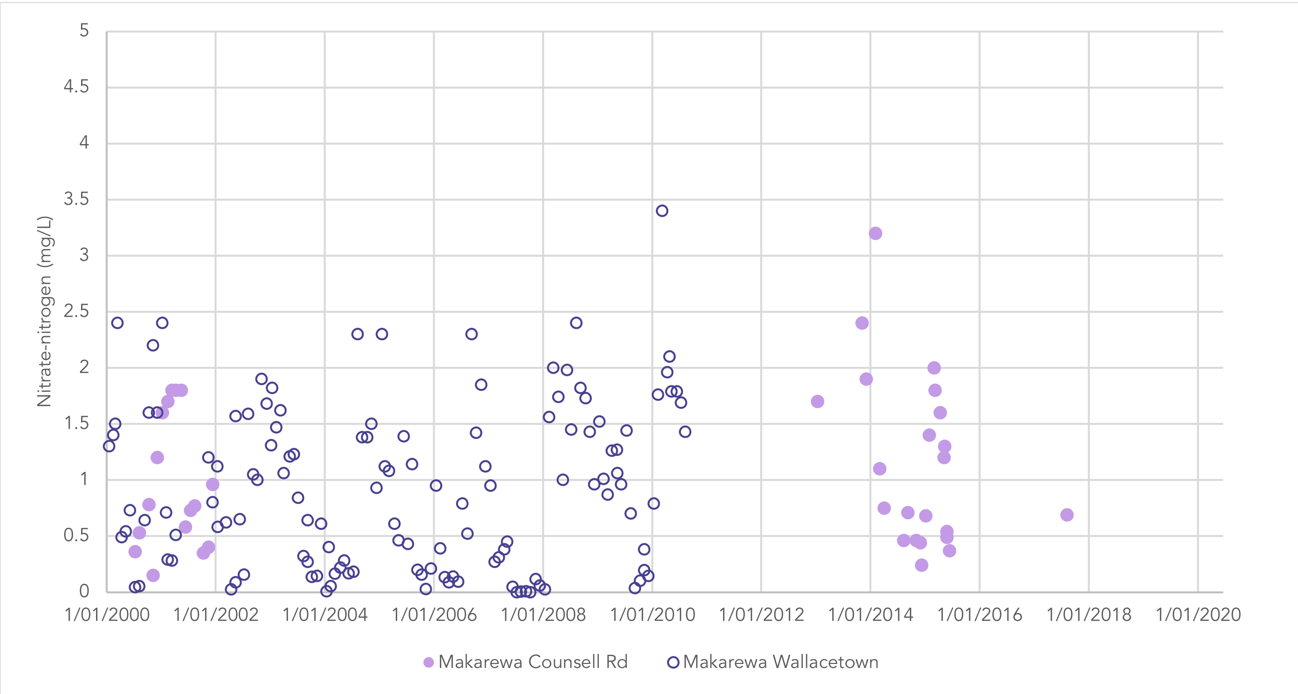

Figure 3.4: Nitrate-nitrogen concentrations for Makarewa River at Counsell Road and Wallacetown monitoring sites (Environment Southland, 2019).

3.2 Makarewa Groundwater Management Zone

The Makarewa GMZ is located on the eastern Southland Plains and covers an area of 79,000 ha of broadly rolling topography. The GMZ is broadly demarcated by the foot of the Hokonui Hills in the north and the Makarewa River catchment to the east (Environment Southland, 2019). The Makarewa GMZ consists of an unconfined aquifer in the relatively thin layer of Quaternary gravel deposits (<5 – 30 m) which overlies the confined aquifer sediments of the Tertiary Gore Lignite Measures (Figure 3.3).

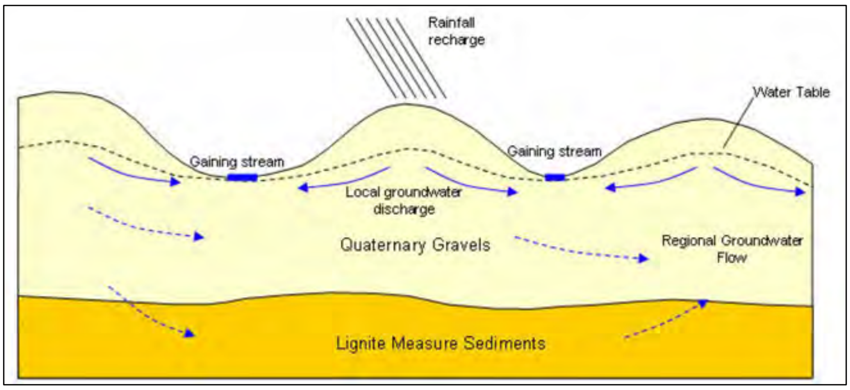

Figure 3.3: Schematic cross-section depicting the hydrogeological setting of the Makarewa GMZ (Environment Southland, 2019).

The gravel deposits of the unconfined aquifer are thicker beneath undulating ridges the occur on the land surface and are characterised by quartz gravels which occur in a weathered and clay matrix. Groundwater levels of the unconfined aquifer adjacent to streams and rivers are often very close to the land surface and occur at greater depth beneath the elevated topography (e.g., 2 – 10 m BGL). As a result, topography exerts a control on the local flow of shallow groundwater towards the nearest surface water body. Rainfall recharge to the Makarewa GMZ is estimated at 436 mm/yr and is the only source of recharge to the aquifer. Extensive land drainage from mole, tile, and artificial drains is likely to considerably reduce the actual amount of recharge to the aquifer. As a result, seasonal groundwater levels increase from rainfall recharge in autumn and winter and subsequently decrease in spring and summer due to drainage into primary order drains, streams, and rivers. Permeability in the unconfined aquifer is relatively low across the majority of the Makarewa GMZ resulting in reasonably low abstraction rates from bores (e.g., a specific capacity of < 25 m^3/day/m). Overall, groundwater quality in the Makarewa GMZ is good although water quality can vary considerably based on the source aquifer and location. Although groundwater in the unconfined aquifer can be susceptible to nutrient enrichment, water quality generally remains within acceptable limits of drinking water standards.

The confined aquifer is extensive and extends beneath the majority of the Makarewa GMZ, although is poorly defined. Lignite measure sediments are variable and range from thick mudstone (Invercargill, Otapiri) to water-bearing quatzose gravel and sand (north and east of aquifer). Artesian flows are observed from the confined aquifer in the vicinity of Hedgehope. Groundwater from the confined aquifers can contain high iron concentrations as a result of interaction with mudstone and lignite geology. Elevated iron reflects reducing conditions which are associated with low levels of dissolved oxygen in the groundwater.

3.3 Lower Oreti Groundwater Management Zone

The Lower Oreti GMZ covers an area of 41,144 ha within the recent floodplain of the Oreti River, south of Ram Hill. The Lower Oreti GMZ is demarcated by the basement rock of the Hokonui and Taringatura Hills to the north of Centre Bush, and by the lower portion of alluvial terraces of the recent Oreti River floodplain to the east and west (Environment Southland, 2019). The Lower Oreti GMZ includes a relatively thin layer of Quaternary gravels which forms an unconfined aquifer that overlies Tertiary deposits and a confined aquifer system consisting of lignite measure sediments (Figure 3.4). Very little knowledge of the underlying tertiary aquifer system (e.g., Winton Hill, Gore lignite measures) exists since drilling below the Quaternary gravel deposits is uncommon.

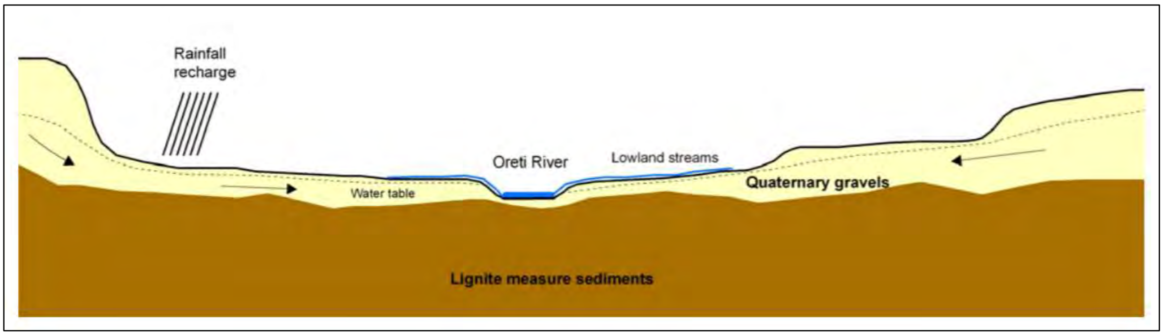

Figure 3.4: Schematic cross-section depicting the hydrogeological controls on the Lower Oreti GWZ (Environment Southland, 2019).

Thickness of gravel deposits is variable and decreases from > 40 m in the vicinity of Dipton, to 20-30 m in the Centre Bush-Winton area, to < 10 m in the Wallacetown area. Gravel deposits are generally poorly sorted, clay bound, and poorly stratified and generally have relatively low permeability across the entire system. Groundwater levels are seasonal and characteristic of lowland aquifers (e.g., peaky). Interaction is likely to occur along the riparian margins of the Oreti River with the adjacent unconfined aquifer, as observed to the west and north of Winton. Elsewhere in the catchment (e.g. south of Lochiel) the surrounding unconfined aquifer is perched above the Oreti River as the riverbed has incised through the Quaternary gravels into the underlying Tertiary sediments. The Lower Oreti GMZ is primarily recharged via rainfall, with a mean annual land surface recharge estimated to be 368 mm/year. Surface water recharge to groundwater may occur locally along small streams that cross the Oreti floodplain and along the riparian margin of the Oreti River. Discharge from the Lower Oreti GMZ occurs through small contact springs and influent streams on the Oreti River floodplain.

Groundwater in the Lower Oreti GMZ is generally of a reasonable quality and remains within drinking water standards. Groundwater quality in the unconfined gravel deposits varies with location and depth and can be susceptible to nutrient enrichment. Groundwater that is sourced from the deeper Tertiary aquifers can contain high iron, which is characteristic of the mudstone and lignite geology.

3.4 Groundwater quality data

A previous study of Oreti Plains groundwater (Rekker and Jones, 1998) confirmed strong interaction between groundwater and the surface. The study concluded that the shallow groundwater in the Oreti plains is susceptible to contamination from nitrate accumulation, agricultural chemical residues and faecal coliform contamination (Rekker and Jones, 1998). Very limited (more recent) groundwater quality information was available to provide an indication of groundwater quality in the vicinity of the applicant's property. Of the information available, water quality results indicated land use impacts including increased levels bacterial presence (e.g., *E. coli* <1 – 77 MPN; enterococci < 1 – 14 CFU; and faecal coliform < 1 – 87 CFU) (Environment Southland, 2019). Due to the variable concentrations of bacterial parameters over time, it is likely that preferential flow events and/or localised contamination of the groundwater system may be occurring. Likewise, nutrient concentrations in the vicinity of the applicant's property were reasonably variable and elevated at times (e.g., a range of 12.6 mg/L - < 0.005 mg/L, with an average of 3.13 mg/L) (Environment Southland, 2019). Nitrate concentrations greater than the average (3.13 mg/L) occurred throughout the year, indicating highly variable nutrient concentrations and evidence for preferential flow pathways for contaminants (e.g., macropore bypass).

3.5 New River Estuary

New River Estuary is a large (4,600 ha), shallow (mean depth ~2 m) intertidal dominated, tidal lagoon that discharges to the eastern end of Oreti Beach near Invercargill. The estuary drains a 4,314 km^2 catchment with land use cover including 55% intensive pasture, 14% low producing pasture, 20% native forest, and 9% exotic forest. New River Estuary is a key estuary in the long term coastal monitored undertaken by Environment Southland. Broad scale habitat mapping of New River Estuary has been undertaken over time, with a focus on sediment, eutrophication, and habitat modification of the estuarine environment. The most recent broad scale habitat assessment was undertaken by Stevens and Robertson (2012) and additional macroalgal monitoring was undertaken in 2018 (Stevens, 2018).

Key conclusions of Stevens and Robertson (2012) focused on substrate, nuisance macroalgal growth, gross eutrophic condition, and seagrass habitat. Estuary substrate has continued in a poor condition (Figure 3.23) and is dominated by 75% sand (2,199 ha) in the central estuary basin and towards the estuary mouth; extensive areas (24%) of soft and very soft mud (669 ha), mostly in the upper northern reaches and the Waihopai Arm. Dense (>50%) nuisance macroalgae growth has increased from very low to high (Figure 3.5). This is a dramatic increase 23 ha cover (2001) to 428 ha cover (2018) of the estuaries with highest densities in the east, west and north arms, and near the Oreti River mouth. Low macroalgal growth was observed in the tidal area. Gross eutrophic conditions have degraded from fair (<1%) to very poor (8%) due to a significant increase from 32 ha (2001) to 240 ha (2012). Seagrass habitat is poor and has declined largely in the Waihopai Arm (94% between 2001 to 2018) due to sedimentation and macroalgal growth. Saltmarsh areas are moderate (Figure 3.23) and have remained relatively stable with 48% rushland, 26% grassland, and 12% herbfield. Historic displacement (e.g., for sea wall construction) is the predominant modification factor, although some areas are currently prone to erosion (e.g., eastern arm) and displacement by grassland (e.g., Waihopai Arm). There has been no change in vegetated margins.

RATINGS		CONDITION RATINGS			CHANGE RATINGS
Major Estuary Issue	Indicator	2001	2007	2012	2001-2012 Change
Sediment	Soft mud area	POOR	POOR	POOR	LARGE INCREASE
Eutrophication	Macroalgal Coefficient	GOOD	GOOD	GOOD	TRENDING UP = WARNING
	Dense (>50%) macroalgal cover	VERY LOW	MODERATE	HIGH	VERY LARGE INCREASE
	Gross eutrophic condition area	FAIR	POOR	VERY POOR	VERY LARGE INCREASE
Habitat Modification	Seagrass Coefficient/area	POOR	POOR	POOR	VERY LARGE DECREASE
	Saltmarsh area	MOD-HIGH	MODERATE	MODERATE	SMALL DECREASE
	Densely vegetated margin area	not measured	GOOD	GOOD	NO CHANGE

Figure 3.5: Summary of the three major estuary issues addressed in broad scale habitat monitoring, including: sediment, eutrophication, and habitat modification and change ratings between 2001 to 2012 (Steven and Robertson, 2012).

Overall, results of the 2012 broad scale habitat monitoring indicate a significant decline in estuary quality since 2001 (and particularly over the past five years) for all measured parameters excluding the extent of densely vegetated margin (Stevens and Robertson, 2012). This is supported by results from the 2018 macroalgal study, which indicate that nuisance macroalgal growth is widespread and has significantly increased in the upper estuary with an associated decline in estuary quality (Stevens, 2018). Large areas of macroalgal growth and associated seagrass loss occurred in the eastern Waihopai Arm, near Bushy Point, Daffodil Bay, and the lower reaches of the Oreti River, causing significant negative changes in sediment condition (e.g., increased smothering and muddiness, and decreased sediment oxygenation). These conditions limit food availability for fish and birdlife, and demonstrate that the ability of the estuary to assimilate nutrient and sediment loads from the catchment is currently exceeded. Issues identified in other monitoring studies of New River Estuary include: disease risk associated with shellfish consumption and bathing, toxicity near urban stormwater drains, and excessive nutrient inputs. The recently developed NZ Estuary Trophic Index (ETI) was used to assess the overall trophic (nutrient enrichment) state of the estuary. The NZ ETI score of 0.96 indicates that the New River Estuary is eutrophic, with conditions consistently worsening since monitoring commenced in 2001.

In summary, New River Estuary is exhibiting significant problems associated with excessive macroalgal growth and likely represents the largest impact of this type to have occurred in a NZ SIDE estuary (Stevens, 2018). Studies indicate that unless nutrient inputs to the estuary are reduced significantly, it is expected that there will be a continuation of these difficult to reverse adverse impacts within the estuary (Stevens, 2018).

3.6 Tangata whenua associations

As summarised in Te Tangi a Tauria, tangata whenua have important associations with the Oreti River (Nicol and Robertson, 2018). The Oreti River is understood to have formed one of the main trails from inland Murihiku (Southland) to the coast, with an important pounamu trade route continuing northward from the headwaters of the Oreti and travelling (via the Mavora Lakes system or Von River Valley), to the edge of Wakatipu and onto the Dart and Routeburn pounamu sources. There are numerous archaeological sites in the upper catchment, including sites related to stone resources that are considered to be among the oldest in New Zealand. In addition, kai resources of the Oreti supported numerous parties venturing into the interior, and returning by mōkihi, laden with pounamu and mahinga kai. Nohoanga along the river supported such travel by providing bases from which travellers could obtain waterfowl, eels, and inanga.

3.7 Drinking water supplies

There are likely a number of private drinking water supplies obtaining groundwater from the Makarewa and Lower Oreti GMZ's. In addition, there are a number of known public drinking water supplies downstream and/or downgradient of the applicant's property (Figure 3.6). These sites include:

- Lochiel School (*c.* 1.5 km south of the applicant's property) which obtains groundwater from the Makarewa GMZ;
- Invercargill City Council and Alliance Lorneville which abstract surface water from the Oreti River;
- Alliance Makarewa and Alliance Lorneville which abstract surface water from the Makarewa River; and
- Wallacetown School and Waianiwa School, which are understood to obtain rainwater from the school roof.

Overall, proposed activities on the applicant property have the potential to influence both groundwater and surface water drinking water supplies in downstream surface water and groundwater environments. These sites include Lochiel School; Invercargill City Council; Alliance Lorneville; and Alliance Makarewa. The proposed activities are unlikely to influence drinking water supplies from Wallacetown and Waianiwa Schools due to the supply source being rainwater from the rooftops of the schools.

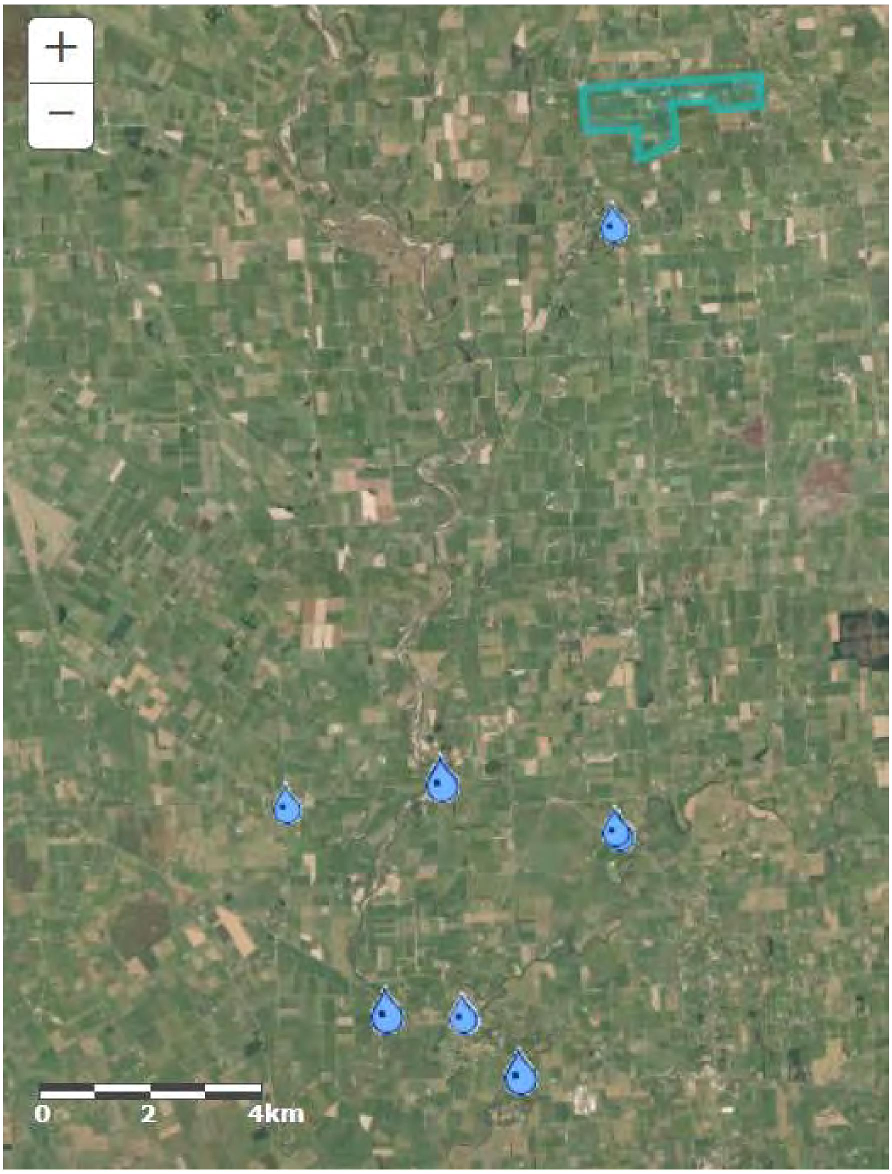

Figure 3.6: Location of applicants property boundary and downgradient drinking water supplies (Environment Southland, 2019).

It is understood that groundwater sourced for the Lochiel School water supply is obtained from a bore located on the school grounds, approximately 30 m to the east of the main classroom building 'Block A' (Watkinson, 2019). Groundwater is pumped from the bore E46/1473 which is located within the Makarewa GMZ at approximate coordinates 1240188E, 4872500N (Environment Southland, 2019). It is understood that a specialist water treatment contractor (Cleanflo Invercargill) is responsible for maintenance of the treatment system. The water is pumped from the bore and undergoes a UV filtration system before being stored in a tank where it is pumped from the tank through a second UV filter before being distributed to the buildings (Watkinson, 2019). Water quality is sampled monthly from the school on a monthly basis and analysed at Water Testing Laboratory, Lake St, Invercargill (Miller, 2019). Test results provided by the school indicate that the water quality supply has had variable compliance with the drinking water standards, largely due to different testing requirements (Miller, 2019). The school are responsible for factoring in water treatment and infrastructure into their budget and property plans submitted to the Ministry of Education (Watkinson, 2019).

The largest public water supply abstracts surface water to supply the township Invercargill City (Branxholme Plant) from the Oreti River. Overall, surface water quality results for the Invercargill Water Supply (Branxholme) showed impacts from land use within the catchment. In particular, there was high concentrations and high variability in bacterial presence, including 10 – 5,000 cfu/100 mL for *E. coli* and 10 – 7,000 cfu/100 mL for faecal coliforms (Table 3.3). In comparison, nutrient concentrations were lower, and ranged from 0.36 – 3.10 mg/L NO_3-N and 0.53 – 4.8 mg/L for total nitrogen (Table 3.3).

There does not appear to be any information in the application regarding potential effects of the proposed activities on surface water quality for Alliance Makarewa and Alliance Lorneville water supplies.

4.0 Soil hydrology

4.1 Soils

The applicants' property is located on Pukemutu and Edendale soils based on topoclimate classification (Figure 4.1). General soil vulnerability factors presented in Table 4.1 show almost opposed characteristics between Pukemutu and Edendale soils types, particularly structural compaction and waterlogging (Table 4.1). Pukemutu soils are characterised by a heavy silt loam grading with depth to silty clay; are poorly drained, with very slow permeability in the subsoil with a dense fragipan between 60 and 90 cm depth that restricts drainage (Figure 4.1). These factors combined with limited aeration during sustained wet periods results in Pukemutu soils responding well to mole and tile drainage. In comparison, Edendale soils are well-drained and have a deep rooting depth, high water-holding capacity, and silt-loam textures. Although well-drained, the compact subsoil is slowly permeable and may be prone to short-term waterlogging after heavy rainfall. Soil vulnerability factors are generalised and should not be taken as absolutes for this soil type in all situations. Actual risks of compaction, leaching, and waterlogging depend on the environmental and farm management conditions prevailing at a particular place and time. Both Pukemutu and Edendale soils are categorised as Category A for Farm Dairy Effluent (FDE) application – artificial drainage or coarse soil structure. Therefore, average FDE application rate needs to be less than the soil infiltration rate and must only be applied when a soil water deficit exists

However, it is suggested that the risk to water quality associated with dairy farming and discharge of FDE on Pukemutu Soils should be considered (overall) to be higher (e.g., moderate to high) compared to that identified in the FDE classification. It appears as though macropore bypass potential (which can be very significant) is not accounted for in the Environment Southland FDE vulnerability classification (Table 4.1). Previous studies (e.g., Rekker and Greenwood, 1996; Rekker and Jones, 1998) indicate that Pukemutu Soils have a high potential for nutrient and bacterial contamination. This is due to the clay faction and clay sub-soil being highly prone to cracking with prismatic clay fractures penetrating to the base of the soil. A study of groundwater nitrate in the Central Plains indicated high concentration of nitrate-nitrogen, extensive correlation with Pukemutu soils and stable nitrogen isotopes results consistent with little soil fraction as evidence for macropore bypass (Rekker and Jones, 1998). The report concluded that the broad assessment indicates several nutrient 'hotspots' in the Oreti Plains, and identified the likely susceptibility of the Pukemutu soil overlying Oreti Plains groundwater.

Table 4.1: Summary of soil types, farm location and vulnerability factors (Environment Southland, 2019).

Soil type	Physiographic Zone	Structural compaction	Nutrient leaching	Waterlogging
Pukemutu	Gleyed	very severe	slight	severe
Edendale	Oxidising	slight	moderate	slight

Figure 4.1: Pukemutu soil profile showing grading between the heavy silt-loam to silty-clay and low-permeable fragipan (Environment Southland, 2019).

4.2 Physiographic zone contaminant pathways

The applicant's property is located on a combination of Gleyed and Oxidising physiographic zones (PZ). Oxidising PZ's are good at absorbing and storing water and nitrogen, with little ability for de-nitrification to occur. During drier months, nitrogen can accumulate in soil to high levels. During winter when soils are wet, any nitrogen not used by plants leaches down into the underlying groundwater (termed deep drainage). Artificial drainage is used where soils have low subsoil permeability to help to reduce waterlogging. Contaminant loss through artificial drains to nearby streams can be high during wetter months.

Gleyed PZ's are composed of predominately flat to undulating land located between major river systems where soils are fine textured and poorly drained. Soils undergo extending periods of soil waterlogging which creates distinctive redoxomphoric features (e.g., mottling and gleying), and denitrification processes occur (e.g., removal of nitrogen from water to the atmosphere). Denitrification is often bypassed when contaminants are flushed to nearby surface water bodies via artificial drains and overland flow following heavy or sustained rainfall event.

4.3 Land surface recharge

Both the Makarewa and Lower Oreti aquifers are predominantly recharged by land surface recharge (e.g., rainfall recharge). Rainfall recharge to groundwater generally occurs when rainfall on the land surface brings the soil up to field capacity, and water infiltrates through the soil profile into the groundwater system. Estimated rainfall recharge rates in a normal year ranges from 370 mm/yr in the Lower Oreti aquifer to 440 mm/yr in the Makarewa aquifer (Environment Southland, 2019). Soil moisture monitoring can provide an insight into the timing of rainfall recharge. The closest soil moisture monitoring site to the applicant's property is at Makarewa Aquifer at McKinnon Road which is located on Pukemutu soil, approximately 7 km to the south-east of the applicant's property (Figure 4.1). Twelve years of data exists for the Makarewa monitoring site (2007 – 2019). Daily average soil moisture ranges from around 35% - 48%. Soil moisture is generally 45 – 48% between May – September, indicating that drainage is likely to occur throughout this time (Figure 4.2, Figure 4.3, Table 4.2). On occasion, differences in weather events results in an earlier onset (e.g., 2009, 2011) or later onset (e.g., 2013) of land surface recharge occurring (Table 4.2). Effluent irrigation should not be undertaken when a soil is at or near field capacity to minimise the risk of leaching and discharge of contaminants to groundwater and surface water. Soil moisture content has been consistently high during May – October (e.g., consistently > 45%) indicating that careful management of effluent application will be required during these periods.

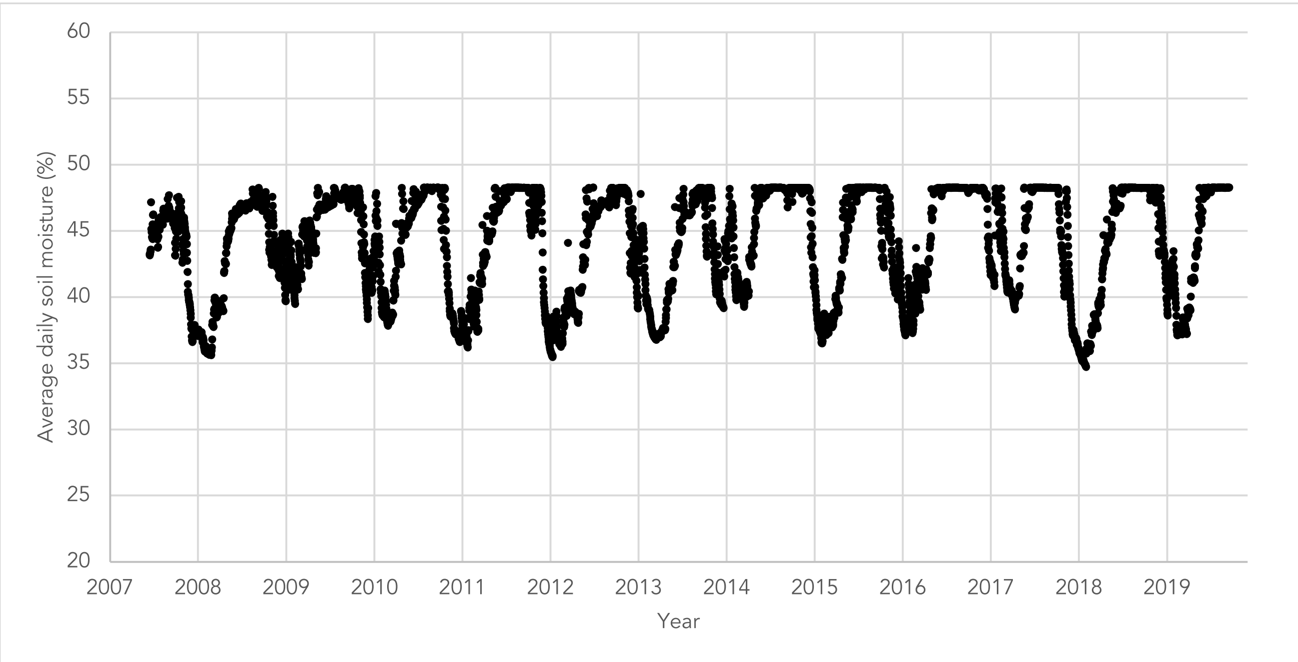

Figure 4.2: Average daily average soil moisture content at the Makarewa Aquifer at McKinnon Road monitoring site (Environment Southland, 2019). General trends indicate the lowest soil moisture content occurs in summer (e.g., Dec – Feb) and highest soil moisture content occurs in winter to spring (e.g., Jun – Sep).

Table 4.2: Summary of monthly average soil moisture for the Makarewa Aquifer at McKinnon Road monitoring site. Months where average soil moisture is 45% are highlighted, as land-surface recharge (e.g., drainage) is highly likely to be occurring during this period.

Month	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
January	-	36.96	42.32	43.95	37.34	36.92	43.7	45.24	38.55	38.44	44.3	35.32	41.14
February	-	35.87	41.58	39	39.45	36.98	38.83	41.03	37.53	39.28	45.29	36.56	38.32
March	-	38.82	44.16	39.05	40.37	39.78	37.05	40.18	38.34	40.79	40.88	38.59	37.98
April	-	40.63	44.37	43.7	43.94	38.82	37.78	43.15	41.07	42.66	39.92	42.51	40.79
May	-	45.15	46.14	45.52	46.25	42.29	40.87	47.33	45.61	47.66	44.23	45.64	45.33
June	-	46.43	46.87	46.79	47.15	45.96	44.39	47.95	47.7	48.12	47.67	47.14	48.06
July	45.08	46.73	47.36	47.54	48.04	46.49	46.38	48.25	48.21	48.27	48.27	48.23	48.23
August	46.04	47.15	47.56	48.22	48.27	47.1	46.97	48.25	48.27	48.26	48.26	48.26	48.27
September	46.02	47.16	47.52	48.25	48.26	47.64	48.08	48.06	48.17	48.21	48.25	48.26	-
October	45.63	45.87	47.7	46.28	46.86	48.04	46.91	48.2	45.49	48.2	45.37	48.17	-
November	42.94	43.92	44.3	39.17	47.14	46.88	42.81	48.17	43.92	48.18	42.96	47.5	-
December	37.59	42.55	41.04	37.29	38.52	42.74	40.9	45.72	41.2	45.94	37.02	44.15	-

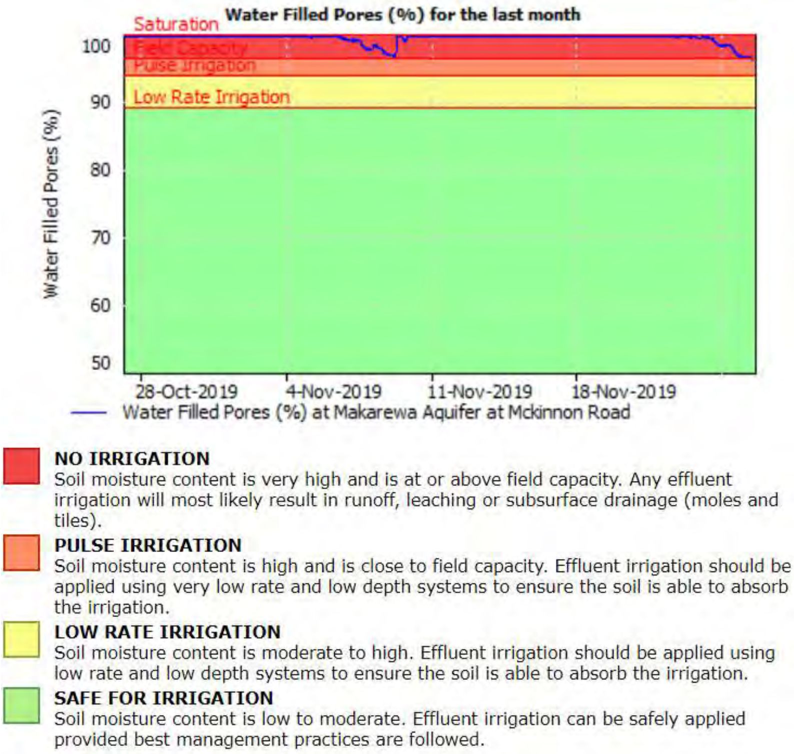

Figure 4.3: Summary of soil moisture (% water filled pores) for October - November, 2019 showing recommended conditions for safe irrigation (< 90%); low-rate irrigation (89 – 93%); pulse irrigation (93 – 95%); and field capacity (96% = no irrigation) for FDE application (Environment Southland, 2019).

4.4 Farm Dairy Effluent Discharge, relevant to hydrology

Intensive dairy farming poses several potential risks to water quality including accelerated contamination of waterways by nutrients, sediment, and faecal microorganisms. Application of FDE is likely a major contributor to surface water quality degradation, as poorly managed FDE may generate nutrient-rich surface runoff and drainage waters with potential to pollute surface and groundwater (Houlbrooke and Monoghan, 2009). The following key points have been abstracted from Houlbrooke and Monoghan (2009) as context for implications of FDE application on surface and groundwater resources:

- The three primary mechanisms for transport of water (and associated solutes and suspended solids) through soil are: matrix flow, preferential flow, and overland flow. " *The risk of direct contamination of water bodies associated with FDE application is dependent on the transport mechanism of water and, therefore, solutes and suspended solids*" (Houlbrooke and Monoghan, 2009)
- Overland flow: "*Soils that exhibit preferential or overland flow are capable of considerable direct contamination loss of FDE when applications are made when soils are considered too wet (insufficient soil water deficit to store incoming moisture) and/or when the application rate of FDE is too high for the receiving soil's infiltration rate. Preferential or overland flow provides little soil contact time and decreased opportunity to attenuate the applied contaminants. Critical landscapes with a high degree of risk include soils with artificial drainage or coarse soil structure, soils with either an infiltration or drainage impediment, or soils on rolling/sloping country.*"
- Matrix flow: "*Soils that exhibit matrix flow show a very low risk of direct contamination loss of FDE under wet soil moisture conditions. Matrix flow involves the relatively uniform migration of water through and around soil aggregates (so called 'piston' type displacement) and therefore provides a greater soil contact time and opportunity for nutrient attenuation and filtering of sediments and faecal micro-organisms. Such soils are typically well-drained with fine soil structure and high porosity.*"
- "*Research conducted in New Zealand suggests there is a low risk of direct contamination from FDE applied to well-drained soils. However, well drained soils typically have an inherently higher nitrogen leaching risk associated with the direct deposition of animal urine patches to land as a result of the smaller denitrification influence and smaller water holding capacities often associated with such soils.*"
- "*Therefore, the extent and impact from N inputs added as FDE to free draining soils that leach to ground water indirectly should be kept in context as FDE makes up approximately 10% of the daily nutrient load from cattle excreta. Therefore, effective mitigation techniques for N loss on these free draining soils should target the cumulative effects of autumn-applied urine patches during animal grazing. The effectiveness of current effluent best management practices (deferred irrigation and low application rate tools) varies between soil types depending on their inherent risk of direct contamination from land-applied FDE. Best practice management should therefore be targeted where it will be most effective.*"

5.0 Consideration of Assessment of effects

5.1 Assessment of receiving environment

The overall description of the receiving environment provided in the application is generally appropriate. However, the assessment of the effects on the receiving environment is lacking consideration of more recent water quality information, and the broad approach undertaken fails to adequately consider the impacts of the proposed changes to land use by focusing on the Oreti Catchment. This is of importance as change in land use (and effects) is proposed for the 'East Block' which is located in the Tussock Creek / Makarewa Catchment. Overall, the analysis of potential effects on the receiving freshwater environments is acceptable, but not as complete as it could have been and with a narrow focus on the Oreti Catchment. To address these knowledge gaps, additional information on the freshwater receiving environment has been compiled in Section 3 of this report.

Appropriateness of datasets used is acceptable:

- The assessment largely relies on information extracted from Environment Southland databases and publications (e.g., Environmental Database "Beacon" mapping; groundwater zone factsheets), and limited SOE monitoring data presented on the Land Air Water Aotearoa (LAWA) database.
- Reference to a several relevant reports has been made.
- Reference is generally made to SOE monitoring sites in LAWA, including NOF categories and 5-year median trends which are based on data for the 2012 – 2017 period. Although considerable surface water datasets exist, very little (if any) analysis of data has been considered or undertaken, including more recent data.
- Very little consideration of available groundwater data has been incorporated into the assessment.
- In all instances, only monitoring sites downgradient of the farms have been considered. Comparison to upgradient monitoring sites could have been shown for completeness to better understand variation in land use impacts through the catchment.

Appropriateness of assessment of effects is acceptable:

- The application correctly states the location of the applicant's property in relation to the WLP (2010). It should be emphasized that the applicant's property is located in the Oreti FMU, and Lower Oreti and Makarewa groundwater management zones (pSLWP, 2018).
- The application includes a GIS map of surface waterways on the property (Figure 7a and 7b) (Landpro, 2019). However, given the location of the property in an area of high order streams (e.g., beginning of waterways), some validation of whether the waterways are flowing (e.g., continuously, intermittently, or ephemerally) would have been useful.
- An attempt to map the existing tile drains would have aided the assessment, given that some knowledge of the location of tiles drains is held by the applicant "*There are tile drains across the property but most of these were installed before the applicant took possession of the property and so their exact location is not known*" (Para.2, Pg.8 (Landpro, 2019)). Alternatively, it should have been mentioned that Critical Source Areas (CSA's) identified on Figure 7a are likely locations of tile drains, if this were the case.
- The application indicates that all waterways on are fenced off (stock exclusion) and culverted which is supported by observations during site visits.

5.1.1 Oreti Catchment

The application provides a basic assessment of water quality in the Oreti Catchment centered around information presented on LAWA (2019). Only the Oreti River at Wallacetown monitoring site is included. For completeness and a better indication of contaminant pathways through the catchment, the upstream Bog Burn and the Oreti River at Branxholme (Invercargill City water supply) monitoring sites should have been considered.

A basic interpretation of water quality and ecological datasets indicates that the Oreti River (Wallacetown) is impacted by land use in the catchment, including elevated *E. coli*, nitrogen, and DRP.

- Five-year median values for key parameters include:
  - *E. coli*: 130 n/100 ml (max 1,000 n/100 ml); worst 50% of like sites, NOF Band D (MfE, 2016)

- Total Nitrogen: 1.13 mg/L; Total Oxidised Nitrogen: 0.94 mg/L (max 2.5 g/m^3) worst 25% of like sites; both above ANZECC GV's of 0.514 mg/L and 0.44 mg/L, respectively;
    - Dissolved Reactive Phosphorus: 0.006 mg/L (max 0.04 mg/L) the best 50% of like sites; and
    - Macroinvertebrate Community Index: 95, poor and likely degrading, indicative of fair water quality and/or habitat condition

- Very limited information on hydrogeology is provided in the application (since limited information is available), and information that is provided indicates evidence of land use impacts on water quality.

- The application provides a very basic summary of current water quality in the New River Estuary, which indicated that estuary health and water quality was declining (e.g., "*The key water quality issue in the New River Estuary is eutrophication and sediment deposition that appears to be driven by N, P and sediment loads to the estuary from the main surface water inputs.*" (Pg. 25; Landpro, 2019). The application also indicated that the proposed activities have an 'insignificant' contribution to the overall health of New River Estuary, and that catchment wide mitigations were the best chance of reducing land use effects on water quality. Therefore, it is suggested that any practicable mitigations are implemented to reduce nitrogen, phosphorus, sediment, and bacterial losses from the proposed activities.

5.1.2 Lower Oreti and Makarewa Groundwater management zones

The application included a basic interpretation of available groundwater quality information, for which limited data was available. Groundwater quality information was addressed using an overall approach rather than assessing the current state of the designated groundwater management zones (e.g., Lower Oreti and Makarewa) and the cumulative effects of the activities on these zones. It is suggested that effects on each GMZ should have been considered separately and then overall.

Further, the application focused on using Environment Southland regional nitrate-nitrogen concentrations to provide an indication of groundwater quality in the receiving environment. The GIS layer indicated groundwater quality in the underlying unconfined aquifer has nitrate-nitrogen concentrations around 0.4 – 3.5 mg/L (2007 – 2012), and higher concentrations downgradient of the property 3.5 – 8.5 mg/L (2007 – 2012). Reported concentrations were indicative of minor to moderate, and moderate to high land use impacts, respectively. Limitations of the regional nitrate dataset are considerable, some of which were described in the application (e.g., limited number of results to create contours; data was sourced from variable bore depths; and potential well-head security issues). Further, this regional nitrate map has been updated with more accurate information, albeit following submission of the assessment of effects report (Landpro, 2019).

The application indicated that additional groundwater quality data sourced from Environment Southland showed a general pattern of nitrate-nitrogen concentrations in the area does not appear to have changed significantly. The application also referenced peak nitrate-nitrogen values of 8.7 g/m^3 (14.5 km west) and 10.3 g/m^3 (8.5 km south south-west) which indicated higher groundwater nitrate-nitrogen concentrations compared to 2007 – 2012.

5.2 Effects of groundwater abstraction

There following inconsistencies in the application regarding proposed groundwater abstraction may need clarified:

- The application proposes that existing water permit (AUTH-301044) for up to 60 m^3/day be replaced with a water permit for increased groundwater abstraction, yet the application also states "*This application seeks to replace existing groundwater permits with no increase in the volume of water sought, therefore there will be no effect on current allocation volumes*"
    - The application proposes a maximum take of:
        - 120 L/cow/day during 'summer' (120 L x 680 cows = 81.6 m^3/day) which is greater than the currently allocated volume (60 m^3/day); and
        - 70 L/cow/day during 'winter' (70 x 86 = 6 m^3/day) which is far less than the currently allocated volume.

- The periods of 'summer' and 'winter' are not defined anywhere in the application and it cannot be assumed that these are based on equinoxes due to the predominant influence of farming operations on cow numbers (rather than solar seasons).
    - It is not clear which of the existing bores would be used for groundwater supply, or whether groundwater is to be abstracted from a combination of the two existing bores.
- An increase in the abstraction of groundwater is proposed, however there appears to be no provision of data or assessment of the effects of this abstraction presented in the application. Therefore, it is concluded that insufficient information has been provided in the consent application regarding the proposed groundwater abstraction and therefore an assessment of effects associated with the proposed (increased) abstraction is incomplete.

Information to support the proposed abstraction includes: the proposed take is equivalent to (or less than) the Environment Southland guidelines (e.g., 120 L/cow/day = 81.6 m^3/day); and groundwater abstraction is for use in the dairy shed and for stock drinking water.

5.3 Effects of increased dairy cows and associated increased effluent discharge area

It is understood that the applicant purchased a 13.9 ha sheep grazing block 'East Block' sometime during 2016 – 2017 period. Several dates for the purchase of this property are provided in Landpro (2019) the application (e.g., 2016 (Pg.1); April 2017 (Pg.7); October, 2016 (Pg. 33)). The applicant has "… *gradually transitioned* (East Block) *into a dairy support block*" and through this application proposes to incorporate East Block into the dairy platform. As a result, the applicant proposes to increase cow numbers from 599 cows to 680 cows (a 13.5% increase) and concurrently increase the area of effluent discharge (Figure 5.1). The actual increase in discharge area has not been identified. It is likely that additional cows will be distributed across the Oreti River and Makarewa / Tussock Creek Catchments. The proposed application of (an average of) 67 kg/N/ha/yr is approximately 44% of the recommended maximum areal rate of 150 kg/N/ha/yr.

Figure 5.1: Map showing the applicants property boundary, existing effluent discharge area, and proposed discharge area. This figure was adapted from that provided in Landpro (2019) and originally published in the applicants Farm Activity Focus Plan.

Additional mitigations proposed by the applicant to offset potential increase in nitrogen losses from the increased cow numbers include:

- reducing the winter crop area on the dairy platform and utilizing 4 ha of grass/baleage over winter;
- increasing the effluent discharge area so that the concentration is effluent in any one area is reduced;
- reduced nitrogen fertiliser use on the effluent discharge area; and
- maintaining the same level of off-platform wintering as the current scenario

This review is limited to the impacts on groundwater and surface water and does not address appropriateness or capacity of on-farm systems (e.g., effluent systems, storage ponds, dewatering, composting, liquid effluent holding, spreading systems).

5.4 Groundwater and surface water quality

Potential effects on groundwater and surface water quality include an increase in total amount of effluent discharged into the receiving environment, due to the increase in cow numbers on the property. The applicant proposes to discharge farm dairy effluent (FDE) collected from dairy shed washdown and other locations, onto land. Discharge of effluent and slurry creates a new diffuse source of potential nutrient and bacterial contamination and combined with point source discharge when stock are on paddock, pose risks to the shallow groundwater and downstream surface water systems. Houlbrooke and Monaghan (2009) report that results from a literature review on land-application of FDE and its effects on water quality, indicate between 2 - 20% of nitrogen and phosphorus applied in FDE is lost either in runoff or via leaching. Therefore, there is potential that (even if BMP's are followed) an increase in the nitrogen and phosphorus in the receiving environment may occur. The proposed increase in cow numbers will result in an increased total volume of effluent to be discharged which is mitigated by the proposed increase in effluent discharge area. There will be an increase in the total loading of nutrients applied to the catchment with associated cumulative impacts on surface water and groundwater.

Groundwater quality in the Makarewa and Oreti GMZ's show impacts from land use processes, including increased nutrients (e.g., NO_2-NO_3, TP) and bacteria (e.g., *E. coli*, faecal coliforms).

- It is unknown whether an increase in the effluent discharge area will have a positive impact on water quality in the receiving environment. The applicant must adhere to all relevant BMP's, particularly around application of effluent. Additional effluent will be generated from April/May to September when soils in the region are generally at or above field capacity. Systems to store all of the liquid effluent/sludge and apply it only once the soils have fallen below field capacity are essential.
- Nitrate-nitrogen: Information from 2007 – 2012 demonstrates that local groundwater has been impacted from land use including elevated nitrate-nitrogen of 0.4 – 8.5 mg/L, which is indicative of moderate to high land use impacts. The application states (in regard to Environment Southland nitrate survey "*… the property is in an area where the underlying unconfined groundwater nitrate N concentrations were likely to have been primarily between 0.4 – 3.5 mg/L between 2007 – 2012, or indicative of minor to moderate land use impacts. The downgradient area appears to have had slightly higher nitrate N concentrations, between 3.5 – 8.5 mg/L indicative of moderate to high land use impacts.*"
- *E. coli* levels in nearby groundwater have been highly variable (e.g., ranging from <1 – 77 MPN).
    - The applicant indicates that insecure well head protection may be responsible for some elevated nitrate-nitrogen concentrations observed in the local area (e.g., Pg.23 (Landpro, 2019) "…*For example, the 18.4 g NO_3-N/m^3 result from a bore to the west of the Driscoll farm has been acknowledged by Environment Southland as likely caused by a "direct or semi-direct contamination"…. Uncertainties about well head protection make interpretation of the relationship between land use and groundwater results challenging*". It is suggested that (even if) the elevated nitrate-nitrogen concentrations are a result of direct or semi-direct contamination, that this effect is a result of the land use activities and should still be considered as appropriate. Further, this concentration exceeds the Maximum Acceptable Value (MAV) for drinking water of 11.3 mg/L (MoH, 2018).

Limitations of Overseer should be considered when assessing the estimated nutrient loss values, particularly the inability of the model to account for macropore bypass (e.g., preferential flow pathways) which are likely occurring in this setting (as shown by elevated nutrient concentrations). It is unknown what proportion of nitrogen loading will result in a contribution to impacting surface waters or groundwater, which will be a combination of effects of weather events (e.g., rainfall intensity, total rainfall, and land management). In addition, Overseer takes into consideration all mitigation measures and management practices undertaken on-farm. If any of these measures are not followed or a breached, then the actual nutrient losses to the environment are likely to be greater than estimated.

5.5 Soil moisture and FDE application

- The application presents insufficient information on how soil moisture levels are determined 'on farm' and how available information is used to determine FDE application timing and rates.
    - The application simply states (Pg. 29; Landpro, 2019) "*The applicant checks weather forecasts, checks the nearest soil moisture site on the ES website and checks paddocks before application to ensure that effluent is only applied when a soil water deficit exists.*"

- o This is a very generic statement, lacks suitable information on the closest soil moisture monitoring site, lacks reference to how appropriate this site is in regards to soil type, and lacks a description on what 'checks paddocks' entails. This statement also lacks sufficient information to understand how this information is incorporated to inform farm operations.
- o For completeness, details of the closest soil moisture monitoring site (Makarewa Aquifer at McKinnon Road) is provided in Section 4.3.

- Actual soil moisture datasets from Makarewa Aquifer at McKinnon Road (Pukemutu Soils), indicate soil is predominantly above field capacity during the period June – October. If FDE is applied during these months, there is a higher likelihood of impact on surface and/or groundwater receiving environments as runoff and leaching processes will likely occur. This is not address in the application which simply states "*Effluent will be discharged to land year-round, on days when conditions are suitable.*" (Pg., 30 Landpro, 2019).

- The application regularly uses strong wording (e.g., Pg., 29, "*will maintain nutrients*", "*whilst avoiding*", "*to ensure that*" to indicate certainty regarding FDE application and lack of effects on the receiving environment. However, it is suggested that the conveyed level of certainty in this case would be difficult to measure and predict, and that more appropriate wording should be used, such as "likely" or "should".

- The applicant indicates a desire to install soil moisture monitoring on the property (Pg., 29; Landpro, 2019). The installation of soil moisture monitoring by a qualified specialist and training in the use and limitations of the soil moisture monitoring data is supported. It is suggested that this information, along with that provided from the McKinnon Road monitoring site, be used for decision making in FDE application rates and timing. It is suggested that the probe/tape be installed upon granting of the consent, rather than within 6 months of the consent being exercised.
    - o "*The applicant also plans to install his own soil moisture probe/tapes on the property to ensure a higher level of effluent management that is targeted at site-specific soil conditions. It is appropriate for the discharge consent sought to require that this is installed within 6 months of the consent being exercised.*"

5.6 Potential effect on drinking water supplies

The groundwater supply at Lochiel School (LOC001) is currently of sufficient quality to meet the New Zealand Drinking Water Standards and currently shows no bacterial contamination.

- Bacterial parameters (e.g., *E. coli*, faecal coliforms, and enterococci) were consistently reported as 'absent' or below detection level (<1.0 cfu/100 mL) when sampled from post-treatment water.
- It is unknown what the NO_3-N concentration is relative to the NZDWS MAV of 11.3 mg/L (Ministry of Health, 2018). Therefore, it is recommended that water quality monitoring be undertaken from the bore (e.g., annually, quarterly) to determine if there is an increasing trend in NO_3-N concentration.
- Furthermore, capture zone modelling of the bore could be undertaken to determine the likely land surface area that is contributing recharge to the bore. Appropriate land use practices and mitigations could be implemented to ensure on-going security of the groundwater supply.

Activities proposed in the consent application will result in a cumulative effect on surface water quality in the Oreti River catchment. Therefore, the proposed activities will cumulatively effect water quality of the Invercargill City water supply from the Oreti River. The activities may also have adverse effects on the Alliance Makarewa and Alliance Lorneville water supply sites.

- Water quality results for the Branxholme Water Supply (Oreti River) were highly variable, with (at times) considerable bacterial contamination, albeit with relatively low nutrient concentrations (Table 3.3). Contamination of surface water, particularly by *E. coli* and faecal coliforms, is the result of cumulative land use processes in the upper catchment, including land where the applicant proposes to discharge FDE. It is understood that the treatment provided at the plant is sufficient to remove bacterial contamination.
- No consideration of effects has been undertaken for the Alliance Makarewa and Alliance Lorneville water supply sites.

6.0 Assessment of cumulative effects

The assessment of cumulative effects largely relies on modelled outputs from Overseer. Limitations of the model with relevance to the accuracy of the output are not adequately described, which places a far greater uncertainty on the modelled results reflecting actual losses from the proposed activities. These results are then used to calculate the proportional percent of loading onto the New River Estuary, follow a reasonable method. However, the conclusion that there will be 'minimal' effects is not supported in regards to consideration of the current (very poor) condition of the New River Estuary. Again, the calculation of loading to Makarewa / Tussock Creek Catchment is based on Overseer outputs, but follows a method with a high level of uncertainty. Any instance of mitigation measures proposed in the Farm Environment Plan or Overseer are not followed will result in an increased risk of nutrient, sediment, and/or bacterial loss to the receiving environment.

6.1 Overseer modelling

The assessment off effects presented in the application largely relies on results of Overseer modelling which showed a decrease in nutrient loss under the proposed consent activities (10,507 kg/N/yr; 212 kg/P/yr), when compared to the current activities (11,513 kg/N/yr; 230 kg/P/yr). This is equivalent to a 9% reduction in nitrogen loss and an 8% reduction in phosphorus loss. Primary drivers for the decrease in nitrogen and phosphorus loading included:

- Removing winter crop area from the dairy platform and replacing it with grass/baleage wintering to enable the wintering of 216 cows on farm.
- Increasing the effluent discharge area so that the concentration of effluent in any one area is reduced; and
- Reduced N fertiliser use on the effluent discharge area and overall.
- Increased use of barley.
- Increased in the area utilised for baleage grass wintering.
- A reduction in Olsen P to 30 on the dairy platform (but with the level increasing to 30 on the East Block)

It is suggested that this reduction could likely be 'real' and occur on-ground. This reduction has largely been overstated in the application with continual reference to the modelled reduction being a "*significant reduction*" (Pg. 35; Landpro, 2019) or "*nutrient losses are significantly less*" (Pg 37; Landpro, 2019). More appropriate terminology should have been used, particularly since the proportion of nutrient loss reduction is in no way statistically supported as being 'significant'.

	Current Total Farm System	Proposed Total Farm system	Reduction
N (kg/yr)	11,513	10,507	-~9%
P (kg/yr)	230	212	-~8%

Figure 6.1: Modelled results from Overseer nutrient budget for the proposed activities on Driscoll Farm (Landpro, 2019)

Overseer is useful at modelling long-term average nutrient losses of farming systems using long-term climatic and other records, however there are several important limitations of the model relevant to this assessment. These include (but are not limited to) the ability of the model to:

- indicate the routing of (or percentage) of nutrient loss to water resources (e.g., to surface water or groundwater);
- predict transformations, attenuation or dilution of nutrients between the root zone and the receiving water body; and
- model contaminants other than nitrogen and phosphorus, including bacteria and/or sediment.

6.2 Receiving environment

The general approach taken to determine the cumulative effects on the Oreti River and New River Estuary (Pg., 43, Landpro, 2019) was based previous work by Snelder and Ledgard (2014) and is relatively sound. This method is likely to provide a reasonable estimate of the actual effects of the activities on the receiving environment. However, very limited information regarding the calculated loads is provided in the application and several important limitations of the approach have not been presented:

- It is not stated how the calculation of farm coverage of the total catchment area or percentage loading into the Oreti River and New River Estuary has been undertaken. For example, the estimate should have stated catchment area (e.g., 4,314 km^2); land use (e.g., 55% intensive pasture, 14% low producing pasture, 20% native forest, and 9% exotic forest); land area of the property within each catchment (e.g., 225 Ha).
- The assessment conclusion for New River Estuary (e.g., effects will be 'minimal') is not supported by facts. The activities proposed in the application will certainly impact on water quality in the New River Estuary, and due to the poor condition of the estuary, potentially have considerable impact. Any nutrient loading into the estuary is likely to have an adverse effect on the receiving environment, particularly based on the current state of the estuaries.
- The application omitted to address that there will likely be an increase in effects on the Makarewa and Tussock Creek Catchments

7.0 Limitations and assumptions

Any instance where stated or proposed mitigation measures are not followed will result in an increase of nutrient, sediment, and/or bacterial loss to the receiving environment. As a result, the effects of the activities on water quality of groundwater and surface water resources will be increased. Furthermore, any breach of these measures will considerably affect the modelling nutrient loadings estimated using Overseer.

The following should be addressed by a suitably qualified professional as part of the consent application review process as they are outside the area of expertise of the author.

- The effect of effluent discharge on physical soil properties of Glenelg and Pukemutu Soils.
- Whether effluent storage is sufficient to support expected durations of 'deferred irrigation' based on high soil moisture levels and necessity to store effluent for longer time periods (e.g., until suitable soil conditions arise). The application simply states "*The Dairy Effluent Storage Calculator (DESC) attached shows that the pond is adequately sized to allow for effective deferred irrigation.*" without indicating the duration (e.g., days, weeks, or months) that operations can cope with deferred storage.
- The approach used in modelling nutrient losses with Overseer, in particular selection of farm management scenarios.

8.0 Closing statement

The description of the receiving environment provided in the application is relatively basic and relies on limited data sources, which have been supplemented by additional information in this report. Overall, the data presented in the application clearly indicates that surface water, groundwater, and estuarine environments have been impacted by land use in the Oreti Catchment, in particular the New River Estuary. The modelled reduction in nutrients from the current scenario to the proposed scenario indicates that a reduction in nitrogen and phosphorus loss is likely. The potential impacts on bacterial contamination and sediment are more uncertain, since these contaminants cannot be modelled in Overseer and since the potential for Pukemutu Soils to undergo bypass (preferential) flow is not well considered. Furthermore, it must be considered that the reduction in nutrient loss relies heavily on the mitigation measures proposed in the Farm Environment Plan and Overseer being implemented and operating successfully.

The following aspects of the application are not adequately described (or have been contradicted in the application) and should be addressed:

- Whether increased abstraction from bore E46/1067 is proposed, and if so, why an assessment of the effects for the increased abstraction has not been undertaken; and
- A description of how soil moisture management is actually implemented or how relevant soil moisture data is used to determine current soil conditions to ensure effects of FDE application are minimised, has not been provided

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Overseer Audit – September 2019

OVERSEER Nutrient Budget review

For: Environment Southland – Driscoll Family Trust

Prepared by: Nicky Watt, CNMA

Introduction

1. Regarding the consent application for Driscoll Family Trust, I have reviewed the following OVERSEER ® Nutrient Budget (OVERSEER) models:
   a) PROPOSED - AUG19 MITIGATED (v2)
   b) CURRENT PLATFORM - AUG19 (v1)
   c) CURRENT - EAST TRANSITION AUG19 (v1)
   d) CURRENT - EAST SHEEP AUG19 (v1)
   e) CURRENT - EAST DAIRY SUPPORT AUG19 (v1)

2. Along with the files I have reviewed the following accompany reports:
   - Prepared by Tanya Copeland, Senior Scientist/Planner Landpro for T J & J A Driscoll being trustees of the T&J Family Trust Resource Consent Application to Environment Southland to Use Land for Dairy Farming and Associated Permits. In particular: Attachment C (Nutrient Budget Report) 'Overseer modelling report for the purposes of as part of a consent application for expanding dairying' Report by Farmwise, Mo Topham and peer reviewed by Miranda Hunter (pages 79-99).

3. I have completed a robustness check on the files for sensibility based on data available and checked to ensure the modelling aligns with the OVERSEER FM Best Practice Data Input Standards for v6.3.0.

4. It must be assumed that the information provided in the OVERSEER models that the current farming system as modelled is a viable farming system, using actual stock and fertiliser inputs. Therefore, the actual and proposed scenario is also assumed to be appropriate for the location and climate.

5. A 'sensibility test' has been undertaken on the Driscoll Family Trust nutrient budgets with the following five output screens from OVERSEER forming the basis of the determination of the robustness of the nutrient budget:
   a) Is the nutrient loss consistent with what you would expect for an operation of this type and soils in this location?
   b) Does the summary of inputs and outputs make sense? Especially clover fixation and change in block pools?
   c) Check the 'Other values' block reports for rainfall, drainage, and PAW
   d) Select the Scenario reports other values and check the production and stocking rate
   e) Select the pasture production in the scenario report and check pasture growth.

6. Answers to each of these five points will be provided further in this report and then a final determination of the robustness of the nutrient loss to water will be provided at the end of this report.

OVERSEER AUDIT

Appropriateness of the Overseer inputs

1. The five Overseer FM models stated in paragraph 1 of this report have been reviewed for consistency between the files and appropriateness of the inputs regarding the farming systems and the Overseer Best Practice Data Input Standard (BPDIS).

2. I concur that there is no deviation from the BPDIS.

3. The 3 East Block models all have 13.9 ha of Total/effective area and the Current dairy has a total area of 210.6 ha (202.6 ha effective) and the Proposed Dairy has 224.5 ha total area with 216.5 ha effective. The Proposed model has the 13.9-ha total area of the new East Block of which 13.9 ha is considered effective. The East Block models show a change in the type of stock grazed on the farm over 3 seasons. The Current model shows the average of the last 3 seasons and a peak stocking rate of 3 cows/ha. The Proposed model shows a 9% increase to peak stocking rate (when adding the 13.9 ha of East Block) or 3.3 cows/ha. The Proposed model also indicates wintering an extra 112 cows in June and July on 7ha pasture rather than crop.

4. Reviewing the NZ Dairy statistics for the 2017/2018 season, shows the average milk solids production on this property (Proposed 449.5 kgMS/cow; Current 452.6 kgMS/cow) is greater than the Southland regional average of 408 kg MS/cow. The stocking rate for both Proposed and Current models is higher than the Southland average for the 2017/2018 season of 2.64 cows/ha. The Proposed per cow production is less than 1% lower than the Current model and the per hectare production in the Proposed Model is predicted to increase from the Current model (1338 kgMS/ha) by just over 9% which is due to the increase in stocking rate. Lactation length has remained the same.

Table 1: Summary of Production and stocking rate

	East S[1]	East T[2]	East D[3]	Current*	Proposed**
Total Ha	13.9	13.9	13.9	210.6	224.5
Effective Area (ha)	13.9	13.9	13.9	202.6	216.5
KgMS	-	-	-	271130	319600
MS kg/ha grazed	-	-	-	1338	1476
MS kg MS/cow	-	-	-	452.6	449.5
Dairy RSU	-	-	-	5872	6908
Lactation Length	-	-	-	266	266
Cows/ha	-	-	-	3.0	3.3
Cows October	-	-	-	573	680
Cows June	-	-	-	83	195
Cows July	-	-	-	140	252
Dairy Heifer Calves	-	-	-	160	190
Replacement East RSU	-	41	292	-	-
Sheep East RSU	206	-	-	-	-
N lost kg/ha/yr	14	9	27	54	44

[1] CURRENT - EAST SHEEP AUG19 (v1) -East S

[2] CURRENT - EAST TRANSITION AUG19 (v1)- East T

[3] CURRENT - EAST DAIRY SUPPORT AUG19 (v1)- East D

*CURRENT PLATFORM - AUG19 (v1)- Current

**PROPOSED - AUG19 MITIGATED (v2)- Proposed

5. There is only cropping in the Current model as can be seen in Table 2 below. The average crop area for the last 3 seasons in the Current model is 3.8 ha. No crops in Proposed model, only wintering on 7ha of land.

Table 2: Crop Details

	East S	East T	East D	Current	Proposed
Dairy Fodder Ha	-	-	-	2.8 – FB rotates through all blocks	-
Dairy Fodder Yield (tDM/ha)	-	-	-	25	-
Dairy Turnips Ha	-	-	-	1.0	-
Dairy Turnips Yield (tDM/ha)	-	-	-	8	-

6. Supplements imported have varied over the years to meet cow demand (see Table 3). Pasture silage has been made where there was a surplus of pasture.

Table 3: Supplements imported and Harvested

	East S	East T	East D	Current	Proposed
Supplements Imported (tDM)	-	-	-	724	1190
Supplements Imported (tDM/Eff ha)	-	-	-	3.6	5.5
Total Area (ha)	13.9	13.9	13.9	210.6	224.5
Effective Area (ha)	13.9	13.9	13.9	202.6	216.5
Peak Cows/ha	-	-	-	3.0	3.3
Average N Fertiliser applied on Dairy (kgN/ha)	-	-	-	201	185
Average N Fertiliser applied on Non-Effluent Area Dairy (kgN/ha)	-	-	-	211	203
Average N Fertiliser applied on Effluent Area Dairy (kgN/ha)	-	-	-	211	183
N Fertiliser applied on East Block (kgN/ha)	0	0	0	-	154
Pasture Growth Dairy Effluent (TDM/ha)	-	-	-	16.2	16.0
Pasture Growth Dairy Non-Effluent (TDM/ha)	-	-	-	16.2	16.0
Pasture Growth East Block (TDM/ha)	11.8	11.8	11.9	-	15.6
Silage Harvested (tDM) - Dairy (Excl East)	-	-	-	109	259
Silage Harvested (tDM) - East	-	160	29	-	140

7. The Proposed model shows the pasture growth is 16.0 tDM/ha for non-effluent/effluent land and 15.6 tDM/ha for East Block. This is less than the Current model and greater than the East model pasture growth. The Current average N used has been 201 kgN/ha and the Proposed model is predicting decreasing N applied by 8% (185 kgN/ha). The Proposed model indicates applying 154 kgN/ha to the East Block, where no N was applied in the past. The supplement used for the Current model was 3.6 tDM/ha and the Proposed is predicting using 5.5 tDM/ha or 1.9 tDM/ha increase in supplement used. Based on this

information, the Proposed models a 34.5 % increase in supplement imported which covers the 9% increase in stocking rate, 8% decrease in nitrogen applied and is why there is a slight decrease in predicted pasture growth (see Table 3 above).

8. The N loss of the East block has decreased from an average of 17 kgN/ha to 13 kgN/ha (see Table 4a below). When the East block has been included in the calculations (as in Table 4b below) the average N loss for the Current + East Block average of the last 3 season shows a loss of 51 kgN/ha which is around 14% higher than the Proposed model loss of 41 kgN/ha. The P loss of the East block has remained the same across all models at 0.7 kgP/ha (see Table 4a below).When the East block has been included in the calculations (as in Table 4b below) the average P loss for the Current + East Block average of the last 3 season shows a loss of 1.2 kgP/ha which is around 8% higher than the Proposed model loss of 1.1 kgP/ha. It must be assumed that the information provided in the East Block 3 seasons and the Current model farming systems are modelled as a viable farming system, using actual stock and fertiliser inputs. Therefore, the future scenario is also assumed to be appropriate for the location and climate.

Overseer Outputs

Table 4b: OVERSEER outputs

Overseer v6.3.0	East S	East T	East D	East Block Ave 3 Seasons	Current	Proposed (includes East Block)	Proposed East Block Only
N lost to water kg/ha/yr	14	9	27	17	54	44	13
Total N lost kg/farm	203	132	385	240	11273	9908	183
P lost kg/ha/yr	0.7	0.7	0.7	0.7	1.2	1.1	0.7
Total P lost kg/farm	10	9	10	10	253	256	10
Other sources – N	4	1	5	3	409	427	
Other sources – P	1	0	2	1	104	106	

Table 4b: Adding East Block to Current

Overseer v6.3.0	Current + East Block Ave 3 Seasons	Proposed
N lost to water kg/ha/yr	51	44
Total N lost kg/farm	11513	9908
P lost kg/ha/yr	1.2	1.1
Total P lost kg/farm	263	256
Other sources – N	412	427
Other sources – P	105	106

Change in block pools

9. Overall there is no significant difference in the change in block pool values between the 3 years of East models, Current and Proposed models for P. This is the case for all models for N except East T model.

10. It appears N is potentially being immobilized for all models except the East T model. This is observed with a positive value in the Organic pool for N. The N in the East T model is being mobilized as seen by the negative value n the Organic Pool.

11. Maintenance P was applied to all the models seen by the nil or slight change in Inorganic Soil Pool levels.

Table 5: Change in block pool (N)

	East S	East T	East D	Current	Proposed
Organic Pool	25	-23	78	125	136
Inorganic Material	0	0	0	0	0
Inorganic Soil Pool	0	0	0	1	0

Table 6: Change in block pool (P)

	East S	East T	East D	Current	Proposed
Organic Pool	11	11	12	19	18
Inorganic Material	0	0	0	2	2
Inorganic Soil Pool	2	0	0	0	0

Rain/clover N Fixation

12. The average Biological fixation for the last 3 seasons in the East models has averaged 107 compared to the Current of 72 and Proposed of 69 (see table 7 below).

13. Average N fertilizer added to the Proposed model is around 8% less than the Current model of 201 kg N/ha/yr but there is 23% more N added from imported supplement in the Proposed model compared to the Current model.

14. The small decrease in biological fixation is mostly due to the increase in N supplied from imported supplements in the Proposed model. This is deemed to be an acceptable variance and within the limitations of the model.

Table 7: Biological fixation

	East S	East T	East D	Current	Proposed
Biological Fixation	94	148	78	72	69
Average N applied to whole farm kg/ha/yr	0	0	0	201	185

15. It is likely the decrease in N applied, increase in N from supplements and decrease in biological fixation will be able to maintain the pasture production modelled.

Pasture Production

16. The effluent N inputs decrease for Proposed model when compared to the Current model due to the increase in area effluent is applied. This is over a 34% increase in area (see table 8 below).

17. The Current model has applied the same N fertilizer to effluent and non-effluent areas, the Proposed model has decreased the N applied to the effluent areas by almost 10%. No N fertilizer applied to the East models but has 154 kgN/ha applied to the East block within the Proposed model

18. No pond solids are applied. Liquid effluent is only applied to the effluent block in Current and Proposed models using an application depth of <12mm.

19. Long term pasture growth in Southland between 1979 and 2012 indicated that average pasture growth for newer pastures was 12.7T DM/ha/yr. Average growth data for Wallacetown, from Dairy NZ data sheets, showed 14.3 tDM/ha with 176 kgN/ha applied (adding an additional 35 kgN/ha of nitrogen at a 10:1 response will give pasture growth of 14.7 tDM/ha). The pasture production on this property, for dryland, is around 10% higher than the long-term growth. It is likely that Overseer is over estimating pasture covers due to the assumptions on lower energy levels modelled for pasture than that happening. Pasture growth for the East models are around 5% below the average pasture growth for Southland (12.7 tDM/ha) and Wallacetown (12.5 tDM/ha with no N added).

20. The proposed pasture production is more in line with pasture growth expectations for dryland and irrigated pastures but still on the high side.

21. The animal distribution is modelled the same in all scenarios except East block in the Proposed model is modelled with a Relative Productivity of 0.97 (rest areas are 1).

Table 8: Pasture production and N inputs (fertiliser and effluent)

	East S	East T	East D	Current	East Block Proposed	Proposed
Effluent Area (ha)*	0	0	0	61	0	93
Pasture Growth (tDM/ha/yr)						
Effluent	0	0	0	16.2	0	16.0
Non-Effluent	11.8	11.8	11.9	16.2	15.6	16.0
N Fertiliser inputs (kg/ha/yr)						
Effluent	0	0	0	211	0	203
Non-Effluent	0	0	0	211	154	183
N Effluent Inputs (kg/ha/yr)						
Effluent	0	0	0	76	0	51
Non-effluent (includes solids)	0	0	0	0	0	0
Total N Inputs (kgN/ha/yr)						
Effluent	0	0	0	287	0	234
Non-Effluent	0	0	0	211	154	203

**Effluent area is area that receives liquid effluent*

Mitigations Modelled

22. As described in the appended nutrient budget analysis of the Driscoll Family Trust application (pages 85-88), there are several mitigation measures to mitigate N loss that have been included in the Proposed model. The below table details if the mitigation measures have been included in the proposed scenario and if they are accurately modelled.

Table 9: Mitigation option for proposed

Farm system strategies	Included in Proposed OVERSEER scenario
Increase milk solids production from 271,130 to 319,600 kg MS; 473 to 470 kgMS/cow; no change in Mean Calving or drying off date	Yes and No, Milk solids increased 271,130 to 319,600 kgMS; 452.6 to 449.5 kgMS/cow; same calving and dry off date
Increase in Peak cows farmed from 573 to 680	Yes. The stocking rate has increased from 3.0 cows/ha to 3.3 cows/ha, and peak cows have increased from 573 to 680
Dairy Farm Replacement on farm until weaning at 4 months (160 to 190)	Yes. Replacements increased from160 to 190
Increase in breeding bulls from 13 to 15	Yes. Bulls increased from 13 to 15
No change in relative productivity other than East block (0.97)	Yes. Relative productivity is 0.97 for the East block in the Proposed model.
Fodder crop management is changed from 2.8 ha fodder beet and 1 ha of turnips in the Current to no crops and wintering on 7 ha of land with 150 tDM baleage fed out	Yes. There are no crops in the Proposed model. The area wintered on in the Proposed model is 7 ha and 150 t baleage is distributed specifically to the winter blocks and 500 tDM to all blocks except East block
Supplements imported increase from 692 tDM to 1190 tDM	Yes. Supplements imported increased from 724 tDM (3.6 tDM/ha) to 1190 tDM (5.4 tDM/ha)
N fertilizer 213 kgN/ha on all blocks to 203 kgN/ha for non-effluent and 183 kgN/ha to effluent areas and 154 kgN/ha to East block	Yes and No. N fertilizer 211 kgN/ha on all blocks in Current model to 203 kgN/ha to non-effluent and 183 kgN/ha to effluent areas and 154 kgN/ha to East block in Proposed model
Increased Effluent area and the application depth has remained at <12mm	Yes. The effluent area has increased from 61 ha to 93 ha and the application depth has remained at <12mm
Drainage all 100% all mole and tile drained in Current and Proposed models	Yes. All blocks have 100% drainage

23. Most of the mitigation measures are robust, however there are several areas where what the report indicates does not relate to the modelling that may need to be addressed.

24. It is important that these mitigation measures are measured and monitored as if they are not adhered to the N loss reductions proposed may not occur.

CONCLUDING COMMENTS

Determination of the robustness of the nutrient loss to water

25. The questions below were described at Paragraph five of this report. Whilst these have been answered throughput this report, this section summarizes the answer to each question to make an overall conclusion about the robustness of the nutrient budgets.

Is the N loss consistent with what you would expect for an operation of this type and soils in this location?

26. Based on my experience, the N loss estimates are reasonably consistent with an operation of this scale and soil types present.

Does the summary of inputs and outputs make sense? Especially clover fixation and change in block pools?

27. There is no significant difference in the change in block pool values between 5 models presented for both N (except N mobilized in the East T model) and P.

28. There is a small decrease in biological fixation in the Proposed model and an 8% decrease in applied N but a 23% increase in N added from imported supplements. Clover and pasture inputs are the same across all 4 scenarios.

29. It is not apparent from reviewing the Overseer technical manuals or the nutrient budgets if the difference in pasture production and N fertiliser use accounts for the small decrease in biological fixation.

Check the 'Other values' block reports for rainfall, drainage, and PAW

30. The rainfall and soil information have been entered based on protocols for the location and soil type selected.

Production and stocking rate

31. Based on my experience as well as reviewing NZ Dairy statistics for the Current and Proposed model the stocking rate is higher than the Southland Region average in the 2017/2018 season. The milk production per cow for both the Current and Proposed models is higher than the Southland Region average in the 2017/2018 season

32. The average milk solids production per cow on this property for the last 3 seasons is 452.6 kg MS/cow/year which is higher than the Southland regional average of 408kg MS/cow. The target of 449.5 kgMS/cow is very similar to the last 3 season and if not achieved is likely to result in a lowered N loss.

33. The stocking rate at 3.0 cows/ha for the last 3 season and 3.3 cows/ha for the proposed model is higher than the Southland average for the 2017/2018 season of 2.64 cows/ha.

34. It is assumed that since the 3 seasons worth of actual scenarios for Current and East models are based on year end information that all scenarios represent viable production and stocking rate.

Select the pasture production in the scenario report and check pasture growth.

35. A detailed explanation of the pasture production has been outlined in the above sections.

36. There is a small decrease in pasture growth between the Proposed model and the Current model. This is acceptable as there is 8% decrease in N applied and a 23% increase in supplement being imported, and a 9% increase in peak stocking rate.

37. Long term pasture growth in Southland between 1979 and 2012 indicated that average pasture growth for newer pastures was 12.7T DM/ha/yr. Average growth data for Wallacetown, from Dairy NZ data sheets, showed 14.3 tDM/ha with 176 kgN/ha applied (adding an additional 35 kgN/ha of nitrogen at a 10:1 response will give pasture growth of 14.7 tDM/ha). The pasture production on this property, for dryland, is around 10% higher than the long-term growth. It is likely that Overseer is over estimating pasture covers due to the assumptions on lower energy levels modelled for pasture than that happening. Pasture growth for the East models are around 5% below the average pasture growth for Southland (12.7 tDM/ha) and Wallacetown (12.5 tDM/ha with no N added).

38. I have assumed an adequate level of robustness around the 3 seasons of actual Overseer Modelling as it is based on an actual farming system, and with that, I have assumed actual stock and fertiliser inputs used.

39. Check that the information provided in the nutrient budget analysis of the Driscoll Family Trust application (pages 85-88), matches that in the Proposed model (see Table 9 above)

40. The data input protocols have been followed for all scenarios with no deviations. This leads to a high level of robustness for the relevant input data for example, climate, soils, and pasture type.

41. Based on the concerns raised regarding what is written in the nutrient budget report and the Proposed inputs and outputs in the Overseer models, I consider that the robustness of the nutrient loss estimates for the Proposed scenario are medium-high, this is due to the robustness of the nutrient loss estimates for the actual scenarios is medium-high (what is written varies to what is modelled).

42. The area of concern in Current and Proposed models is: The variance in the models compared to what is reported needs to be addressed.

43. It is vital that the Proposed changes (especially around changes to the East block with the 154kgN/ha of N fertilizer applied which less than all other blocks; the grazing of stock on this block which excludes cows from start May to end of August; relative productivity of East Block be 0.97 in all models and there is no effluent applied) to the future farm system are effectively measured and monitored as if these are not adhered to then the reductions in N loss proposed may not occur.

References:

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Overseer Audit – December 2019

OVERSEER Nutrient Budget review

For: Environment Southland – Driscoll Family Trust - Current 1819 modelling added

Prepared by: Nicky Watt, CNMA

Introduction

1. Regarding the consent application for Driscoll Family Trust, I have reviewed the following OVERSEER ® Nutrient Budget (OVERSEER) models:
   a) PROPOSED - DEC19
   b) CURRENT – EAST SHEEP DEC 19
   c) CURRENT - PLATFORM 1819 SEASON (DEC19)
   d) CURRENT – EAST 1819 SEASON (DEC19)
   e) CURRENT – EAST DAIRY SUPPORT (DEC2019)'
   f) CURRENT- EAST TRANSITION DEC2019
   g) CURRENT PLATFORM - DEC2019

2. Along with the files I have reviewed the following accompanying reports:
   - File Note: T and J Driscoll Family Trust December 2019
   - Appendix 1: Updated detailed description of modelling inputs (Dec2019)
   - Appendix 2: Nutrient budgets taken from Overseer FM Dec2019
   - T & J Driscoll Family Trust (Adjustments to nitrogen losses in the proposed system)
   - Appendix 4: Further information: T and J Driscoll Family Trust consent application dated Dec2018
   - Appendix 5: Overseer modelling report for the purposes of as part of a consent application for expanded dairying Report by Farmwise, Mo Topham and peer reviewed by Miranda Hunter.
   - Appendix 6: T and J Driscoll Family Trust Farm Maps

3. I have completed a robustness check on the files for sensibility based on data available and checked to ensure the modelling aligns with the OVERSEER FM Best Practice Data Input Standards for v6.3.2.

4. It must be assumed that the information provided in the OVERSEER models that the current farming system as modelled is a viable farming system, using actual stock and fertiliser inputs. Therefore, the actual and proposed scenario is also assumed to be appropriate for the location and climate.

5. A 'sensibility test' has been undertaken on the Driscoll Family Trust nutrient budgets with the following five output screens from OVERSEER forming the basis of the determination of the robustness of the nutrient budget:
   a) Is the nutrient loss consistent with what you would expect for an operation of this type and soils in this location?
   b) Does the summary of inputs and outputs make sense? Especially clover fixation and change in block pools?
   c) Check the 'Other values' block reports for rainfall, drainage, and PAW
   d) Select the Scenario reports other values and check the production and stocking rate
   e) Select the pasture production in the scenario report and check pasture growth.

6. Answers to each of these five points will be provided further in this report and then a final determination of the robustness of the nutrient loss to water will be provided at the end of this report.

OVERSEER AUDIT

Appropriateness of the Overseer inputs

1. The seven Overseer FM models stated in paragraph 1 of this report have been reviewed for consistency between the files and appropriateness of the inputs regarding the farming systems and the Overseer Best Practice Data Input Standard (BPDIS).

2. I concur that there is no deviation from the BPDIS.

3. The 4 East Block models (East S, East T, East D and East C) all have 13.9 ha of Total/effective area, the Current 2018 2019 dairy (Current 1819) and the model of the last 3 seasons (15/16 to 17/18 seasons) current dairying (Current All) has a total area of 210.6 ha (202.6 ha effective), and the Proposed Dairy (Proposed) has 224.5 ha total area with 216.5 ha effective (see Table 1 below). The Proposed model has added the 13.9-ha total area of the new East Block of which 13.9 ha is considered effective. The East Block models show a change in the type of stock grazed on the farm over 4 seasons. The Current model shows the average of the last 4 seasons and a peak stocking rate of 3 cows/ha. The Current 2018 2019 has a stocking rate of 3.1 cows/ha. The Proposed model shows a 9% increase to peak stocking rate (when adding the 13.9 ha of East Block) or 3.3 cows/ha. The Proposed model also indicates wintering an extra 112 cows in June and July on 7ha pasture rather than crop.

4. Reviewing the NZ Dairy statistics for the 2017/2018 season, shows the average milk solids production on this property (Proposed 449.5 kgMS/cow; Current 1819 487.9 kgMS/ha; Current All 452.6 kgMS/cow) are greater than the Southland regional average of 408 kg MS/cow. The stocking rate for the Proposed, Current 1819 and Current All models are higher than the Southland average for the 2017/2018 season of 2.64 cows/ha. The Proposed per cow production is 2.5% lower than the Current All and Current 1819 models (461.1 kgMS/cow) and the per hectare production in the Proposed Model is predicted to increase from the Current All model (1382.8 kgMS/ha) by just over 6% which is due to the increase in stocking rate. Lactation length has remained the same.

Table 1: Summary of Production and stocking rate

	East S[1]	East T[2]	East D[3]	East C[4]	Current 1819*	Current All**	Proposed***
Total Ha	13.9	13.9	13.9	13.9	210.6	210.6	224.5
Effective Area (ha)	13.9	13.9	13.9	13.9	202.6	202.6	216.5
KgMS	-	-	-	-	307406	271130	319600
MS kg/ha grazed	-	-	-	-	1517	1338	1476
MS kg MS/cow	-	-	-	-	487.9	452.6	449.5
Dairy RSU	-	-	-	-	6444	5976	7031
Lactation Length	-	-	-	-	266	266	266
Cows/ha	-	-	-	-	3.1	3.0	3.3
Cows October	-	-	-	-	599	573	680
Cows June	-	-	-	-	75	83	195
Cows July	-	-	-	-	75	140	252
Dairy Heifer Calves	-	-	-	100 (Nov only)	200	160	190
Replacement East RSU	-	-	-	-	-	-	-
Beef RSU	-	43	303	12	-		18
Sheep East RSU	206	-	-	-	-	-	-
N lost kg/ha/yr	14	10	29	5	53		45

[1] CURRENT - EAST SHEEP DEC19 -East S
[2] CURRENT - EAST TRANSITION DEC19- East T
[3] CURRENT - EAST DAIRY SUPPORT DEC2019 - East D
[4]CURRENT - EAST 1819 SEASON (DEC19) – East C
*CURRENT - PLATFORM 1819 SEASON (DEC19)- Current 1819
**CURRENT PLATFORM – DEC19 – Current All
***PROPOSED – DEC19 - Proposed

5. There is only cropping in the Current All model as can be seen in Table 2 below. The average crop area for the last 4 seasons in the Current model is 3.8 ha. No crops in Proposed model, only wintering on 7ha of land.

Table 2: Crop Details

	East S	East T	East D	East C	Current 1819	Current All	Proposed
Dairy Fodder Ha	-	-	-	-	-	2.8 – FB rotates through all blocks	-
Dairy Fodder Yield (tDM/ha)	-	-	-	-	-	25	-
Dairy Turnips Ha	-	-	-	-	-	1.0	-
Dairy Turnips Yield (tDM/ha)	-	-	-	-	-	8	-

6. Supplements imported have varied over the years to meet cow demand (see Table 3). Pasture silage has been made where there was a surplus of pasture.

Table 3: Supplements imported and Harvested

	East S	East T	East D	East C	Current 1819	Current All	Proposed
Supplements Imported (tDM)	-	-	-	154	1039	724	1190
Supplements Imported (tDM/Eff ha)	-	-	-	11.1	5.1	3.6	5.5
Total Area (ha)	13.9	13.9	13.9	13.9	210.6	210.6	224.5
Effective Area (ha)	13.9	13.9	13.9	13.9	202.6	202.6	216.5
Peak Cows/ha	-	-	-		3.1	3.0	3.3
Average N Fertiliser applied on Dairy (kgN/ha)	-	-	-	-	177	201	185
Average N Fertiliser applied on Non-Effluent Area Dairy (kgN/ha)	-	-	-	-	188	211	203
Average N Fertiliser applied on Effluent Area Dairy (kgN/ha)	-	-	-	-	188	211	183
N Fertiliser applied on East Block (kgN/ha)	-	-	-	185	-	-	154
N Fertiliser Applied to Baleage on Dairy Winter Area (kgN/ha)	-	-	-	-	115		
Pasture Growth Dairy Effluent (TDM/ha)	-	-	-	-	16.6	16.6	16.4
Pasture Growth Dairy Non-Effluent (TDM/ha)	-	-	-	-	16.6	16.6	16.4
Pasture Growth East Block (TDM/ha)	11.7	11.9	12.6	11.8	-	-	15.9
Silage Harvested (tDM) - Dairy (Excl East)	-	-	-	-	-	109	259
Silage Harvested (tDM) - East	-	160	29	-	-	-	140

7. The Proposed model shows the pasture growth is 16.4 tDM/ha for non-effluent/effluent land and 15.9 tDM/ha for East Block. This is less than the Current All and Current 1819 models and greater than the East model pasture growth. The Current All plus Current 1819 average N used has been 195 kgN/ha and the Proposed model is predicting decreasing N applied by 5% (185 kgN/ha). The Proposed model indicates applying 154 kgN/ha to the East Block, where no N was applied in the past. The supplement used for the Current 1819 + Current All models was 4.0 tDM/ha and the Proposed is predicting using 5.5 tDM/ha or 1.5 tDM/ha increase in supplement used. Based on this information, the Proposed models 27.3 % increase in supplement imported which covers the 9% increase in stocking rate, 5% decrease in nitrogen applied and is why there is a slight decrease in predicted pasture growth (see Table 3 above).

8. The N loss of the East block has decreased to a current loss of 5 kgN/ha and Current 1819 N loss is similar to Current All. The Proposed N loss is 45 kgN/ha (see Table 4a below). When the East block has been included in the calculations (as in Table 4b below) the average N loss for the Current average of the last 4 seasons + East Block average of the last 4 season shows a loss of 51.8 kgN/ha which is around 13% higher than the Proposed model loss of 45 kgN/ha. The P loss of the East block has remained constant at a loss of 0.7 kgP/ha and Current 1819 P loss is the same as Current All at 1.2 kgP/ha. The Proposed P loss is 1.2 kgN/ha (see Table 4a below). When the East block has been included in the calculations (as in Table 4b below) the average P loss for the Current average

of the last 4 seasons + East Block average of the last 4 season shows a loss of 1.2 kgN/ha which is around 12.4% higher than the Proposed model loss of 1.2 kgN/ha. It must be assumed that the information provided in the East Block 4 seasons and the Current 1819 and Current All model farming systems are modelled as a viable farming system, using actual stock and fertiliser inputs. Therefore, the future scenario is also assumed to be appropriate for the location and climate.

Overseer Outputs

Table 4a: OVERSEER outputs

Overseer v6.3.0	East S	East T	East D	East C	Current All	Current 1819	Proposed (includes East Block)
N lost to water kg/ha/yr	14	10	29	5	55	53	45
Total N lost kg/farm	203	138	405	70	11510	11201	10193
P lost kg/ha/yr	0.7	0.7	0.7	0.7	1.2	1.2	1.2
Total P lost kg/farm	10	9	10	9	255	250	260
Other sources – N	4	1	5	0	417	437	437
Other sources – P	1	0	2	0	106	113	109

Overseer Outputs

Table 4b: Adding East Block to Current

Overseer v6.3.0	East Block Ave 4 Seasons	Current Ave 4 Seasons	Current + East Block	Proposed (includes East Block)
N lost to water kg/ha/yr	14.5	54.5	51.8	45
Total N lost kg/farm	204	11433	11637	10193
P lost kg/ha/yr	0.7	1.2	1.2	1.2
Total P lost kg/farm	9.5	254	263.5	260
Other sources – N	2.5	422	424.5	437
Other sources – P	0.7	108	108.7	109

Change in block pools

9. Overall there is no significant difference in the change in block pool values between the 3 years of East models, Current and Proposed models for P. This is the case for all models for N except East T model.

10. The organic pool for N indicates the amount of N that is being either immobilized as seen by a 'positive' Organic pool N value or being mineralized as seen by a 'negative' Organic pool N value. N being immobilized is being used for increased biological activity and temporarily locked up. Once the microorganisms die the organic N in their cells is converted by mineralization and nitrification to plant available nitrate. It appears N is potentially being immobilized in all models except for East T where N is being mobilized.

11. The inorganic soil pool for P indicates the amount P that exceeds soil P maintenance as seen by a 'positive' inorganic soil P value or is less than the soil P maintenance requirements as seen by a 'negative' inorganic soil P value. Slightly above maintenance P was applied to all models and proposed models which is seen by the slight increase in Inorganic Soil Pool levels. Maintenance P

was applied to all the models seen by the nil or slight change in Inorganic Soil Pool levels.

Table 5: Change in block pool (N)

	East S	East T	East D	East C	Current 1819	Current All	Proposed
Organic Pool	25	-23	81	39	142	127	138
Inorganic Soil Pool	0	0	0	0	0	1	0

Table 6: Change in block pool (P)

	East S	East T	East D	East C	Current 1819	Current All	Proposed
Organic Pool	11	11	12	11	18	20	18
Inorganic Soil Pool	2	0	1	0	1	0	1

Rain/clover N Fixation

12. All plants, including forage crops, need relatively large amounts of nitrogen for growth and development. Biological nitrogen fixation is the term used for a process in which nitrogen gas (N2) from the atmosphere is incorporated into the tissue of certain plants. Only a select group of plants can obtain N this way, with the help of soil microorganisms. Among forage plants, the group of plants known as legumes (predominantly Clover in NZ pastures) are well known for being able to obtain N from air N2. The OVERSEER Technical Manual – Characteristics of Pasture, April 2015 indicates that biological N fixation is based on total pasture production and includes the fertiliser induced reduction in N fixation.

13. The average Biological fixation for the last 4 seasons in the East models has averaged 99 compared to 112 for the last 4 season of the current dairy and Proposed of 75 (see table 7 below).

14. Average N fertilizer added to the Proposed model is around 4.3% more than the Current 1819 plus East C N applied 177 kg N/ha/yr.

15. The decrease in biological fixation is mostly due to the increase in N supplied from fertiliser and imported supplements in the Proposed model. This is deemed to be an acceptable variance and within the limitations of the model.

Table 7: Biological fixation

	East S	East T	East D	East C	Current 1819	Current All	Proposed
Biological Fixation	94	149	85	68	93	77	75
Average N applied to whole farm kg/ha/yr	0	0	0	183	177	201	185

16. It is likely the increase in N applied, increase in N from supplements and decrease in biological fixation will be able to maintain the pasture production modelled.

Pasture Production

17. The effluent N inputs decrease for Proposed model when compared to the Current models due to the increase in area effluent is applied. This is over a 33% increase in area (see table 8 below).

18. The Current models have applied the same N fertilizer to effluent and non-effluent areas, the Proposed model has decreased the N applied to the effluent areas by almost 10%. No N fertilizer applied to the East models but has 154 kgN/ha applied to the East block within the Proposed model (see Table 3 above).

19. No pond solids are applied. Liquid effluent is only applied to the effluent block in Current and Proposed models using an application depth of <12mm.

20. Long term pasture growth in Southland between 1979 and 2012 indicated that average pasture growth for newer pastures was 12.7T DM/ha/yr. Average growth data for Wallacetown, from Dairy NZ data sheets, showed 14.3 tDM/ha with 176 kgN/ha applied (adding an additional 35 kgN/ha of nitrogen at a 10:1 response will give pasture growth of 14.7 tDM/ha). It is also likely that Overseer is over estimating pasture covers due to the assumptions on lower energy levels modelled for pasture than that happening.

21. Pasture growth for the East models are around 5% below the average pasture growth for Southland (12.7 tDM/ha) and Wallacetown (12.5 tDM/ha with no N added).

22. The Current 1819, Current All and Proposed pasture production are 11% higher than pasture growth expectations for dryland pastures. An explanation from Mo Topham, File Note T and J Driscoll Family Trust December 2019 indicated the following "*A study of five dairy farms by Dalley and Geddes (2012)1 found that on farm regular pasture measurements underestimated pasture grown by as much as 38% due to an underestimation of pasture grown between pasture measurements. Overseer has estimated pasture production at 16.6tDM for the current scenario – 40% higher than that measured by the Driscoll's over the last four years. I am therefore confident that the pasture production is feasible*". This is deemed to be an acceptable explanation for the higher pasture cover.

23. The animal distribution is modelled the same in all scenarios except East block in the Proposed model is modelled with a Relative Productivity of 0.97 (rest areas are 1).

Table 8: Pasture production and N inputs (fertiliser and effluent)

	East S	East T	East D	East C	Current 1819	Current All	Proposed
Effluent Area (ha)*	0	0	0	0	62	61	93
Pasture Growth (tDM/ha/yr)							
Effluent	0	0	0	0	16.6	16.6	16.4
Non-Effluent	11.7	11.9	12.6	11.8	16.6	16.6	16.4
N Fertiliser inputs (kg/ha/yr)							
Effluent	0	0	0	0	188	211	203
Non-Effluent	0	0	0	185	188	211	183
Wintering Area Eff	0	0	0	0	115	0	203
Wintering Area Non-Eff	0	0	0	0	115	0	183
N Effluent Inputs (kg/ha/yr)							
Effluent	0	0	0	0	79	78	52
Non-effluent (includes solids)	0	0	0	0	0	0	0
Wintering Area Eff	0	0	0	0	79	0	52
Wintering Area Non-Eff	0	0	0	0	0	0	0
Total N Inputs (kgN/ha/yr)							
Effluent	0	0	0	0	287	289	235
Non-Effluent	0	0	0	185	188	211	203
Wintering Area Eff	0	0	0	0	194	0	235
Wintering Area Non-Eff	0	0	0	0	115	0	203

**Effluent area is area that receives liquid effluent*

Mitigations Modelled

24. Previous reporting out lined the following: As described in the appended nutrient budget analysis of the Driscoll Family Trust application (pages 85-88), there are several mitigation measures to mitigate N loss that have been included in the Proposed model. The below table details if the mitigation measures have been included in the proposed scenario and if they are accurately modelled.

Table 9: Mitigation option for proposed

Farm system strategies	Included in Proposed OVERSEER scenario
Increase milk solids production from 271,130 to 319,600 kg MS; 473 to 470 kgMS/cow; no change in Mean Calving or drying off date	Yes and No, Milk solids increased 271,130 to 319,600 kgMS; 452.6 to 449.5 kgMS/cow; same calving and dry off date
Increase in Peak cows farmed from 573 to 680	Yes. The stocking rate has increased from 3.0 cows/ha to 3.3 cows/ha, and peak cows have increased from 573 to 680
Dairy Farm Replacement on farm until weaning at 4 months (160 to 190)	Yes. Replacements increased from160 to 190
Increase in breeding bulls from 13 to 15	Yes. Bulls increased from 13 to 15
No change in relative productivity other than East block (0.97)	Yes. Relative productivity is 0.97 for the East block in the Proposed model.
Fodder crop management is changed from 2.8 ha fodder beet and 1 ha of turnips in the Current to no crops and wintering on 7 ha of land with 150 tDM baleage fed out	Yes. There are no crops in the Proposed model. The area wintered on in the Proposed model is 7 ha and 150 t baleage is distributed specifically to the winter blocks and 500 tDM to all blocks except East block
Supplements imported increase from 692 tDM to 1190 tDM	Yes. Supplements imported increased from 724 tDM (3.6 tDM/ha) to 1190 tDM (5.4 tDM/ha)
N fertilizer 213 kgN/ha on all blocks to 203 kgN/ha for non-effluent and 183 kgN/ha to effluent areas and 154 kgN/ha to East block	Yes and No. N fertilizer 211 kgN/ha on all blocks in Current model to 203 kgN/ha to non-effluent and 183 kgN/ha to effluent areas and 154 kgN/ha to East block in Proposed model
Increased Effluent area and the application depth has remained at <12mm	Yes. The effluent area has increased from 61 ha to 93 ha and the application depth has remained at <12mm
Drainage all 100% all mole and tile drained in Current and Proposed models	Yes. All blocks have 100% drainage

25. The report has not been changed in original report (Appendix 5) but has been addressed in Appendix 1.

    As described in Appendix 1 East and Current 1819 season has been added to the comparison to the Proposed modelling. Table 10 below details if the mitigation measures have been included in the proposed scenario when compared to the average of 4 season worth of current modelling and if they are accurately modelled.

Table 10: Mitigation option for proposed

Farm system strategies	Included in Proposed OVERSEER scenario
Increase milk solids production from Current All at 271,130 kgMS , Current 1819 at 307404 to Proposed at 319,600 kg MS; Current All at 473 kgMS/cow (allowing for 573 cows peak milk); Current 1819 at 513 kgMS/cow (allowing for 599 cows peak milk); Proposed at 470 kgMS/cow (allowing for 680 cows peak milk); no change in Mean Calving or drying off date	Yes, Milk solids increased as in model as is outlined in the report; same calving and dry off date
Peak cows farmed were 573 for Current All, 599 for Current 1819 and Proposed to be 680	Yes. The stocking rate has increased from 3.0 cows/ha to 3.3 cows/ha, and peak cows have increased from 573 Current All, 599 Current 1819 to 680 for the Proposed modelling
Dairy Farm Replacement on farm until weaning at 4 months – 160 for Current All, 200 for Current 1819 and Proposed to be 190	Yes. Replacements have been modelled as indicated
Increase in breeding bulls from 13 Current All, 14 Current 18191 to 15 for Proposed modelling	Yes. Bulls increased as indicated
No change in relative productivity other than East block (0.97)	Yes. Relative productivity is 0.97 for the East block in the Proposed model.
Fodder crop management is changed from 2.8 ha fodder beet and 1 ha of turnips in the Current All to no crops and wintering on 7 ha of land with 150 tDM baleage fed out for Current 1819 and Proposed modelling	Yes. There are no crops in the Current 1819 Proposed model. The area wintered on in the Proposed model is 7 ha and 150 t baleage is distributed specifically to the winter blocks and 500 tDM to all blocks except East block
Supplements imported are 724 tDM for Current All, 1039 tDM for Current 1819 and 1190 tDM for Proposed modelling	Yes. Supplements imported are modelled as indicated in report
Olsen P modelled as 28 in Current 1819	Yes, soil test information modelled as indicated in report
N fertilizer 211 kgN/ha on all blocks for Current All; 115 kgN/ha for baleage winter block and 188 kgN/ha for rest of blocks for Current 1819 modelling; 203 kgN/ha for non-effluent and 183 kgN/ha to effluent areas and 154 kgN/ha to East block for Proposed modeling	Yes. N fertilizer modelled as indicated in the report
Increased Effluent area and the application depth has remained at <12mm	Yes. The effluent area has increased from 61ha in Current All, 62 ha in Current 1819 toa to 93 ha and the application depth has remained at <12mm

Drainage all 100% all mole and tile drained in Current and Proposed models	Yes. All blocks have 100% drainage

26. All mitigations have been modelled correctly.

27. It is important that these mitigation measures are measured and monitored as if they are not adhered to the N loss reductions proposed may not occur.

CONCLUDING COMMENTS

Determination of the robustness of the nutrient loss to water

28. The questions below were described at Paragraph five of this report. Whilst these have been answered throughput this report, this section summarizes the answer to each question to make an overall conclusion about the robustness of the nutrient budgets.

Is the N loss consistent with what you would expect for an operation of this type and soils in this location?

29. Based on my experience, the N loss estimates are reasonably consistent with an operation of this scale and soil types present.

Does the summary of inputs and outputs make sense? Especially clover fixation and change in block pools?

30. There is no significant difference in the change in block pool values between 7 models presented for both N (except N mobilized in the East T model) and P.

31. There is a small decrease in biological fixation in the Proposed model and an 4.3% decrease in applied N but is accounted for in the increase in N added from imported supplements. Clover and pasture inputs are the same across all 7 models.

32. It is not apparent from reviewing the Overseer technical manuals or the nutrient budgets if the difference in pasture production and N fertiliser use accounts for the small decrease in biological fixation.

Check the 'Other values' block reports for rainfall, drainage, and PAW

33. The rainfall and soil information have been entered based on protocols for the location and soil type selected.

Production and stocking rate

34. Based on my experience as well as reviewing NZ Dairy statistics for the Current and Proposed model the stocking rate is higher than the Southland Region average in the 2017/2018 season. The milk production per cow for the Current

All, Current 1819 and Proposed models are higher than the Southland Region average in the 2017/2018 season

35. The average milk solids production per cow on this property for the Current All is 452.6 kg MS/cow/year and Current 1819 is 487.9 kgMS/cow/year both of which are higher than the Southland regional average of 408kg MS/cow. The target of 449.5 kgMS/cow is very similar to the current average modeling of the last 4 seasons at 461.4 kgMS/cow and if not achieved is likely to result in a lowered N loss.

36. The stocking rate at 3.0 cows/ha for the last 4 season and 3.3 cows/ha for the proposed model is higher than the Southland average for the 2017/2018 season of 2.64 cows/ha.

37. It is assumed that since the 4 seasons worth of actual scenarios for Current and East models are based on year end information that all scenarios represent viable production and stocking rate.

Select the pasture production in the scenario report and check pasture growth.

38. A detailed explanation of the pasture production has been outlined in the above sections.

39. There is a small decrease in pasture growth between the Proposed model and the Current model. This is acceptable as there is 4% decrease in N applied and an increase in supplement being imported, and a 9% increase in peak stocking rate.

40. Long term pasture growth in Southland between 1979 and 2012 indicated that average pasture growth for newer pastures was 12.7T DM/ha/yr. Average growth data for Wallacetown, from Dairy NZ data sheets, showed 14.3 tDM/ha with 176 kgN/ha applied (adding an additional 35 kgN/ha of nitrogen at a 10:1 response will give pasture growth of 14.7 tDM/ha). It is likely that Overseer is over estimating pasture covers due to the assumptions on lower energy levels modelled for pasture than that happening.

41. Pasture growth for the East models are around 5% below the average pasture growth for Southland (12.7 tDM/ha) and Wallacetown (12.5 tDM/ha with no N added).

42. The Current 1819, Current All and Proposed pasture production are 11% higher than pasture growth expectations for dryland pastures. An explanation from Mo Topham, File Note T and J Driscoll Family Trust December 2019 has explained this in Appendix 1 and her explanation is deemed to be an acceptable explanation for the higher pasture cover.

43. I have assumed an adequate level of robustness around the 4 seasons of actual Overseer Modelling as it is based on an actual farming system, and with that, I have assumed actual stock and fertiliser inputs used.

44. The original report provided by Mo Topham on the nutrient budget analysis of the Driscoll Family Trust application (pages 85-88), has not been updated (as shown in Table 9). However, Appendix 1 (Updated detailed description of modelling inputs (Dec2019)) mitigation changes have been outline in Table 10 and this shows that what has been reported is accurately modelled.

45. The data input protocols have been followed for all scenarios with no deviations. This leads to a high level of robustness for the relevant input data for example, climate, soils, and pasture type.

46. Based on this report and the Proposed inputs and outputs in the Overseer models, I consider that the robustness of the nutrient loss estimates for the Proposed scenario are high, this is due to the robustness of the nutrient loss estimates for the actual scenarios are high.

47. There are currently to areas of concern in the Current and Proposed modelling.

48. It is vital that the Proposed changes (especially around changes to the East block with the 154kgN/ha of N fertilizer applied which less than all other blocks; the grazing of stock on this block which excludes cows from start May to end of August; relative productivity of East Block be 0.97 in all models and there is no effluent applied) to the future farm system are effectively measured and monitored as if these are not adhered to then the reductions in N loss proposed may not occur.

References:

New Zealand Dairy Statistics 2017/2018. Produced by LIC and DairyNZ 2018.
https://www.dairynz.co.nz/media/5790451/nz-dairy-statistics-2017-18.pdf
Overseer Definition of Terms, previously Technical Note 6. May 2016
Overseer Technical Manual – Characteristics of Pasture, April 2015

Smith. L. C. 2012. Proceedings of the New Zealand Grassland Association 74: 147-152 (2012) *Long Term pasture growth patterns for Southland New Zealand: 1978-2012.* www.grassland.org.nz/publications/nzgrassland_publication_2284.pdf

https://www.dairynz.co.nz/media/5790163/average-pasture-growth-data-south-island-2018.pdf

Loss Assessment Audit – September 2019

P Loss Calculation Review

For: Environment Southland – Driscoll Family Trust

Prepared by: Nicky Watt, CNMA

Introduction

1. Regarding the consent application for Driscoll Family Trust, I have reviewed the following reports:
   a) Landpro, Tanya Copeland "Request for Further information under Section 92 (1)'
   b) Farmwise, Mo Topham 'Further Information'

2. The purpose of this report is to review the information provided and assess the P loss calculations outside of Overseer and determine if the calculations are feasible and if I agree with the methods.

3. The Table 1a below shows the summary of N and P loss for the East model and the Current and Proposed models. The P loss for the Current shows a total P loss of 253 kg and the Proposed shows a P loss of 256 kg. This is in an increase of 1.2% P. Table 1b below shows that the total P loss of East modelling plus Current modelling is 263 kgP compared to 256 kgP for the Proposed modelling which is a 2.7% drop in P loss. Based on this information the Overseer modelling shows that the Proposed system will reduce the P loss by 7kg/annum or by 2.7%.

Overseer Outputs

Table 1a: OVERSEER outputs

Overseer v6.3.0	East S	East T	East D	East Block Ave 3 Seasons	Current	Proposed (includes East Block)	Proposed East Block Only
N lost to water kg/ha/yr	14	9	27	17	54	44	13
Total N lost kg/farm	203	132	385	240	11273	9908	183
P lost kg/ha/yr	0.7	0.7	0.7	0.7	1.2	1.1	0.7
Total P lost kg/farm	10	9	10	10	253	256	10
Other sources – N	4	1	5	3	409	427	
Other sources – P	1	0	2	1	104	106	

Table 1b: Adding East Block to Current

Overseer v6.3.0	Current + East Block Ave 3 Seasons	Proposed
N lost to water kg/ha/yr	51	44
Total N lost kg/farm	11513	9908
P lost kg/ha/yr	1.2	1.1
Total P lost kg/farm	263	256
Other sources – N	412	427
Other sources – P	105	106

Mitigations Proposed

4. As described in the report provided there are mitigation measures outside of Overseer modelling. These are summarized and commented on in Table 2 below:

Good Management Practices	Feasible and Agree with Methods
Fencing and planting of streams	Yes, feasible. The fencing of waterways is aimed to keep stock away from waterways and to allow a natural vegetative buffer between waterways and paddocks to adequately filter runoff of nutrients, sediment and pathogens will ensure this P loss reduction. Preparation of a short to medium term riparian planting plan would be beneficial.
Appropriate vegetative buffers from waterways	Yes, feasible. A buffer wide enough to allow the filtering of nutrient, sediment and pathogens and ensuring any low spots along the waterways are addressed will ensure the P loss reduction.
Avoid working CSA's (critical Source Areas)	Yes, feasible. It is important that the runoff from farm tracks, gateways, bridges, culverts and water troughs are directed away from waterways or filtered through adequate riparian buffers to minimize the risk to waterways.
Minimising run-off from tracks, lanes and stream crossings using cut-offs and shaping	Yes, feasible. It is important that the runoff from farm tracks, gateways, bridges, culverts and water troughs are directed away from waterways or filtered through adequate riparian buffers to minimize the risk to waterways.
Using low rate effluent application	Yes, feasible. It is important that effluent is applied at a rate and timing that does not lead to ponding or runoff (knowledge of soil capabilities and moisture levels will help this decision making).
Spread fertiliser evenly and precisely and avoiding applying fertilizer directly into streams	Yes, feasible. Calibration of spreading equipment (contractor or owned) ensures that fertilizer is applied at the rate and distribution it was designed to. Use of GPS technologies on the equipment and clear identification of where waterways are will reduce the risk of fertilizer in waterways.
Targeting optimum Olsen P	Yes, this P loss reduction is feasible and covered in Overseer. Ensuring the P applied does not exceed the agronomic requirements of the crop and the soil Olsen P levels are maintained or reduced to optimum agronomic levels will reduce the potential for P loss
Restricted grazing and shifting break fences strategically	Yes, this P loss reduction is feasible and not covered in Overseer (assuming restricted grazing means holding cattle on yard during wet conditions). This target ensures the risk of soil compaction by stock in wet conditions is minimized and appropriate management practices have been put in place to minimize the compaction risk. Minimising soil compaction minimizes the run-off of water and sediment loss.

5. Notes: If this farm was to be audited under the guidelines of the ‘Canterbury Certified FEP Auditor Manual’ then all of the GMP practices proposed would need to be implemented to achieve a ‘Pass’ at the second audit. I have therefore assumed that this will be the case in Southland (this may not be the case). Also, Overseer does assume the farm is using GMP

CONCLUDING COMMENTS

6. The Proposed model has a P loss of 256 kgP/annum which is 2.7% less than the Current modelling, when East block is included, of 263 kgP/annum. It would be up to Environment Southland to determine if the GMP practices in the table above should be adhered to.

References:

Canterbury Certified Farm Environment Plan (FEP) Auditor Manual

Environment Court Decision – December 2019

BEFORE THE ENVIRONMENT COURT
I MUA I TE KOOTI TAIAO O AOTEAROA

Decision No. [2019] NZEnvC 208

IN THE MATTER	of the Resource Management Act 1991
AND	of appeals under clause 14 of the First Schedule of the Act
BETWEEN	ARATIATIA LIVESTOCK LIMITED (ENV-2018-CHC-029) ... (continued on last page) Appellants
AND	SOUTHLAND REGIONAL COUNCIL Respondent

Court: Environment Judge J E Borthwick
Environment Commissioner R M Bartlett
Environment Commissioner S G Paine
Special Advisor W R Howie

Hearing: at Invercargill on 4, 5, 6, 7, 10, 11, 12, 13, 14, 18, 19, 20, 21 June and 29, 30, 31 July 2019
Site visits held on 27 and 28 July 2019

Appearances: P A C Maw and K J Wyss for Southland Regional Council
B J Matheson and K S Brown for Fonterra Co-operative Group Limited and DairyNZ Limited
H A Atkins for Horticulture New Zealand
D A Allan for Aratiatia Livestock Limited
A D E Hitchcock for Wilkins Farming Co
M R Garbett for Gore District Council, Southland District Council and Invercargill City Council
P D Williams and D van Mierlo for Director-General of Conservation
S Ongley for Southland Fish and Game Council
S W Christensen for Meridian Energy Limited and Alliance Group Limited
C Lenihan for Federated Farmers of New Zealand (Southland)
M Russell for Heritage New Zealand Pouhere Taonga
J G A Winchester and S K Lennon for Waihopai Rūnaka, Hokonui Rūnaka, Te Rūnanga o Awarua, Te Rūnanga o Oraka Aparima (collectively Ngā Rūnanga) and Te Rūnanga o Ngāi Tahu
S R Gepp for Royal Forest and Bird Protection Society of New Zealand Incorporated
R Donnelly for Waiau Rivercare Group
V J Hamm for Ballance Agri-Nutrients Limited
M R G Christensen for Ravensdown Limited

Date of Decision: 20 December 2019

Date of Issue: 20 December 2019

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REASONS

Introduction

[1] The proposed Southland Water and Land Plan is a regional plan intended to give direction and guidance on the sustainable use, development and protection of land and water resources in the Southland Region.[1] Twenty-four persons appealed Southland Regional Council's decision to accept recommendations from a Hearing Panel appointed to hear the submissions on the proposed plan. This decision concerns ten of those appeals and addresses the higher order provisions of the plan including most of its objectives and certain key policies.[2]

[2] Unless otherwise indicated, the court has not made a final determination on the merits of any appeal. This is necessarily so because the court is not yet fully seized of all matters on appeal, with the majority of plan provisions under appeal adjourned for a future hearing or for alternate dispute resolution processes. Secondly, significant issues of plan interpretation and implementation are outstanding.

[3] A summary of the court's findings on individual provisions is attached to this decision and labelled Annexure 1.

Scope of the pSWLP

[4] The scope of this plan is important. While many objectives address the management of fresh water,[3] they are not "freshwater objectives" established in accordance with Policy CA2 of the 2017 NPS-FM. Therefore, the provisions of this plan do not introduce limits or targets for the six Freshwater Management Units recognised by the plan. The Regional Council intends to promulgate a plan change to introduce limits and targets and anticipates this separate process will be completed by December 2025.[4]

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[1] McCallum-Clark, EiC at [16].

[2] In addition to the ten appellants and the respondent, Southland Regional Council, nine parties joined the appeals pursuant to s 274 of the Act. The parties joining are Ballance Agri-Nutrients Limited, DairyNZ Limited; Fonterra Co-Operative Group Limited, Horticulture New Zealand, Ravensdown Limited, Gore District Council, Southland District Council, Invercargill District Council and the Waiau Rivercare Group.

[3] We adopt the language of the NPS-FM for "fresh water" as a single word and "freshwater" only when used as an adjective.

[4] pSWLP (Decisions Version 4 April 2018), Introduction, Purpose of this Plan at 7, see also Policies 44 to 47.

[5] If not limit setting, then what guidance and direction can this plan provide?

[6] This plan has the potential to deliver vital change in the way land and water resources are managed. In the past, it has very likely been assumed that the effects of change from an individual's use of land and water were measurable and so we talk about activities having a minor effect, less than minor effect, significant effect *etcetera* on the environment. But attributing an actual effect on water quality to an individual property or person can be problematic.

[7] This plan redirects the usual RMA focus on the scale and significance of effects of resource use onto the mauri or lifeforce of water and the enquiry becomes how do users of resources protect the water's mauri and health. Secondly, while many persons within the farming sector will rightly consider themselves good environmental stewards, by defining what is meant by 'degraded' water quality with reference to the attributes of ecosystem, cultural and human health[5] this should afford resource users a better more holistic understanding of those attributes and their interactions. This will facilitate the focus on the causes of degradation, which may not be the same for every waterbody, and promote a more desirable state of the environment. Finally, while the farming sector may be regarded as contributing a disproportionate volume of contaminants to waterways relative to other sectors, this plan requires all people to work on the causes of degradation.

[8] The characteristics of the waterbodies in Southland have changed significantly over time and many are likely degraded.[6] Acknowledging urban and rural communities must each "recognise that current practices will need to change"[7], the Regional Council, through this plan, is working on both the structural and behavioural causes of degradation throughout the region.

[9] The proposed Southland Water and Land Plan anticipates a long-term process of change. Through its objectives the plan sets in place a new paradigm for the way people and communities regard water and use land and water resources. Once implemented, the plan will place users of land and water in a better position to engage in limit and target

[5] This work is ongoing and is the subject matter of the Topic B hearing.

[6] JWS for Water Quality and Ecology (Lakes, Intermittently Closed and Open Lakes and Lagoons (ICOLLs) and estuaries held 9-10 May 2019 at Appendices 3 and 4; JWS for Water Quality and Ecology (Rivers and Wetlands) held 7-9 May 2019 at [40]-[48].

[7] Regional Council, opening submissions at [4]-[5].

setting in the FMU process and in any future plan change.

2019 draft National Policy Statement for Freshwater Management and proposed National Environmental Standards for Freshwater

[10] In September 2019 the Government announced a new draft National Policy Statement for Freshwater Management and proposed National Environmental Standards for Freshwater. We are not able to consider the 2019 draft policy and proposed standards in our decision and so when we talk about the Regional Council's Freshwater Management Unit processes, we are referring to the processes set out in the proposed Southland Water and Land Plan.

Abbreviations used in this decision

[11] The following abbreviations are used in this decision:

- "DV" means decision version of the proposed Southland Water and Land Plan;
- "FMU" means Freshwater Management Unit;
- "Hauora" means health, particularly the health of the environment, the health of the waterbody and the health of the people;
- "MTADA" means the Manapōuri Te Anau Development Act 1963;
- "Ngā Rūnanga" refers to four hapū that are Waihopai Rūnaka, Hokonui Rūnaka, Te Rūnanga o Awarua, Te Rūnanga o Oraka Aparima and Te Rūnanga o Ngāi Tahu;
- "NPS-FM" means the National Policy Statement for Freshwater Management 2014 (amended 2017);
- "NZCPS" means New Zealand Coastal Policy Statement 2010;
- "pSWLP", "proposed plan" and "plan" are used interchangeably when referring to the proposed Southland Water and Land Plan which is a regional plan;
- "Regional Council" means Southland Regional Council;
- "RMA" or "the Act" means the Resource Management Act 1991;
- "RPS" means Southland Regional Policy Statement;
- "territorial authorities" refers to Gore District Council, Southland District Council and Invercargill City Council.

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The role of the court on a regional plan appeal

[12] The court "has the same power, duty, and discretion in respect of a decision appealed against ... as the person against whose decision the appeal or inquiry is brought"[8] and has the same duty as a local authority to evaluate the proposed plan under s 32 and s 32AA RMA. Schedule 1, clauses 14 and 15 govern the jurisdiction and procedure of the court. Part 5 RMA, in particular ss 63 to 70 set out matters relevant to the purpose, contents and preparation of regional plans, as well as matters to be considered in preparing or changing a regional plan.

[13] The directions in s 67(3) and (4) RMA require that a regional plan must give effect to any national policy statement, any New Zealand coastal policy statement, and any regional policy statement; and that the regional plan in question must not be inconsistent with (relevantly for present purposes) any other regional plan for the region. In addition, the court must take into account any relevant planning document recognised by an iwi authority.[9] The following planning framework is therefore relevant to determining the appeals on the pSWLP:

(a) National Policy Statement for Freshwater Management 2014 (as amended 2017);
(b) New Zealand Coastal Policy Statement 2010;
(c) National Policy Statement for Renewable Electricity Generation 2011;
(d) National Policy Statement for Electricity Transmission 2008;
(e) Southland Regional Policy Statement 2017;
(f) Te Tangi a Tauira (Ngāi Tahu ki Murihiku National Resource and Environmental Management Plan 2008); and
(g) Te Rūnanga o Ngāi Tahu Freshwater Policy 1992.

[14] In determining these appeals, we must also have regard to the Commissioners' decision that is the subject of these appeals.[10] However there is no presumption in favour of the provisions of the proposed plan.[11]

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[8] RMA, s 290(1).
[9] RMA, s 66(2A)(a).
[10] RMA, s 290A.
[11] *Hibbit v Auckland Council* [1996] NZRMA 529 (PT) at 533.

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[15] Finally, because the pSWLP was publicly notified in June 2016, the applicable version of the RMA includes all amendments up to that date, inclusive of the Resource Management Amendment Act 2013 (but does not include the extensive amendments made by the Resource Legislation Amendment Act 2017).

National significance of fresh water and Te Mana o te Wai

[16] The health and wellbeing of our freshwater bodies is vital for the health and wellbeing of our land, our resources and our communities.[12] In te ao Māori,[13] water is the life-blood of the whenua (land).[14] When water is in a healthy state it provides for the health and wellbeing of the land and people.[15]

[17] The purpose of a national policy statement is to state objectives and policies for matters of national significance that are relevant to achieving the purpose of the RMA (s 45(1)).[16] Under the National Policy Statement for Freshwater Management (NPS-FM), it is a matter of national significance that fresh water is managed through a framework that considers and recognises Te Mana o te Wai as an integral part of freshwater management.[17] When we speak about Te Mana o te Wai we are referring to the integrated and holistic wellbeing of a freshwater body.[18] Upholding Te Mana o te Wai acknowledges and protects the mauri of water. While mauri is not defined under the NPS-FM, and we will return to this shortly, the mauri of water sustains hauora (health): the health of the environment, the health of the waterbody and the health of the people. As a matter of national significance the NPS-FM requires users of water to provide for hauora and in so doing, acknowledge and protect the mauri of water. <u>This is our first key understanding.</u>

[18] The NPS-FM leads with the objective that Te Mana o te Wai is to be considered and recognised in the management of fresh water (Objective AA1). Objective AA1 does not use the s 6 RMA language of recognising and providing for Te Mana o te Wai, but it is our understanding that the pSWLP does provide for Te Mana o te Wai and that the

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[12] NPS-FM, National significance of fresh water and Te Mana o te Wai at 7.
[13] Te ao Māori means the Māori world including the key elements of te reo Māori, tikanga and te Tiriti o Waitangi.
[14] Te Tangi a Tauira, Section 3.5: O Te Wai at 147, Cain EiC at [37] and [59], Transcript (Cain) at 1492.
[15] Transcript (Cain) at 1492; NPS-FM, National significance of fresh water and Te Mana o te Wai at 7.
[16] Section 45(1) RMA.
[17] NPS-FM, National significance of fresh water and Te Mana o te Wai at 7.
[18] NPS-FM, National significance of fresh water and Te Mana o te Wai at 7.

NPS-FM and the pSWLP intend for the health and wellbeing of freshwater bodies to be at the forefront of discussion and decisions about fresh water.

[19] Te Mana o te Wai will be achieved when regional policy statements and plans consider and recognise Te Mana o te Wai, and in doing so recognise the connection between water and the broader environment – te hauora o te taiao (the health of the environment), te hauora o te wai (the health of the waterbody) and te hauora o te tangata (the health of the people) – noting that values identified by the community, including tangata whenua, will inform the setting of freshwater objectives and limits (policy AA1).[19]

[20] While expressed in te reo Māori, Te Mana o te Wai benefits all New Zealanders.

[21] In summary, it is a matter of national significance that the management of fresh water is through a framework that considers and recognises Te Mana o te Wai as an integral part of freshwater management. By upholding Te Mana o te Wai the mauri of the water is acknowledged and protected.[20]

Treaty of Waitangi

[22] The Treaty of Waitangi is the underlying foundation of the relationship between the Crown and iwi and hapū with regard to freshwater resources.[21] In furtherance of this, s 8 RMA provides that in achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall take into account the principles of the Treaty of Waitangi (te Tiriti o Waitangi). Te Mana o te Wai expresses Treaty principles, including the principles of rangitiratanga and active protection.

Regional Policy Statement ("RPS")

[23] The RPS, to which the pSWLP must give effect,[22] explains that the Crown, exercising governance, has established a system of delegated authority with the functions delegated to regional councils and territorial authorities set out in ss 30 and 31

[19] NPS-FM, Objective AA1 and Policy AA1.
[20] NPS-FM, National significance of fresh water and Te Mana o te Wai at 7.
[21] NPS-FM, Preamble at 4.
[22] RMA, s 67(3).

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of the Act.[23] This proceeding is concerned with a regional plan for water and land, encompassing most (if not all) of the extensive provisions of s 30.[24]

[24] The RPS identifies resource management issues of significance to Ngāi Tahu. Of particular importance in this proceeding are the following:[25]

(a) degradation of mauri and wairua of natural resources used for customary purposes, and loss of quality and access to mahinga kai;[26] and
(b) destruction, damage and modification to wāhi tapu, wāhi taonga and sites of significance to tangata whenua.[27]

[25] Responding to those issues, and in accordance with, *inter alia*, Part 2 of the Act,[28] the RPS has two objectives:

> **Objective TW.3 – Tangata whenua spiritual values and customary resources**
>
> Mauri and wairua are sustained or improved where degraded, and mahinga kai and customary resources are healthy, abundant and accessible to tangata whenua.
>
> **Objective TW.4 – Sites of cultural significance**
>
> Wāhi tapu, wāhi taonga and sites of significance are appropriately managed and protected.

[26] The RPS explains that the RMA identifies "the relationship of Māori and their culture and traditions with their ancestral lands, water, sites, wāhi tapu, and other taonga as a matter of national importance".[29] We go further than this and record not only that these are matters of national importance, but that the relationship, culture and traditions with ancestral lands, water, sites, wāhi tapu, and other taonga must also be recognised

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[23] RPS, Chapter 3, 3.3 Policies, Policy TW.1 Explanation/Principal Reasons.
[24] Environment Southland *Updated Evaluation Report, Proposed Southland Water and Land Plan* (19 October 2018) ("s 32AA report") at [2.1.2].
[25] RPS, Chapter 3, 3.1 Issues at 22. The other issues and associated objectives besides which we have not lost sight.
[26] Issue TW.4.
[27] Issue TW.3.
[28] RMA, s 61 (2) RMA.
[29] RPS, Chapter 3, 3.4 Methods, Explanation/Principal Reasons at 28.

and provided for under the pSWLP (s 6 RMA). In furtherance of s 7 of the Act, as the RPS correctly states, particular regard must be had for kaitiakitanga.[30]

[27] Indeed, the RPS sets out to do exactly this in Policy TW.4 and provides:

> When making resource management decisions, ensure that local authority functions and powers are exercised in a manner that:
>
> (a) recognises and provides for:
>
> (i) traditional Māori uses and practices relating to natural resources (e.g. mātaitai, kaitiakitanga, manaakitanga, matauranga, rāhui, wāhi tapu, taonga raranga);
>
> (ii) the ahi kā (manawhenua) relationship of tangata whenua with and their role as kaitiaki of natural resources;
>
> (iii) mahinga kai and access to areas of natural resources used for customary purposes;
>
> (iv) mauri and wairua of natural resources;
>
> (v) places, sites and areas with significant spiritual or cultural historic heritage value to tangata whenua;
>
> (vi) Māori environmental health and cultural wellbeing.
>
> (b) recognises that only tangata whenua can identify their relationship and that of their culture and traditions with their ancestral lands, water, sites, wāhi tapu and other taonga.

[28] What may not be clear from the RPS' glossary of te reo Māori, is that this policy is addressing values that are core to tangata whenua about which there is tikanga – a correct way of doing things. The challenge for Ngā Rūnanga, and we think the Regional Council and the other parties to this proceeding, concerns how well current legislation and processes understand and weigh resource management models that have developed over centuries of learning.[31]

[29] In his opening address, Mr Maw for the Regional Council, submitted, without elaboration, that the plan was intended to take into account the principles of the Treaty of Waitangi.[32] While the Act identifies as a matter of national importance "the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga" (s 6(e)); protections for historic heritage and protected customary

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[30] Kaitiakitanga is defined in the RPS Glossary of Māori words as "the exercise of guardianship by the tangata whenua of an area in accordance with tikanga Maori in relation to natural and physical resources; and includes the ethic of stewardship".

[31] Skerrett, EiC at [39].

[32] Regional Council, opening submissions dated 4 June 2019 at [33].

rights (s 6(f-g)) and s 7 addresses kaitiakitanga – s 8 is a different type of provision, and the principles of the Treaty may have an additional relevance to decision-makers; per *Environmental Defence Society Incorporated v New Zealand King Salmon Company Limited & ors*.[33]

[30] The RPS's objective that the principles of the Treaty are to be taken into account in a systematic way through effective partnerships between tangata whenua and local authorities is a good example of where the principles of the Treaty have been brought to bear.[34] The Treaty's principle of partnership is well-established in jurisprudence. Partnerships also provide capacity for tangata whenua to be fully involved in council decision-making processes (Objective TW.1) and in a manner consistent with the principles of the Treaty (Policy TW.1). Embodying the principle of partnership, the Regional Council and Te Ao Mārama Incorporated ("TAMI"), Ngāi Tahu ki Murihiku resource management consultants, agreed to develop the pSWLP in partnership, not collaboration.[35] While this partnership relationship, built on trust and good faith,[36] accords with the Treaty principles it did not extend to mana whenua the power to accept or decline the recommendations of the Hearing Panel. The recommendations, which were accepted by the Regional Council – in Ngā Rūnanga's view – considerably weakened the outcomes of the plan.[37]

[31] The Treaty establishes principles in addition to partnership. Witnesses for Ngā Rūnanga noted that the principles of active protection and rangatiratanga are also relevant to the pSWLP.[38] The principle of active protection is expressly addressed in the Charter of Understanding between Ngā Rūnanga and the local authorities and defined there as being the duty of active protection of the tangata whenua rights and interests in resource management. This is not simply a passive duty, but is "in all senses active to the fullest extent practicable".[39]

[32] The Regional Council did not explain, and we could find no discussion in the

[33] *Environmental Defence Society Incorporated v New Zealand King Salmon Company Limited & ors* [2014] NZSC 38, [2014] 1 NZLR 593 at [27].

[34] RPS, Chapter 3, 3.2 Objectives, Objective TW.1.

[35] Skerrett, EiC at [100]-[110].

[36] Skerrett, EiC at [118].

[37] Transcript (Winchester for Ngā Rūnanga) at 1367-1368.

[38] Skerrett, EiC at [41]-[42] and [86]; Davidson EiC (corrected version) at [19] and [22]; Cain EiC at Appendix A.

[39] Skerrett, EiC at [42] and Appendix B: He Huarahi mō Ngā Uri Whakatupu The Charter of Understanding. Davidson, EiC at [19].

decision of the Hearing Panel, how the principles of the Treaty were taken into account. For example, are the principles of the Treaty relevant to Objective 15 which recognises and provides for taonga species? Taonga species are of fundamental importance in practice of mahinga kai as indicators of the health of the resources and of the wellbeing of the people. Many species are included in the Ngāi Tahu Deed of Settlement and Ngai Tahu Claims Settlement Act 1998.[40] Does this objective extend to their active protection under subsequent policies – particularly those taonga species that are vulnerable or threatened (eg kanakana) and where the failure to protect may be inimical to Māori health and wellbeing?[41] The parties are to expect that the court will seek further submissions on whether, or how, the Treaty principles are taken into account in this plan.

[33] Returning to the NPS-FM, it appears that the RPS was made operative prior to the 2017 amendments to the NPS-FM and has not been reviewed since.[42] Only Southland Fish and Game Council's ("Fish and Game"), Royal Forest and Bird Protection Society of New Zealand Incorporated's ("Forest and Bird") and Meridian's planning witnesses consider whether RPS gives effect to the NPS-FM as amended in 2017, all concluding that the RPS does.[43]

[34] For Meridian, Ms M J Whyte's analysis of Te Mana o te Wai centres on water quality objectives in the RPS and does not address resource management issues of significance to Ngā Rūnanga and their associated objectives. She observes that Te Mana o te Wai is not a new concept to the NPS-FM and that the only difference between the 2014 and 2017 version of the NPS-FM is the inclusion of a new specific objective and policy recognising Te Mana o te Wai (Objective and Policy AA1). She has not analysed whether the relocation of the 'national significance' statement in the operative provisions of the NPS-FM, together with a detailed explanation of and guidance on processes in respect to Te Mana o te Wai, is a substantive change – as we strongly think that it is. For Fish and Game and Forest and Bird, Mr Farrell concludes, without setting out his analysis, that the RPS and NPS-FM (as amended in 2017) are not in conflict.[44]

[35] On the evidence before us we are not in a position to conclude that the RPS does give effect to NPS-FM (as amended in 2017), and consequently we have borne in mind

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[40] Skerrett, EiC at [56].
[41] Transcript (McArthur) at 826.
[42] Whyte, EiC at Appendix 4.
[43] Whyte, EiC at Appendix 4 and rebuttal evidence at [16]; Farrell, EiC at [38].
[44] Farrell, EiC at [38].

the NPS-FM in our analysis and recommendations on the pSWLP's provisions.

[36] Giving planning evidence on behalf of the Regional Council, Mr M McCallum-Clark advised that only after the NPS-FM was amended did the "significance" of Te Mana o te Wai become obvious to him.[45] Even so, the proposed plan was not changed in response to the amended NPS-FM, as the Regional Council considered the plan already appropriately responded to Te Mana o te Wai.[46] For reasons we will come to, we agree, in part with his assessment and attribute this to the process the Regional Council followed in developing the notified plan in partnership with Ngā Rūnanga.

Proposed Southland Regional Water and Land Plan

[37] This proceeding is concerned with a regional plan. The purpose of the preparation, implementation, and administration of a regional plan is to assist the Regional Council to carry out its functions in order to achieve the purpose of the Act (s 63 RMA). All regional plans must be prepared in accordance with Part 2 of the Act and any national policy statements (s 66 RMA) and must give effect to the national policy statement (s 67 RMA).

[38] The pSWLP states that Te Mana o te Wai is "fundamental to the integrated framework for freshwater management in Southland. It provides a way of expressing Southland's aspirations for fresh water, now and into the future".[47] It was the intention of the plan drafters to put to the forefront of freshwater management the mauri of the waterbody and its ability to provide for the health of the environment, of the waterbody and of the people.[48]

[39] More particularly, Te Mana o te Wai is said to have three key functions in this plan:[49]

(a) it is a korowai (cloak) or overarching statement associating the values relating to a particular waterbody and freshwater management unit;
(b) it provides a platform for tangata whenua and the community to collectively

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[45] Transcript (McCallum-Clark) at 1532.
[46] Transcript (McCallum-Clark) at 1532-1533.
[47] pSWLP, Te Mana o te Wai at 5-6.
[48] pSWLP, Te Mana o te Wai at 5.
[49] pSWLP, Te Mana o te Wai at 5.

express their values for fresh water; and

(c) it aligns management tools with values and aspirations to maintain and improve both water quality and quantity.

Ki uta ki tai

[40] The proposed plan seeks also to manage water in a way that encompasses the Ngāi Tahu philosophy of "ki uta ki tai".[50] Ngāi Tahu are tangata whenua of Murihiku (including all of Southland).[51] In accordance with ki uta ki tai water, land and people are interconnected and natural resources are to be managed in a way that responds to their connectivity.[52] We understand the architecture of the plan, in particular the notified objectives and policies, to express this philosophy. Consequently, there is no specific or separate section in the proposed plan that "deals with" tangata whenua.[53] To reinforce this approach, the plan acknowledges that tangata whenua values and interests have been identified and reflected in the management of fresh water and associated ecosystems[54] and – we were told – 'threaded' through these higher order provisions.

[41] Several witnesses referred to ki uta ki tai as meaning 'Mountains to the Sea'. This literal translation is, however, problematic for the reasons given by Ms A Cain, on behalf of Ngā Rūnanga. Ki uta ki tai does not imply that water is managed within a lineal framework i.e. from the mountains to the sea. Rather, ki uta ki tai requires managers of natural resources to consider, at the same time, both what is happening in and around the headwaters of a catchment, along its length, and at the estuary (or outlet to the sea).[55] Put another way, ki uta ki tai is concerned with each of the parts, and the sum of the parts. Thus, regardless of scale, each sub-catchment, catchment or freshwater management unit[56] is to be managed holistically.[57]

[42] Applying the principle of ki uta ki tai to this plan will require the integrated

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[50] pSWLP, Te Mana o te Wai at 5 and 8.
[51] pSWLP, Te Mana o te Wai at 8.
[52] Cain, EiC at [18].
[53] pSWLP, Te Mana o te Wai at 8.
[54] pSWLP, Te Mana o te Wai at 8 and Objective AA1.
[55] Transcript (Cain) at 1378.
[56] While referred to in policies, 'freshwater management unit' is not defined. Under the NPS-FM, the 'freshwater management unit', is the water body, multiple water bodies or any part of a water body determined by the regional council as the appropriate spatial scale for setting freshwater objectives and limits and for freshwater accounting and management purposes. 'Catchment' is defined under the proposed plan and means 'the land area that contributes to the river's flow'.
[57] Transcript (Cain) at 1389. See also Kitson, EiC for illustration of the concept generally including at [44].

management of fresh water with the use of land in whole catchments (NPS-FM, Objective C1). Indeed, the Regional Council is tasked with recognising the interactions between fresh water, land, associated ecosystems and the coastal environment and second, managing fresh water and land use and development in an integrated and sustainable way (NPS-FM, Policies C1 and C2).

[43] That said, a major issue for the court concerns *how* Te Mana o te Wai and ki uta ki tai have been addressed in this plan.

Ngā Rūnanga – definitions of key concepts

[44] In *Sustainable Matatā v Bay of Plenty Regional Council and Waikato District Council*[58] the court records an observation made by Dr Daniel Hikuroa, that Te Mana o Te Wai would need to be defined by reference to tāngata whenua values and from a mātauranga Māori (Māori knowledge/wisdom) base which is context specific. This accords with our understanding. Because the proposed plan is the product of a partnership between the Regional Council and Ngā Rūnanga, it is important that parties understand the depth and meaning of key terms and concepts employed by the plan's authors. We refer in particular to water, mauri, ki uta ki tai, Te Mana o te Wai, kaitiakitanga, and mahinga kai.

[45] In Murihiku (Southland), Ngā Rūnanga regard water this way:[59]

> Water is a taonga, or treasure of the people. It is the kaitiaki responsibility of tangata whenua to ensure that this taonga is available for future generations in as good as, if not better quality.
>
> Water has the spiritual qualities of mauri and wairua. The continued wellbeing of these qualities is dependent on the physical health of the water. Water is the lifeblood of Papatūānuku, and must be protected. We need to understand that we cannot live without water and that the effects on water quality have a cumulative effect on mahinga kai and other resources.

[46] Mauri is referred to in the NPS-FM and in Objective 3 to the pSWLP but not defined and so now we tread lightly in offering our understanding of this concept. We

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[58] *Sustainable Matatā v Bay of Plenty Regional Council and Waikato District Council* [2015] NZEnvC 90 at [398].

[59] Cain, EiC at [37] quoting from Te Tangi a Tauira, section 3.5 at 147.

understand all things (animate and inanimate) have mauri, a life force.[60] Being interconnected, the mauri of water provides for the hauora and mauri of the environment and of the waterbodies and of the people.

[47] Ki uta ki tai was developed by Ngāi Tahu as a key tool to assist iwi to address a wide range of compounding issues with regards to environmental management.[61] The Regional Council is seeking to manage water and land in a way that encompasses the Ngāi Tahu philosophy of ki uta ki tai.[62] Like the concept of integrated management under the Resource Management Act, ki uta ki tai reflects the mātauranga (knowledge/wisdom) that all environmental elements are connected and must be managed as such.[63] More particularly, Ngāi Tahu understands ki uta ki tai as:[64]

> ... a paradigm and an ethic. It's a way of understanding the natural environment, including how it functions, how people related to it and how it can be looked after appropriately ...
>
> Ki Uta Ki Tai gives reference to the Ngāi Tahu understanding of the natural world and the belief that all things are connected – a belief shared by many other iwi and indigenous people. It also highlights the central importance of mahinga kai, the traditional seasonal food gathering rituals of Ngāi Tahu and the role this played in the traditional understanding and management of natural resources.
>
> While being founded on traditional values and understanding, Ki Uta Ki Tai is also a modern management framework that involves the creation of a number of tools, such as natural resource management plans, monitoring and reporting processes and resource inventories and their associated strategies to address the continuing challenges and threats faced by all aspects of the natural environment from the mountains to the sea – ki uta, ki tai.
>
> ... Ki Uta Ki Tai, as a concept, comes from the traditions, customs and values of Ngāi Tahu Whānui in relation to the natural environment, and in particular the custom of mahinga kai and transferred between generations through purakau, whakatauki, waiata, korero and on-going practices is the foundation upon which this modern Ngāi Tahu natural resource management framework is built.

[48] Section 66(2A)(a) of the RMA requires the Regional Council to take into account any relevant planning document recognised by an iwi authority when preparing a plan or

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[60] Te Tangi a Tauira at 27, 50, and elsewhere. Transcript (Cain) at 1497.
[61] Cain, EiC at [26]; Skerrett, EiC at [86].
[62] pSWLP, Preamble at p 5.
[63] Cain, EiC at [41].
[64] Kauapapa Taiao (2003) *Ki Uta Ki Tai: Mountains to the Sea Natural Resources Management* p 9-10 cited in Cain, EiC at [40].

plan change. In Southland there are two iwi management plans; namely Te Rūnanga o Ngāi Tahu Freshwater Policy and Te Tangi a Tauira (Ngāi Tahu ki Murihiku Natural Resource and Environmental Iwi Management Plan). The kaupapa of Te Tangi a Tauira is ki uta ki tai.[65]

[49] The proposed plan records that kaitiakitanga is central to Ngāi Tahu and is key to their mana whenua. Kaitiakitanga describes "the exercise of guardianship/stewardship by the tangata whenua of an area and resources in accordance with tikanga Māori".[66] The plan explains kaitiakitanga this way:[67]

> Kaitiakitanga is central to Ngāi Tahu and is key to their mana whenua. By exercising kaitiakitanga, Ngāi Tahu ki Murihiku actively work to ensure that spiritual, cultural and Mahinga kai values are upheld and sustained for future generations. Kaitiakitanga in this context includes ensuring the protection, restoration and enhancement of the productivity and life-supporting capacity of mahinga kai, indigenous biodiversity, air, water, land, natural habitats and ecosystems, and all other natural resources valued by Ngāi Tahu ki Murihiku.

[50] Importantly, tikanga goes beyond any rights or obligations that may attach to the use of water. As explained above, it is the kaitiaki responsibility to ensure that water is available for future generations in as good as, if not better quality.

[51] Ngā Rūnanga's nomadic lifestyle, based on mahinga kai, meant association with the land and waterbodies was not confined to a small spatial scale.[68] It was and is the expectation of Ngā Rūnanga that the landscape and environment sustain the traveler no matter where they went.[69]

[52] For Ngā Rūnanga provision for mahinga kai is elemental; it is of central importance to their identity, mātauranga and social cohesion.[70] Mahinga kai is about:[71]

> ... places, ways of doings things, and resources that sustain the people. It includes the work that is done (and the fuel that is used) in the gathering of all natural resources (plants, animals, water, sea life, pounamu) to sustain well-being. This includes the ability to clothe, feed and provide shelter.

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[65] Davidson, EiC at [37].
[66] Cain, EiC at [47].
[67] Environment Southland (2016) 8 and cited by Cain, EiC at [48].
[68] Cain, EiC at [54].
[69] Skerrett, EiC at [76].
[70] Skerrett, EiC at [49].
[71] Cain, EiC at [42].

[53] Water is a significant feature in mahinga kai with the preferential sites for mahinga kai being hāpua (estuaries, lagoons), repo (wetlands) and the riparian zones of rivers, streams and lakes.[72] The land and the water are part of the person and "symbols of the group and therefore of kinship and self-view".[73] Saliently, degradation of the waterbodies and land has negatively impacted the mana of the people, their hapū and iwi, as well as their collective cultural identify.[74]

[54] Drawing these key concepts together, mahinga kai persists under ki uta ki tai and kaitiakitanga as the basis of Ngāi Tahu's long-term planning and environmental ethos. The inclusion of Te Mana o te Wai in the NPS-FM resonated with Ngā Rūnanga, as one witness put it – "Te Mana o te Wai disrupts the regulation of the status quo by RMA tools as it makes the mana of water, its health and status, the paramount priority".[75]

Interpretation – Te Mana o te Wai and ki uta ki tai in the pSWLP

[55] In June 2018, we sought the respondent's assistance to understand the underpinnings of the pSWLP and design approach.[76] The respondent did not reply as directed but instead furnished the court with an updated s 32AA report. Neither the updated s 32AA report nor the decision on appeal address the NPS-FM beyond a bare recital of its provisions.

[56] We do not think it inaccurate to reflect that some planning witnesses and counsel had comparatively little regard for the scheme of the plan or to the wider context of the higher order planning instruments preferring instead to debate the substantive wording of the individual plan provisions. We posit that all provisions of the plan are to be interpreted and applied in a manner that gives effect to Te Mana o te Wai and implemented in accordance with ki uta ki tai. This is what the plan means when it talks about Te Mana o te Wai being "fundamental to the integrated framework for freshwater management in Southland".[77] If this is not the correct interpretation, then we can only

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[72] Cain, EiC at [45].
[73] Skerrett, EiC at [21] citing Tā Tipene o Regan in Wilson, J ed. (1987) *From the Beginning: The Archaeology of the Maori,* 23.
[74] Cain, EiC at [71].
[75] Cain, EiC at [85].
[76] Minute dated 25 July 2018 at [6] and [8]; and Record of Pre-Hearing Conference dated 12 September 2018 at [4]-[7].
[77] pSWLP, Introduction at 6. Oxford English Dictionary (Online) defines "fundamental", a noun, as meaning "A basic or primary principle, rule, law, or article, which serves as the groundwork of a system: an essential part".

say again it behooves the parties to set out their understanding of the scheme of the proposed plan (in other words its plan's architecture) so that the court has a basis upon which to assess their planning evidence.

[57] The clearest evidence on the role of Te Mana o te Wai and ki uta ki tai in this plan was from Mr B Farrell, giving evidence on behalf of Forest and Bird and Fish and Game. He said:[78]

> The suite of Objectives in the pSWLP are to be read together. No Objective overrides any other Objective. The Objectives are wound together by the concept of "*ki uta ki tai*" and the concept of "*Te Mana o te Wai*" was placed at the top of the plan structure. This is evidenced in the pSLWP's [sic] preamble which has not been substantively amended since it was agreed by the Council after various Councillor workshops undertaken in 2014-2015.

[58] While not referred to directly, ki uta ki tai is almost certainly expressed in Objective 1 and Te Mana o te Wai in Objective 3. In addition, witnesses for the Regional Council and Ngā Rūnanga talked about a "golden thread" woven through the fabric of the plan[79] – addressing provisions beyond these two objectives. This "thread" or the "korowai", may be those parties' particular approach to plan interpretation and implementation, but if correct this may not have been understood by other parties.

[59] As a matter of national significance, the health and wellbeing of water are to be placed at the forefront of discussion and decision-making. Only then can we provide for hauora by managing natural resources in accordance with ki uta ki tai. This is our second key understanding. This understanding is consistent with the evidence of Kaiwhakahaere and Upoko of Waihopai Rūnaka and Murihiku Marae, Mr M Skerrett. He said:[80]

> ... We all know the values and they are enshrined in Te Mana o te Wai – the mana/prestige and the ability of wai and its mauri to sustain human health, animal health, instream values, riparian values, transport (not transport pollutants) to name a few. [our emphasis].

[60] Returning to the NPS-FM, the section addressing the matter of national

[78] Farrell, EiC at [8].

[79] Transcript (Skerrett) at 950; Transcript (McCallum-Clark) at 1530-1531 and 1557. See also Transcript at 1557 where counsel for Meridian cross-examining Mr McCallum-Clark elicited the response that both Objective 1 and 3 were intended to be and are the golden thread woven through the plan.

[80] Skerrett, EiC at [115].

significance has several parts.[81] Having defined Te Mana o te Wai,[82] the NPS-FM records that upholding Te Mana o te Wai acknowledges and protects the mauri of the water.[83] Thus, acknowledgement and protection of mauri is an outcome of upholding Te Mana o te Wai. The mauri of water is, therefore, expressly linked with its use.

[61] In directive language the NPS-FM "requires that in using water you must also provide for" the health of the environment, the health of the waterbody and the health of the people.[84] We interpret the direction "you must also provide for" [our emphasis] as applying to local authorities in their capacity to make policy statements and plans and consequently, consent authorities whose permission is needed in order to carry out an activity for which consent is required and ultimately, every user of water.

[62] We interpret 'also' as meaning 'in addition',[85] thus in using water you must in addition provide for the health of the environment, of the waterbody and of the people. Subject to what the parties may say about how the Treaty principles are taken into account in this plan, this direction appears in line with the Treaty principle of active protection and would impose a positive obligation on all persons exercising functions and powers under the Act to ensure that when using water people also provide for health. This may have been what Ngā Rūnanga's planning witness was meaning when she referred to the Treaty principles.[86] This direction juxtaposes with the usual line of inquiry as to how health will be impacted by a change in water quality (i.e. the effects of the activity on the environment). The NPS-FM makes clear that providing for the health and wellbeing of waterbodies is at the forefront of all discussions and decisions about fresh water.[87] This is our third key understanding.

[63] If we are correct in our understandings, and this approach is indeed threaded through the proposed plan, this is a fundamental shift in perspective around management of this natural resource. The correctness of our interpretation above may well be of moment on appeals addressing policies (i.e. the course of action to implement objectives) and rules (i.e. the methods to give effect to the objectives and policies).

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[81] "The matter of national significance to which this national policy statement applies is the management of fresh water through a framework that considers and recognises Te Mana o te Wai as an integral part of freshwater management".
[82] "Te Mana o te Wai, is the integrated and holistic well-being of a freshwater body".
[83] NPS-FM, National significance of fresh water and Te Mana o te Wai at 7.
[84] NPS-FM, National significance of fresh water and Te Mana o te Wai at 7.
[85] New Zealand Oxford Dictionary (Oxford University Press, 2005).
[86] Davidson, EiC at [19].
[87] NPS-FM, National significance of fresh water and Te Mana o te Wai at 7.

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[64] This understanding of a shift in perspective appears to be shared by the Regional Council who put to Mr M Skerrett in cross-examination, "the proposed plan is an evolutionary step forward in terms of incorporating the golden thread ... in terms of Te Mana o te Wai".[88] Mr Skerrett accepted this statement as being correct.

Plan scheme (architecture)

[65] Given the above, we posit that the plan was drafted in a way that all objectives and policies were intended to express Te Mana o te Wai and ki uta ki tai. The structure (architecture) of the plan is to progressively elaborate on these outcomes with each successive objective building on the foregoing. If we are correct, the construction of the plan is atypical and needs careful explanation.

[66] We illustrate this possible interpretation, through three examples.

[67] First, Objective 15[89] states "Taonga species, as set out in Appendix M, and related habitats, are recognised and provided for". Ordinarily we would regard phrases such as 'recognise and provide for' as lacking meaning when they appear in an objective. The uncertain future for taonga species is underscored by Policy 3 (the implementing policy), which states "... manage activities that adversely affect taonga species, identified in Appendix M." On the other hand, is the outcome for taonga species secured through the implementation of Te Mana o te Wai and ki uta ki tai? There may be more than one course of action and method in the policies and rules to give effect to objectives, but all objectives, policies and rules assume effect is given to Te Mana o te Wai and ki uta ki tai is implemented. If this is the case, does the outcome for taonga species need any further elaboration?

[68] Again by way of illustration, Objective 2 (DV) provides "Water and land is [sic] recognised as an enabler of primary production and the economic, social and cultural wellbeing of the region". Merely *recognising* something in an objective, does not breathe meaning into the outcome that is to be achieved. Are not the three wellbeings expanded upon by Objectives 9 and 13 which in turn implement Te Mana o te Wai and ki uta ki tai?

[88] Transcript (Skerrett) at 951.
[89] Objective 15 is not under appeal.

[69] Finally, there will be access to and sustainable use of mahinga kai, nohonga, mātaitai and taiāpure (Objective 5)[90] when (we interpolate) the interconnection between land, water and people is recognised and natural resources are managed accordingly. While Objective 5 does not refer to Te Mana o te Wai or ki uta ki tai, the objective is promulgated on the basis that land and water resources are managed in a way to give effect to Objectives 1 and implement Objective 3.[91]

[70] If the scheme of the plan, properly interpreted, is not to progressively give effect to Te Mana o te Wai and to implement ki uta ki tai, then in our view many of the objectives are weakly drawn. That is because objectives usually have the purpose of clearly stating what it is that a plan is intent on achieving. At the simplest level an objective is a goal or aim of the plan.[92] Policies are the course of action to achieve or implement the same. An alternative drafting style adopted by several parties in this hearing would instead leave the outcomes to be articulated by the policies. Thus, planners espoused that something be "recognised", "provided for" and "recognised and provided for" in the plan. This is with the apparent intention that the policies particularise the outcomes. The planning evidence before us tended to adopt one of the two drafting styles, with the latter creating conflict where probably none actually exists or simply creating uncertainty for the other parties.

[71] We return to Objective 15 again by way of illustration. Objective 15 states "Taonga species, as set out in Appendix M, and related habitats, are recognised and provided for". The implementing policy, Policy 3, provides for taonga species through the management of activities that adversely affect the same. If Te Mana o te Wai is not the foundational principle, implemented in the way we posit, then the outcomes for the taonga species are uncertain because the health and mauri of water and its ability to sustain taonga species is not to the fore. Rather, Te Mana o te Wai and ki utu ki tai are two of 18 objectives, the relevance of which is to be argued case by case. If this is the correct interpretation, then we would have anticipated a more conventional drafting approach wherein the objective, in positive language, clearly states the outcomes for taonga species, e.g. taonga species are abundant and their habitat intact.

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[90] Objective 5 is not under appeal.

[91] pSWLP, Preamble at 5.

[92] See Judge J Hassan et al *Plan drafting – A Guide to Best Practice* (paper presented to RMLA-NZPI Roadshow, Powerful Plans – Perspectives on Best Practice Plan-Making, July 2019).

Objectives 1 and 3

Objective 1 (DV)

Land and water and associated ecosystems are sustainably managed as integrated natural resources, recognising the connectivity between surface water and groundwater, and between freshwater, land and the coast.

Objective 3 (DV)

The mauri of waterbodies provide for te hauora o te tangata (health and mauri of the people), te hauora o te taiao (health and mauri of the environment) and te hauora o te wai (health and mauri of the waterbody).

[72] While we received no evidence on point, Objective 1 of the pSWLP appears to be a clear expression of the ki uta ki tai philosophy.

[73] Objective 3 responds to the matters of national significance in the NPS-FM, ss 6(e)[93] and 7(a)[94] of the Act.[95] The s 32AA report records that while the objective is well aligned with the community's views there is confusion as to how it is measured and achieved.[96]

[74] In its current form Objective 3 does not fully give effect to the matter of national significance and Objective AA1.[97]

[75] In line with the language used in the NPS-FM, mauri is to be "acknowledged and protected" under Objective 3. In this regard we prefer the proposed wording of Forest and Bird, Fish and Game and the Department of Conservation as meaning that the mauri itself is protected so that mauri can sustain hauora.

[76] Secondly, we wonder whether the sense of Objective 3 could be improved by

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[93] Section 6: In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall recognise and provide for the following matters of national importance: (e) the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga.

[94] Section 7: In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall have particular regard to — (a) Kaitiakitanga.

[95] Section 32AA report at [5.3.3].

[96] Section 32AA report at [5.3.3].

[97] Transcript (McCallum-Clark) at 1534-1535, and 1537.

referring to the mauri of “water” rather than “waterbodies”.

[77] Thirdly, the plan likens Te Mana o te Wai to a korowai (cloak). If Te Mana o te Wai is a korowai does this mean all other objectives and policies are to be read in light of Objective 3 (i.e. the plan is to be interpreted and applied this way)? It is our tentative view that this approach would better accord with the matters of national significance in the NPS-FM and is a more appropriate way to ensure that the integrated and holistic wellbeing of a freshwater body will be directly connected with the use of water and land. Fundamentally, what the court is looking for here is guidance on the plan scheme (architecture) .

[78] While there are no direct appeals on these objectives there appears to be scope under Ngā Rūnanga’s appeal, to align the provisions of the plan (from its objectives through to the rules) better with the NPS-FM and Te Mana o te Wai and ki uta ki tai.[98]

Outcome

[79] We recommend Objectives 2 and 3 be reordered and the Te Mana o te Wai objective (presently Objective 3) reworded as follows:

> The mauri of water~~bodies~~ will be acknowledged and protected so that it provides for te hauora o te taiao (health and mauri of the-environment) and te hauora o te wai (health and mauri of the waterbody) and te hauora o te tangata (health and mauri of the people).

[80] Secondly, we will seek further submissions and evidence on whether Objectives 1 and 3 (Te Mana o te Wai) should be identified as the Korowai Objectives and korowai be defined as a method of plan interpretation.

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[98] Ngā Rūnanga, notice of appeal at [8(d) and (e)].

Objective 2

Objective 2 (DV)

> Water and land is recognised as an enabler of primary production and the economic, social and cultural wellbeing of the region.

[81] The Hearing Panel, without giving reasons, amended the notified version of Objective 2 to recognise water and land as an enabler of "primary production". The inclusion of primary production was appealed by Fish and Game and Ngā Rūnanga who both sought its deletion.[99] The appellants argue that reference to primary production could be interpreted as giving greater weight to the use of land and water for this activity above other values and uses, including those that rely on the health of the environment.[100] They point out that the attainment of economic, social and cultural wellbeing is not prioritised under this objective but each wellbeing is afforded equal weight.[101] The enablement of primary production does not, therefore, appropriately recognise Te Mana o te Wai which places the needs of the waterbody first and requires users of water to provide for hauora.[102]

[82] The primary sector, on the other hand, would retain primary production within the objective and they recommend amendments to address the appellants' concerns. They proposed to amend the objective to read:

> Water and land are recognised as enablers of the economic, social and cultural wellbeing of the region, including through primary production and other economic opportunities.

[83] Horticulture New Zealand argued that relocating "primary production" together with the new phrase "or other economic opportunities" at the end of the objective, should allay concerns that the objective will be interpreted so that "primary production" is given precedence over general economic, social and cultural wellbeing.[103]

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[99] Mr Farrell, giving planning evidence on behalf of Fish and Game and Forest and Bird, could support the retention of primary production within limits. He later changed his evidence and in line with Forest and Bird's appeal advised the reference to primary production should be deleted.

[100] Davidson, EiC at [57]; Farrell, EiC at [56]; Transcript (McCallum-Clark) at 425.

[101] Forest and Bird, closing submissions at [18].

[102] Davidson, EiC at [53]-[55].

[103] Horticulture New Zealand, closing submissions at [6]-[8]; Ballance Agri-Nutrients Limited at [4]-[8]; Ruston, EiC at [25]-[26].

[84] Farming makes a significant contribution to the economic and social wellbeing of the region and Federated Farmers is particularly concerned about the regional impact regulation may have – which we were told will be greater than in other regions.[104] Federated Farmer's planning witness, Mr D Sycamore, cited RPS Issue RURAL.1 and Objective Rural 1 in support of the Objective referencing the enabling of primary production. However, on closer examination we could find no direct support in these provisions for the express recognition of primary production. We did note, however, his observation that the objective is not one that seeks to manage activities or outcomes and that the objective is not to be read in isolation, but as one in a suite of objectives that have a focus on maintaining or improving water quality.[105]

[85] DairyNZ and Fonterra hold similar concerns to those of Federated Farmers, submitting that the reference to primary production in the objective is to provide "an appropriate basis for subsequent policies and rules relating to primary production, and how this activity needs to be sustainably managed within limits".[106] They point out that the objective as originally notified, does little more than repeat part of s 5 of the Act.[107] In seeking to refer to "primary production" this is no different to other objectives and policies which also list particular activities to which the provision is to apply. That said, planning witnesses for the primary sector agree that primary production is not the only or necessarily the most important contributor to a region's economic wellbeing.[108]

[86] While the Regional Council takes no position on the outcome of these appeals, its planning witness, Mr McCallum-Clark, acknowledged this recognition had the potential to "skew" the objective towards primary production.[109]

Discussion

[87] As earlier noted, it appears to us that the structure of this plan is to elaborate on the outcomes progressively with each successive objective building on the foregoing.

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[104] Federated Farmers, opening submissions at [4]-[6] and closing submissions at [7]-[8].
[105] Sycamore, as s 274 party in opposition at [28].
[106] Transcript (Matheson) at 179.
[107] DairyNZ and Fonterra Co-operative Group Limited, closing submissions at [5]-[8]. Willis, EiC at [6.9].
[108] See for example Transcript (Sycamore) at 556-558; Transcript (Ruston) at 608-609; Willis, EiC at [6.9].
[109] Transcript (McCallum-Clark) at 1555.

[88] While the enabling of land use activities, including those associated with primary production, may support economic and social wellbeing, in common with the witness for Federated Farmers, we do not interpret Objective 2 as being concerned with the enablement of activities *per se.* The objectives for Te Mana o te Wai and ki uta ki tai form the immediate context for Objective 2. Economic, social and cultural wellbeing are aspects of te hauora o te tangata (the health of the people). If the mauri of water is acknowledged and protected then it will provide for the health of the people (Objective 3), and integrated management of water and land will enable economic, social and cultural wellbeing of the region (Objective 2).

[89] The retention of primary production will obscure the objective if it is interpreted as being concerned with the enablement of activities. This interpretation is reasonably available to users of the plan, as one purpose advanced for retaining reference to primary production in the text is to support (on appeal) subsequent policies, rules and methods that enable primary production and manage the effects of the same.[110] The proposed amendment would create tension with other objectives that address the circumstances in which land and water may be used for productive purposes (see in particular Objectives 9/9A and 13).

Outcome

[90] We do not approve the inclusion of primary production in Objective 2 but approve instead the objective as notified (corrected for grammar):

> Water and land are recognised as ~~an~~ enablers of the economic, social and cultural wellbeing of the region.

[110] DairyNZ and Fonterra Co-operative Group Limited, closing submissions at [6].

Objectives 6 and 7

Objective 6 (DV)

There is no reduction in the overall quality of freshwater, and water in estuaries and coastal lagoons, by:

(a) maintaining the quality of water in waterbodies, estuaries and coastal lagoons, where the water quality is not degraded; and
(b) improving the quality of water in waterbodies, estuaries and coastal lagoons that have been degraded by human activities.

Objective 7 (DV)

Any further over-allocation of freshwater (water quality and quantity) is avoided and any existing over-allocation is phased out in accordance with freshwater objectives, freshwater quality limits and timeframes established under Freshwater Management Unit processes.

[91] The above objectives are subject to a number of appeals. While there was large agreement at the hearing that there were grounds for those appeals, the final wording of both objectives remained in contention. We return to a discussion of the wording after considering the state of the environment next.

State of the environment

[92] Water quality is changed, and the environment adversely affected, by the cumulative discharge of contaminants into water, or onto or into land, in circumstances where the contaminant may enter water.

[93] In their Report and Recommendations to the Regional Council, the Hearing Panel discussed Southland's declining water quality, identifying agricultural land use as a significant contributor to the state of water quality. Indeed, the Panel found it incontrovertible that water quality had declined between 2000–2016 in the region's rivers, lakes and estuaries. Even so, the Panel was unable, on the evidence before it, to reach any conclusion on the direction of trend including whether, as some experts had contended, water quality had improved or had become stable.[111]

[111] Report and Recommendation of the Hearing Panel, dated 29 January 2018 at [148]-[150].

[94] The pSWLP contains an issues statement, the purpose of which is to "[highlight] the importance of maintaining good water quality in upstream rivers".[112] There are three sources of water contamination noted; namely point source and secondly non-point source both of which are said to contribute significant levels of contaminants to waterbodies and finally, land use intensification which "tends" to increase the amount of contaminants.[113] The pSWLP does not actually identify any waterbody as being degraded. The closest the plan comes is in the statement "[d]egraded estuary, lagoon and lake water quality and habitats are particularly difficult and expensive to reverse".[114]

[95] We do not understand any witness to take issue that the quality of water in many waterbodies is likely degraded[115] and nor did any party oppose in principle the objective that where water quality is degraded then it must be improved.[116]

[96] The objective begs the question: what is meant by 'degraded'? The salience of this question should be self-evident: the mauri of water is neither acknowledged nor provided for where water is allowed to or has become degraded by human activities.[117]

Expert conferencing

[97] Expert conferencing is continuing as a matter of urgency given what we were told about the likely state of the environment in Southland. The experts are to report on (amongst other matters):

(a) a recommended classification systems for rivers, lakes and estuaries on an interim basis (pending the FMU processes to follow);
(b) attributes and thresholds to be used as the basis of defining degradation on an interim basis; and
(c) estimated levels of confidence in any recommended attribute thresholds.

[98] On the topic of water quality, the court received expert opinion from a large number of scientists. While we have considered everything they said, we will not be

[112] pSWLP, Issues at 15.
[113] pSWLP, Issues at 15.
[114] pSWLP, Issues at 15.
[115] Transcript (McCallum-Clark) at 382;
[116] Transcript (McCallum-Clark) at 426;
[117] Transcript (McCallum-Clark) at 1539.

discussing their evidence in any detail but instead will focus on the outcomes of joint witness conferences convened ahead of the hearing. Before we do that, we record our gratitude for the way the experts have engaged during expert conferencing.

[99] We return next to the wording and operation of Objectives 6 and 7.

What is "overall" water quality?

[100] As became apparent during the hearing it was unclear from the language of Objective 6 whether the objective applied before or after the FMU limit-setting processes, or is intended to apply at all times. The uncertainty arises because of the inclusion of the term "overall water quality". That wording suggests that the provision is directed at NPS-FM's Objective A2 which provides "overall quality of fresh water within a freshwater management unit is maintained or improved". Water quality within a FMU is for a later plan change.

[101] Objective 6 was amended by the Hearing Panel to include the term "overall" as the Panel thought this would give better effect to Objective A2 of the NPS-FM. We observe that the Regional Council will not be assisted in carrying out its functions by successive planning instruments merely repeating the content of the higher order planning documents. Rather, as the Supreme Court said in *Environmental Defence Society Incorporated v New Zealand King Salmon Company Limited & ors*:[118]

> As we have said, the RMA envisages the formulation and promulgation of a cascade of planning documents, each intended, ultimately, to give effect to s 5, and to pt 2 more generally. These documents form an integral part of the legislative framework of the RMA and give substance to its purpose by identifying objectives, policies, methods and rules with increasing particularity both as to substantive content and locality.

[102] There was general uncertainty at this hearing as to the meaning of the term "overall" with the most relevant RPS objective, WQUAL.1, not even referring to "overall water quality". Experts giving evidence on water quality and ecology considered the term "overall water quality" problematic. Ecosystem health can be described by one or a combination of specific attributes. The NPS-FM defines an "attribute" as meaning a measurable characteristic of fresh water, including physical, chemical and biological

[118] *Environmental Defence Society Incorporated v New Zealand King Salmon Company Limited & ors* [2014] NZSC 38 at [30].

properties, which support particular values.[119] At that time, the experts agreed that if one attribute does not meet the relevant criterion the water quality is considered degraded.[120]

[103] Commenting on ecosystem health, they said[121] the aggregation of multiple attributes may mask the effects of an exceedance of a single attribute state. There is no repeatable methodology to aggregate data across multiple attributes or sites and the development of such an assessment framework would be a substantial and complex body of work requiring significant agreement across multiple disciplines. Any attempt to spatially aggregate water quality data across multiple sites limits the ability to consider locality-specific effects at an appropriate level of detail. Such an approach is limited by the representativeness of the monitoring network. Moreover, the assessment of "overall water quality" would be subjective and the outcome could be interpreted in a number of ways, including spatially, temporally and across multiple attributes.[122]

[104] It is the experts' view that water quality and ecology must be considered using both a whole-of-catchment and site-specific approach. This involves consideration of historic and current land use, the quality and quantity of groundwater and all freshwater bodies and the sea on an integrated basis. As all waterbodies are interconnected, not adopting a holistic whole of catchment approach risks drawing incorrect conclusions.[123]

[105] For completeness, we were referred by one party to guidance published by the Ministry of Environment on what it means to "maintain" in the context of the NPS-FM Objective A2 but were not assisted by this publication as to how "overall water quality" could be implemented by policies and rules in a regional plan.[124]

[106] At the end of the hearing, the parties proposed to delete the opening part of Objective 6 "[t]here is no reduction in the overall quality of fresh water". We consider this part may be severed without altering the meaning of the balance of the objective, which is to maintain water quality where not degraded and to improve water quality where it is. The amendment addresses concerns with the meaning of the term "overall" and does so

[119] NPS-FM, Interpretation.
[120] JWS – Water Quality and Ecology (Rivers and Wetlands) at [47].
[121] JWS – Water Quality and Ecology (Rivers and Wetlands) at [23].
[122] JWS – Water Quality and Ecology (Rivers and Wetlands) at [24].
[123] JWS – Water Quality and Ecology (Rivers and Wetlands) at [25].
[124] A guide to the National Policy Statement for Freshwater Management 2014 (as amended 2017) https://www.mfe.govt.nz/publications/fresh-water/guide-national-policy-statement-freshwater-management-2014 cited in the closing submissions of the territorial authority at [19].

without imposing any "no reduction" test as this would be unable to be achieved for point-source discharges within the zone of reasonable mixing.[125]

[107] In addition to deleting "overall" from the objective, the primary sector proposed water quality would be maintained or improved in *each* freshwater body. The reference to "each" freshwater body was to put beyond doubt that the objective could not be met by water quality *overall*, (or across all waterbodies) being maintained, thus ensuring that improvement in one freshwater body could not be "traded off" against declining water quality in another.[126] The proposed amendment addresses the concern raised by the Regional Council which was to ensure that the spatial scale of assessment not be at a region-wide level or at the level of an individual FMU.[127]

Holding the line

[108] A critical issue for Forest and Bird is whether the pSWLP intends only to "hold the line", or whether the plan requires improvement of degraded waterways in advance of the FMU processes.[128]

[109] The Hearing Panel records in its decision that the pSWLP policies and rules directed at farming are intended to halt any further decline in water quality and that this intention had given rise to a planning ethos colloquially referred to as "holding the line". The realisation of this outcome is now in doubt. Dr A H Snelder, a land and water consultant giving evidence on behalf of the Regional Council,[129] said any reduction in nutrient loadings achieved through changes in land management could be eroded within two to five years by subsequent intensification in land use and improvement in farm productivity.[130] While we acknowledge the witnesses for the Regional Council were not briefed to address the effectiveness of the plan's policies and rules, and that the pSWLP has land management provisions in addition to those considered by Dr Snelder, we were not made aware of any modelling undertaken by the Regional Council that has verified that the provisions of the proposed plan could indeed 'hold the line'.

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[125] Territorial authorities, closing submissions at [12]-[16].
[126] DairyNZ Limited and Fonterra Co-Operative Group Limited, closing submissions at [9]-[12].
[127] McCallum-Clark, supplementary evidence at [11].
[128] Forest and Bird closing submissions at [23].
[129] This evidence was originally presented in 2014 in a report to the Regional Council. See exhibit Ngā Rūnanga 1.
[130] Transcript (Snelder) at 302-304.

[110] Ms R J Millar, giving planning evidence on behalf of the Regional Council, said staff at the Council knew as early as 2013 that "holding the line" would be difficult "[let] alone achieving improvements".[131] Mr M McCallum-Clark, also giving planning evidence for the Regional Council, said while there would be improvement in water quality through the pSWLP's regulatory and non-regulatory methods, any improvement in water quality would likely be "quite limited" and of short duration, being eroded over time.[132] In his opinion, the rule framework was in need of "considerable reassessment".[133] He said many of the plan's non-regulatory initiatives (such as the adoption of good management practices) were a "light touch on existing farming activities".[134]

[111] We acknowledge and appreciate the witnesses' candor on this topic. As we have recorded, at the conclusion of the hearing no party advocated there should not be improvement in the quality of water (where degraded) in advance of the FMU processes.

The duration of Objective 6

[112] The issue that arises in relation to duration concerns whether Objective 6 is to be restricted to the period prior to any plan change establishing freshwater objectives, limits and targets for the six FMUs. Those in support of this proposition say the proposed plan "loses nothing" by restricting the operation of Objective 6 this way.[135] They say this will ensure there is no confusion about how "degraded"[136] water relates to the FMU process and avoids risking the "locking in" of an outcome contrary to the NPS-FM freshwater management unit requirements.[137]

[113] The parties opposing this course say the objective should not be limited in this way because not all contaminants are allocable and therefore some may not be the subject matter of freshwater objectives, limits and targets developed in accordance with Objective 7.[138] *E.coli* and phosphorus were given as examples of contaminants that

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[131] Transcript (Millar) at 1513.

[132] Transcript (McCallum-Clark) at 436.

[133] Transcript (McCallum-Clark) at 412.

[134] Transcript (McCallum-Clark) at 408. See also Transcript (McCallum-Clark) at 407 for discussion on likely effectiveness of non-regulatory methods.

[135] By way of example, the Regional Council's preferred wording is: "Prior to the establishment of freshwater objectives, limits and targets under Freshwater Management Unit processes, ...".

[136] What is meant by 'degraded' water quality is being considered in conferencing of expert witnesses, currently underway.

[137] Ravensdown Limited, closing submissions at [7]–[16]. McCallum, supplementary evidence and table attached.

[138] McCallum-Clark, supplementary evidence at [9]. Transcript (McArthur) at 853-854.

cannot be allocated or will be difficult to allocate under the FMU process. The continuation of Objective 6 post-FMU would not, in their view, cause tension with Objective 7.[139]

[114] The Director-General of Conservation supported the continuation of Objective 6 post-FMU for the specific reason that Objective 7 (which is addressing the future FMUs) does not apply to waterbodies that are not subject to any limit. "Over-allocation" is an NPS-FM term being the situation where the resource:

(a) has been allocated to users beyond a limit; or
(b) is being used to a point where a freshwater objective is no longer being met.

[115] For water that is not over-allocated, Objective 7 does not require water quality to be maintained (where not degraded) or improved.[140] Responding to this, the Regional Council and Ravensdown proposed amending Objective 7 by including a new sub-clause "(aa) where water quality limits are met, water quality is maintained or improved". We will come back to this shortly.

Discussion on the duration of Objective 6

[116] We do not agree with the submission that the continuation of Objective 6 post-FMU risks policies or methods developed for the period prior to the FMU processes being wrongfully or unmeritoriously incorporated in a future plan change. The pSWLP makes clear that policies and methods may be changed under a future FMU process. There is a real risk, however, were Objective 6 not to extend beyond the establishment of freshwater objectives under the FMU processes, that contaminants not amenable to an allocation regime, such *as E.coli*, may not be subject to any control.

[139] Fish and Game, closing submissions at [22].
[140] Director-General of Conservation, closing submissions at [28].

Bridging the gap

[117] As noted, it is not seriously contested that many of the region's waterbodies are likely degraded. The risk to ecosystem health, if improvement in water quality was deferred until after the completion of a future FMU process, was described by one witness as "devastating, particularly for the region's unique and threatened freshwater ecology".[141]

[118] This plan does not propose an allocative regime (i.e. limits or targets) wherein the amount of improvement required to attain ecosystem health and human health (for recreation) is set over a specified timeframe.[142] It is conceivable that under the FMU process, improvement in ground water quality may take decades if not generations to achieve.[143]

[119] A key issue raised by many parties is whether there are methods under the pSWLP that are capable of ensuring, now, that the trajectory of change is towards improvement of a degraded waterbody. In the absence of an allocative regime it will be difficult to relate the magnitude of in-stream improvement to change in the land management of individual properties.[144] If there is to be improvement in degraded waterbodies ahead of the FMU process then our preliminary view is that it is essential the narrative and numeric attributes for degraded water are known and that land management of individual properties address the linkages between those attributes and the contaminant pathways.

[120] Essentially Fish and Game and Forest and Bird are proposing this through their "bridging the gap" initiative.[145] While these parties initially sought to introduce limits and targets into this plan, they now advocate for rules and methods that require identification of contaminant pathways to surface waterbodies and the taking of practicable measures to reduce existing sources of contaminants and avoid increased losses. This may require additional policy defining what is meant by degradation[146] and further rule support.

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[141] McArthur, EiC at [67].

[142] Transcript (McArthur) at 802-804, 827-831. Forest and Bird is no longer pursuing relief on this basis.

[143] NPS-FM, Preamble at 5.

[144] Transcript (McArthur) at 803. Transcript (McCallum-Clark) at 450-451.

[145] Forest and Bird and Fish and Game paper dated 11 June 2019.

[146] DairyNZ Limited and Fonterra Co-operative Group Limited, closing submissions at [11].

[121] This is a very different approach to managing the effects of change brought about by resource use. Under the RMA when we talk about the effects of change, change typically has yet to occur. Effects language is often employed to describe the consequence of change brought about by the use of resources. So when we say the effect of the resource use on the environment will be minor, for example, this usually is a prediction about the future.

[122] We think the initiative highlights the need for pre-emptive risk management. This may be to lessen the reliance made on predictive assessments about the future environment with greater emphasis given to the evaluation of risk. A matter for Topic B hearing is whether the initiative is more effective and practicable than the effects-based assessment methods employed by the Regional Council.

2010 Baseline Environment

[123] Central to Ngā Rūnanga's appeal is the question whether the present-day state of the environment in Southland[147] should be the benchmark against which water quality is assessed.

[124] While no relief was proposed we understand Ngā Rūnanga would use the state of the environment at 2010 as the benchmark environment and so it is convenient to deal with the issue at this juncture. The reason for this benchmark is that under the Regional Water Plan (made operative in 2010), the Regional Council made a commitment to maintain or improve water quality across a range of variables. It seems probable these outcomes have not been achieved.[148] It may be that the removal of the introductory part of Objective 6[149] will address Ngā Rūnanga's concern. Presently, we are not attracted to any time-bound benchmarking of water quality at 2010, which may set a very low bar relative to the cultural and ecological indicators of freshwater health. We can revisit this issue if Ngā Rūnanga decides to pursue this matter by proposing relief.

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[147] More particularly, the date that the pSWLP was notified.
[148] Davidson, EiC at [41]-[51].
[149] "There is no reduction in the overall quality of fresh water [etc]".

Naming of waterbodies

[125] Finally, different iterations supported by individual parties did not take a consistent approach when listing the waterbodies. For example, the primary sector would include aquifers in the wording of the objective whereas Forest and Bird and Fish and Game do not. Aside from water in estuaries and coastal lagoons, Ngā Rūnanga does not list other water bodies. On the other hand, the Regional Council would exclude aquifers claiming there is too much uncertainty spatially (where) or even whether this objective is being met for aquifers[150] and that groundwater is addressed in Objective 8.

[126] Save in relation to the Regional Council, it is not clear from the evidence and submissions whether these differences are purposeful.

[127] As for the Regional Council's reason to exclude aquifers, Objective 8 is limited in scope in that it addresses the quality of groundwater relative to the drinking water standards only. Given the connectivity between all waterbodies, excluding aquifers appears inconsistent with the management philosophy of ki uta ki tai and Objective 1 and it is our provisional finding that types of waterbodies should not be listed in the objective.

Outcome

[128] We accept the submission that Objective 6 is to endure beyond the FMU processes. We further accept that the objective should be amended to refer to "each" waterbody. We will seek submissions on whether the omission of certain types of waterbodies was intentional on the part of some parties and secondly, whether the omission could frustrate the approach of recognising the inter-connectedness of the water bodies and addressing water holistically.

[129] Thus, Objective 6 as proposed to be amended by the court would read:

> Water quality in each freshwater body will be:
>
> (a) maintained where the water quality is not degraded; and
> (b) improved where the water quality is degraded by human activities.

[150] McCallum-Clark, supplementary evidence at [11].

[130] In relation to Objective 7 we accept the amendments proposed by the Regional Council, the primary sector and Ravensdown and further amend new sub-clause (aa) to include both freshwater objectives and limits.

[131] Objective 7 as proposed to be amended by the court would read:

> Following the establishment of freshwater objectives, limits, and targets (for water quality and quantity) in accordance with the Freshwater Management Unit processes:
>
> (a) where water quality objectives and limits are met, water quality is maintained or improved;
> (b) any further over-allocation of fresh water is avoided; and
> (c) any existing over-allocation is phased out in accordance with freshwater objectives, targets, limits and timeframes.

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Objectives 9 and 9A

Objective 9 (DV)

The quantity of water in surface waterbodies is managed so that aquatic ecosystem health, life-supporting capacity, outstanding natural features and landscapes and natural character are safeguarded.

Objective 9A (DV)

Surface water is sustainably managed to support the reasonable needs of people and communities to provide for their social, economic and cultural wellbeing.

[132] These objectives are concerned with the quantity of water in surface waterbodies. At the time of notification two objectives were contained in a single provision which effectively prioritised the environment above the use of water. The creation of two separate objectives removed this prioritisation.

[133] At the conclusion of the hearing all parties accepted that Objectives 9 and 9A should be re-merged with the prioritisation restored. It was also agreed that the objective be amended and refer to "waterbody margins" as per the notified version. Accepting the reasons in support of this outcome, our analysis proceeds on this basis.

Life-supporting capacity – proposed sub-clause (a)

[134] Sub-clause (a) as proposed by the Regional Council and others reads:

The quantity of water in surface waterbodies is managed so that:

(a) aquatic ecosystem health, life-supporting capacity, outstanding natural features and landscapes, natural character of waterbodies and their margins and human health for recreation are safeguarded; and

[135] By way of observation, the number of discrete values to be safeguarded under sub-clause (a) renders this provision cumbersome. This criticism can be levelled at other objectives too.

[136] The sub-clause refers to both "aquatic ecosystem health" and "life-supporting capacity" [we interpolate "the life-supporting capacity of water"]. We heard evidence that

the term "life-supporting capacity" is unique to the RMA and is not a term used by ecologists who refer instead to ecosystem or ecological health.[151] Moreover, the term does not appear to be defined under the Act, NPS-FM, RPS or the pSWLP. The Environment Court summarised its meaning as part of a broader consideration of biodiversity under Part 2 RMA in *Director-General of Conservation v Invercargill City Council*[152] as follows:

> ... safeguarding (or protecting) the life-supporting capacity of ecosystems includes in each case having particular regard to each of its components including – as the definition of 'intrinsic values' implies – ... its biological and genetic diversity, and in particular, the essential (biotic and abiotic) characteristics of:
>
> - the ecosystem's integrity (e.g. what space does it occupy at a given time? Is an occurrence at the limit of the ecosystem's extent of occurrence?);
> - its form (what are the characteristics of its environment – the geomorphology, topography, soils, climate, indigenous and other species of flora and fauna, patterns of distribution, natural processes and other relevant constituents identified in the definition of "environment" in s2 RMA;
> - its functioning (e.g. is it a seral or 'climax' ecosystem? What are the external processes that apply to it? – climate change? pests? weeds? How are the natural cycles and feedback loops – the Carbon, Nitrogen, Phosphorus cycles and others – being changed?); and
> - Its resilience (e.g. at what point is a degraded ecosystem irretrievably doomed to "collapse" or can it recover?).
>
> [Footnotes omitted]

[137] Furthermore, in *Lindis Catchment Group Incorporated v Otago Regional Council*[153] the Environment Court noted:

> Section 5(2)(b) RMA refers to "life-supporting capacity". The word used is "capacity" not "ability". The latter is a qualitative word, whereas capacity is both qualitative and quantitative. It is not merely the ability of (in this case) water to support life which is to be protected, but the volume of water in any given factual matrix.

[138] Also, pertinently, that:[154]

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[151] See Transcript (Death) at 862. Ecologists would refer to "ecosystem health" and not "life-supporting capacity".

[152] *Director-General of Conservation v Invercargill City Council* [2018] NZEnvC 84 at [47].

[153] *Lindis Catchment Group Incorporated v Otago Regional Council* [2019] NZEnvC 166 at [166].

[154] *Lindis Catchment Group Incorporated v Otago Regional Council* [2019] NZEnvC 166 at [168].

It is also worth noting that ecosystems are incredibly complex and that the descriptive pigeonholes ('integrity', 'form', 'functioning', 'resilience') as used in section 2 RMA are (still) often over-simplistic despite their apparent sophistication. Further, ecosystems may be nested or may overlap. These complexities make translating protection of indigenous biodiversity into policies (and under other instruments, rules) very difficult.

[139] If life supporting capacity means the same as aquatic ecosystem health, then the term is redundant and should be deleted; if life supporting capacity is an aspect of Te Mana o te Wai then the term may be redundant if this objective is implementing Te Mana o te Wai as is our understanding. That aside, while the term "life supporting capacity" appears in the higher order documents, presently we do not see how it assists the Regional Council to carry out its functions if this plan does not enlarge on the same.

[140] We will seek submissions / evidence on the meaning of this term within the context of a water quantity objective and to identify the policies that implement the same.

The loss of a parent objective (proposed sub-clause (c))

[141] During the course of the hearing it became apparent that if Objective 7 was amended to apply after the FMU process, then there was no objective (that is, no "parent objective") addressing present-day over-allocation of water quantity.[155] Consequential amendments to Objective 9 were proposed in response. The Regional Council would include a new sub-clause so that water quantity is sustainably managed in accordance with Appendix K of the plan.[156] Appendix K sets out the methodology for establishing minimum flow in waterbodies and allocating water from the same. The Director-General of Conservation and others,[157] proposed alternative wording for a new sub-clause.

[142] We do not recall the parties' amendments version being tested in evidence, which is not a criticism. All parties changed their position on the objectives and policies during the course of the hearing and there is yet to be a full opportunity to consider the amendments proposed in light of s 32AA of the Act.

[155] Transcript (McCallum-Clark) at 1543.
[156] Transcript (McCallum-Clark) at 1543.
[157] Ngā Rūnanga, Forest and Bird and Fish and Game.

[143] We interpret "over-allocation" in the decision version of Objective 7 as referring to <u>both</u> pre and post FMU processes, in other words the objective does not apply the definition of "over-allocation" in the NPS-FM. The term "over-allocation" is peculiar to the NPS-FM and contemplates methods to avoid over-allocation (both quantity and quality) being developed as part of the FMU process (see Objective A2 and Policies A2 and A3; Objective B2 and Policies B5 and B6).

[144] Objective 6 (as proposed to be amended by the court) addresses degradation of water quality only. Objective 7 addresses the over-allocation of fresh water both in terms of its quantity and quality post-FMU. The parties are correct to say there is no objective addressing present-day allocation of water in terms of quantity. With the minor edits track-changed,[158] we prefer the Regional Council's proposed amendment addressing that gap. The alternative version proposed by the Director-General of Conservation and several other[159] parties wants for its grammatical construction.[160]

[145] We turn next to the two key issues in dispute, commencing with historic heritage.

Historic Heritage

[146] The notified version of the objective listed historic heritage values in Objective 9(a). The Hearing Panel recommended the deletion of all references to historic heritage values from the objectives and policies having accepted a submission that the pSWLP could not impose land use rules for the purpose of controlling effects on heritage.[161] The imposition of land use rules is a function of the district councils pursuant to s 31(1)(b) of the Act.

[147] Heritage New Zealand Pouhere Taonga (Heritage NZ) is not seeking that the potential effects of land use or development *per se* be controlled by this objective. Rather, it seeks that the quantity of surface water is managed so that the historic heritage values of waterbodies and their margins are safeguarded.[162] Ngā Rūnanga seeks the

[158] We delete a comma: " ~~,~~in accordance with Appendix K,".

[159] Director-General of Conservation, Ngā Rūnanga, Forest and Bird and Fish and Game.

[160] Appendix K refers at several parts to a precautionary approach being adopted in the absence of quality information.

[161] Report and Recommendations of the Panel, 29 January 2018 at [292].

[162] Anderson, EiC at [18]-[20].

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same relief. The Regional Council adopted a neutral stance on the inclusion of historic heritage values in this objective.[163]

[148] While there were a number of interested parties in this appeal only Federated Farmers addressed the matter in written evidence.[164] Opposing the inclusion of historic heritage values in the objective, the planning witness for Federated Farmers appeared to say that there was protection for these values under the Heritage New Zealand Pouhere Taonga Act 2014.[165] However, Heritage New Zealand Pouhere Taonga Act 2014 affords protection to archaeological sites.[166] As the definition in the RMA makes clear, historic heritage is concerned with more than New Zealand's built environment:[167]

> (a) … those natural and physical resources that contribute to an understanding and appreciation of New Zealand's history and cultures, deriving from any of the following qualities:
>   (i) archaeological;
>   (ii) architectural;
>   (iii) cultural;
>   (iv) historic;
>   (v) scientific;
>   (vi) technological; and
>
> (b) includes—
>   (i) historic sites, structures, places, and areas; and
>   (ii) archaeological sites; and
>   (iii) sites of significance to Māori, including wāhi tapu; and
>   (iv) surroundings associated with the natural and physical resources.

[149] Moreover, the direction to recognise and provide for the protection of historic heritage from inappropriate subdivision, use and development is a matter of national importance (s 6(f)) and embodies the relationship of Māori and their culture and traditions with their ancestral lands, water, sites, wāhi tapu, and other taonga (s 6(e)). In fairness

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[163] Regional Council, opening and closing submissions at [140] and [37] respectively.
[164] Sycamore, EiC as s 274 party in opposition at [59]-[68].
[165] Transcript (Sycamore) at 555.
[166] Archaeological sites are defined under the Heritage New Zealand Pouhere Taonga Act 2014 in relation to buildings or structures associated with human activity that occurred before 1900.
[167] Resource Management Act 1991, s 2.

to Federated Farmer's planning witness, he conceded the omission of historic heritage from the objective.[168]

[150] We approve the relief sought by Heritage NZ and Ngā Rūnanga. The inclusion of historic heritage gives effect to RPS objectives and policies on the same subject-matter.[169] The proposed plan does not identify the values of the region's historic heritage and it may be these sites are too numerous for their values to be comprehensively recorded. In saying that, many of the historic heritage sites are identified in the plan as Statutory Acknowledgement Areas of importance to Ngā Rūnanga.

[151] The section in the plan dealing with the significant resource management issues in the region is to be amended to identify issues arising in relation to historic heritage and where information identifying those sites may be held.

Recreational values

[152] Finally, there was controversy between the parties over an appeal to include "recreational values" in the objective. The proposed safeguarding of recreational values goes considerably further than what is contemplated under RPS Objective and Policy WQUAN.1 and Policy WQUAN.7.[170] All interested parties agree, as do we, that the quantity of surface water should be managed so that human health for recreation (at least) is safeguarded. As noted elsewhere, human health for recreation is a compulsory national value under the NPS-FM:[171]

> In a healthy waterbody, people are able to connect with the water through a range of activities such as swimming, waka, boating, fishing, mahinga kai and water-skiing, in a range of different flows.

The NPS-FM goes on to describe matters to take into account in regard to a healthy waterbody.

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[168] Transcript (Sycamore) at 555-556.

[169] RPS Objective HH.1, Policy HH.2 and Method HH.1 that state: "Historic heritage values are identified and protected from inappropriate subdivision, use and development" (Objective HH.1) and "Avoid, mitigate and, where appropriate, remedy adverse effects on historic heritage values from inappropriate subdivision, use and development. On a case-by-case basis take into account factors such as the significance of heritage values, financial cost and technical feasibility when making decisions relating to the protection of historic heritage." (Policy HH.2).

[170] McCallum-Clark, EiC at [83].

[171] NPS-FM, Appendix 1.

[153] The primary sector submitted that human health for recreation is *primarily* a water quality matter rather than a water quantity matter. In our experience water quantity and water quality interact to determine the health of the waterbody with potential consequential effects for human health when people recreate in water. The interaction and consequential environmental effects exist along a continuum. Some water quality effects may exceed the attributes that support human health for recreation (e.g. *E.coli*) without over use of the water resource. Other water quality effects are the consequence of changes both to water quality and water quantity.

[154] The primary sector proposes a new sub-clause linking water quality and quantity. While we have not had the benefit of detailed submissions from other parties on this matter, we see merit in the amendment, lest water quality and water quantity be managed in separate 'silos' under this plan. The reference to "freshwater quality objectives" in the proposed sub-clause makes clear the integration of quantity and quality occurs under the FMU processes. The new sub-clause would read:

> The quantity of water in surface waterbodies is managed so that:
>
> > [sub-clause] there is integration with the freshwater quality objectives and values (including human health for recreation).

[155] Forest and Bird does not support the proposed amendment as it would not provide for recreational values of water. Forest and Bird interprets "human health for recreation" in the NPS-FM as being concerned with both the effects on human health as a consequence of exposure to contaminants as well as people's ability to connect with water through a range of activities in a range of different flows.[172] We disagree with Forest and Bird that this compulsory national value can be interpreted as safeguarding recreational values *per se*. The interpretation is not directly supported by the NPS-FM matters local authorities are required to take into account in assessing a healthy waterbody for human use (e.g. pathogens, clarity, deposited sediments)[173] or by the numeric or narrative attribute states for "human health for recreation" in the different freshwater bodies.

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[172] Forest and Bird, closing submissions at [34]; Transcript (Gepp) at 1767.

[173] The NPS-FM sets out the matters to be taken into account for human health for recreation in Appendix 1.

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Outcome

[156] Subject to parties making further submissions on sub-clause (a) and (b), the following drafting has provisional approval (changes shown):

> The quantity of water in surface waterbodies is managed so that:
>
> (a) ~~the~~ aquatic ecosystem health, life-supporting capacity,[174] the values of outstanding natural features and landscapes, the natural character and historic heritage values of waterbodies and their margins are safeguarded;
>
> (b) there is integration with the freshwater quality objectives ~~and values~~[175] (including the safeguarding of human health for recreation); and
>
> (c) provided that (a) and (b) are met, surface water is sustainably managed~~,~~ in accordance with Appendix K to support the reasonable needs of people and communities to provide for their economic, social and cultural wellbeing.[176]

[157] We will make directions seeking further submissions on:

(i) the meaning of "life-supporting capacity" in sub-clause (a);

(ii) support for proposed sub-clause (b).

[174] Seeking further submissions on meaning of life-supporting capacity.

[175] Submissions are sought on sub-clause (b) introduced by the primary producers. "Values" does not appear to imply "freshwater quality objectives".

[176] Reordered in line with Objective 2.

Objective 9B

Objective 9B (DV)

The effective development, operation, maintenance and upgrading of Southland's regionally significant, nationally significant and critical infrastructure is enabled.

[158] The above objective is one of two concerning infrastructure.

[159] Fish and Game, Forest and Bird and Ngā Rūnanga have appealed Objective 9B. A large number of parties have joined the appeals pursuant to s 274 of the Act.

Submissions on Objective 9B

[160] There were no objectives relating to infrastructure in the notified plan. In response to submissions by three territorial authorities the Hearing Panel recommended a new objective enabling the effective development of infrastructure. While labelled Objective 9B, the outcomes for infrastructure are not part of the water quantity sequence in Objective 9 and 9A (DV).

[161] It was the Hearing Panel's view that the new objective would give effect to Objectives A4 and B5 of the NPS-FM by better enabling communities to provide for their economic wellbeing, including through the development of productive economic opportunities, and thereby also give effect to the purpose of the Act.[177]

[162] While the Regional Council's functions include the strategic integration of infrastructure and land use (s 30(1)(gb)),[178] the pSWLP does not identify any issue arising in relation to infrastructure.

[163] For the territorial authorities the provision of infrastructure was extensively canvassed in evidence and without detracting from anything that their witnesses said, the salient points made were as follows:

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177 Report and Recommendation of the Hearing Panel, dated 29 January 2018 at [141].

178 This is wrongly referred to in the pSWLP at 11 as the "the integration of strategic infrastructure and land use."

(a) infrastructure provides for the health and wellbeing of people as well as environmental protection and enables economic development across the region;[179]

(b) the operation and upgrade of community water supply, wastewater and stormwater is necessarily continuous;[180]

(c) the community's expected level of service has changed since the majority of the infrastructure was constructed, including with regards to impact on the environment;[181]

(d) each District Council holds consents for water supply, wastewater and stormwater schemes and drainage networks. Those consents authorise the discharge of wastewater to land, streams and rivers and also to the coastal marine area;[182]

(e) well managed, maintained and upgraded infrastructure is the cornerstone of any thriving healthy community and will be required for as long as that community remains.[183] That said, the infrastructure within the districts the territorial authorities manage is aging and in need of replacement;[184]

(f) it is important that the consenting pathway enable consents for essential infrastructure to be obtained at minimum cost and for maximum duration.[185]

[164] The territorial authorities support Objective 9B (DV) as the objective gives effect to RPS Objective INF.1 and Policies INF.1 to INF.4.[186] By "enabled", they submit the plan makes clear that the development, maintenance, upgrade and ongoing operation of infrastructure is expected.[187] Indeed, one method in the RPS is to include objectives and other provisions in regional plans that *enable* infrastructure (Method INF.1). The territorial authorities say the non-complying activity status of its infrastructure activities is incongruent with this enabling method.

[165] The Director-General of Conservation, accepting the importance of this infrastructure to the region, does not support the enablement of activities *per se*. The

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179 Evans EiC at [33].
180 Evans EiC at [8] and [27]: Loan EiC at [5] and [16].
181 Evans EiC at [31(c)].
182 Evans EiC at [19]; Bayliss EiC at [21], [26] and [36]; Loan EiC at [9].
183 Evans EiC at [30]; Bayliss EiC at [39]; Loan EiC at [16].
184 Evans EiC at [27]; Loan EiC at [18]; Bayliss EiC at [51]-[56].
185 Evans EiC at [41]; Bayliss EiC at [99]-[106].
186 Territorial authorities, opening submissions at [7].
187 Territorial authorities, closing submissions at [31].

Director-General of Conservation submits that an enabling element directed towards infrastructure activities does not sit comfortably within a regional plan whose outcomes are otherwise addressing sustainable use, development and protection of land and water resources in the Southland Region.[188] The Director-General of Conservation would amend the objective focusing on the "effective" development of infrastructure:

> Recognise Southland's regionally significant, nationally significant and critical infrastructure and provide for their effective development, operation, maintenance and upgrading.

[166] Likewise, Forest and Bird submitted that infrastructure will be appropriate where it provides for hauora and is not contrary to the water quality and quantity objectives of the plan.[189] They say an objective stating that infrastructure is to be provided for sets an expectation that it should be able to continue in the future, which they consider appropriate. But, they submit, that in providing for hauora, the objective needs to include "managing adverse effects within limits" to avoid a potential conflict between the objectives, as follows:

> The effective development operation, maintenance and upgrading of Southland's regionally and nationally significant infrastructure[190] is provided for while managing adverse effects within limits.

Alternatively, amend Objective 9B as follows:

> The importance of Southland's regionally and nationally significant infrastructure is recognised, and its development, operation, maintenance and upgrading is provided for sustainably and effectively.

[167] Ngā Rūnanga, which supports the Director-General of Conservation's amendments, is concerned that the territorial authorities' support for the enabling objective is simply to secure the least restrictive activity status when seeking resource consent.[191]

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188 Director-General of Conservation, closing submissions at [43].

189 Forest and Bird, closing submissions at [45]. The submission actually talks about a policy to provide for infrastructure, and not an objective. We think this is an error.

190 Forest and Bird omit reference to "critical infrastructure" as this is included in the RPS definition of "regionally significant infrastructure".

191 Ngā Rūnanga, closing submissions at [61]–[64]; Transcript (Kyle) at 1268-1271.

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[168] The benefits of infrastructure notwithstanding, the respondent was also concerned that the territorial authorities' position may be that infrastructure should be enabled without limitation as to effects.[192] While the Regional Council recognises those benefits, it says the development of infrastructure should be "appropriately" provided for.[193] The Regional Council's planning witness gave evidence that "enable" would be interpreted as giving strong direction that – without "limitation", the intended outcome was the development, operation, maintenance and upgrade of infrastructure and this outcome would be given greater weight than the plan's other objectives.[194] In furtherance of this, the Regional Council proposed that effective development of infrastructure be "appropriately provided for" by that, the Regional Council means that it would provide for infrastructure in the policies and rule framework in a way that gives effect to the other objectives in the pSWLP.[195] The objective, as amended by the Regional Council, would read:

> The benefits of regionally or nationally significant and critical infrastructure are recognised and its effective development, operation, maintenance and upgrade are appropriately provided for.

[169] That said, it should be emphasised that none of the parties disputed the importance of infrastructure to the region.

RPS

[170] There are four issues pertaining to infrastructure identified in the RPS. They are:

> **Issue INF.1**
> Land use change and development is not always integrated with local, regional and national infrastructure and this can affect the communities' social and economic wellbeing or health and safety.
>
> **Issue INF.2**
> The impact of climate change and natural hazard events are a risk to critical infrastructure.

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192 Regional Council, closing submissions at [42] and [46].
193 Regional Council, closing submissions at [46].
194 Transcript (McCallum-Clark) at 357.
195 McCallum-Clark, Supplementary at [17].

Issue INF.3

The provision of infrastructure and associated activities are important to enable people and communities to provide for their social, economic and cultural wellbeing, but where not appropriately managed, can result in significant adverse effects on land use and the environment.

Issue INF.4

Subdivision, use and development can result in adverse effects, including reverse sensitivity effects, on existing or planned infrastructure development and activities.

[171] Responding to those issues, Objective INF.1 is concerned not only that infrastructure is secure and operates efficiently, but that it is "appropriately integrated with land use activities and the environment". We note, by way of explanation the RPS states that recognition of the importance of significant infrastructure will lead to greater weight being given to its requirements.[196]

[172] The benefits derived from infrastructure are to be recognised and provision is to be made for their development (Policy INF.1)[197] and where practicable, the adverse effects of infrastructure are to be avoided, remedied or mitigated (Policy INF.2). Importantly, the policy goes onto identify considerations that are relevant when determining whether a measure addressing effects is practicable and, in this way, the requirements of infrastructure are given greater weight. Given this, we would not accept a submission that the RPS prioritises or gives greater weight to development of infrastructure over other environmental outcomes. If a measure to address the effects of infrastructure is practicable then it must be taken. Whether that measure is to avoid, remedy or mitigate an adverse effect is, we understand, the subject matter of other policy.

[173] The RPS has other methods to be used to implement its policies (s 62(1)(e)). In furtherance of the above, there is a method directing the Regional Council to include in its regional plans objectives, policies and methods that enable infrastructure development, "whilst ensuring the management of any associated adverse effects" (Method INF.1).

[174] The RPS provisions for renewable energy are also relevant. Objective ENG.1 and Policy ENG.2 do not place lesser weight on environmental outcomes. Policy ENG.2

[196] RPS, 15.2 Objective, Objective INF.1 Explanation/Principal Reasons at 172.
[197] Policy and Method INF.1 each refer to 'development' as well as 'maintenance, upgrade and operation'.

states development of renewables is to be provided for "while" – we interpret as meaning at the same time – appropriately addressing adverse effects.

Discussion

[175] It is not the case that the territorial authorities intend developing infrastructure without having regard to the effects of their activities. Indeed, their infrastructure witnesses[198] talked about the communities changing expectations as to the level of services to be provided and the impact of those services on the environment. Further their planning witness, Mr J Dunning, accepted that infrastructure may adversely affect the environment,[199] and that these effects require careful management.[200] Mr Dunning supported the "enabling" language of the objective because it provides stronger direction to the consent authority than the alternatives proffered by the other parties.[201] As he says, all other objectives will likely be relevant to an infrastructure proposal and the consent authority is to have regard to them. However, we can find no support from the RPS that environmental outcomes should necessarily be given lessor weight than enabling infrastructure. To the contrary, the RPS objective is for infrastructure to be, *inter alia*, secured and appropriately integrated with land use activities and the environment. Where practicable, the adverse effects of infrastructure are to be avoided, remedied or mitigated (Policy INF.2) and indeed the latter is provided for under pSWLP Policies 26 and 26A.

[176] This objective is a good illustration of the different approaches to plan drafting as between the planning witnesses, i.e. whether objectives state outcomes or whether outcomes are left to be elaborated upon in the policies and rules.[202] For example, Ms Whyte, giving planning evidence for Meridian, could not conceive of an enabling objective without limitation. Rather, the extent to which the activity is enabled depends on the policies and rules. Whereas it is our view – and the view of some other planners – that it is the function of an objective to clearly state what is to be achieved through a plan, preferably in response to an identified issue. That said, because she does not support

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[198] Messrs Bayliss, Evans and Loan.
[199] Transcript (Dunning) at 719.
[200] Transcript (Dunning) at 701 and at 719.
[201] Transcript (Dunning) at 720. See also discussion in Transcript about the need to have regard to pSWLP as a whole at 721-722 and 735-736.
[202] Transcript (Whyte) at 1155.

the unqualified enablement of infrastructure, Ms Whyte had no difficulty with the proposition that the objective should itself be qualified.[203]

[177] We did not find the NPS-FM Objectives A4 and B5 to be particularly relevant as these apply where limits are set and we were not addressed on how the RPS responds to Te Mana o te Wai (bearing in mind the RPS was promulgated before the NPS-FM 2017 amendments).

[178] In principle, we have no difficulty with the proposition that the pSWLP may recognise and provide for infrastructure by enabling the same. However by not addressing infrastructure's integration with land use activities and the environment, Objective 9B (DV) does not give full effect to Objective INF.1.

[179] If the plan, properly constructed, is interpreted and applied in a manner that gives effect to Te Mana o te Wai and is implemented in accordance with ki uta ki tai, there may be no issue with the decision-version objective. If that is not the correct interpretation, the outcomes sought by Forest and Bird and the Director-General of Conservation respond to the issues identified in the RPS and better give effect to the RPS than does Objective 9B (DV). We would reorder Forest and Bird's proposed amendment as follows:[204]

> The importance of Southland's regionally and nationally significant infrastructure is recognised and its sustainable and effective development, operation, maintenance and upgrading enabled.

[180] We intend the meaning of "sustainable and effective" to be both the infrastructure <u>and</u> the manner of its development relative to the environment. If development is neither sustainable nor effective, it will be contrary to this objective.

[203] Transcript (Whyte) at 1156.

[204] Forest and Bird omit "critical infrastructure" from the objective.

Definition of terms

[181] The objective contains a number of defined terms for infrastructure. To assist in explaining the potential scope of the provision we set out the meaning of those terms next:

(a) "regionally significant infrastructure" is not defined by the pSWLP. The RPS defines "regionally significant infrastructure" as meaning "[i]nfrastructure in the region which contributes to the wellbeing and health and safety of the people and communities of the region, and includes all critical infrastructure;

(b) "nationally significant infrastructure" means infrastructure which contributes to the development and wellbeing and health and safety of people and communities extending beyond the region; and

(c) "critical infrastructure" means infrastructure that provides services which, if interrupted, would have a significant effect on the wellbeing and health and safety of people and communities and would require reinstatement, and includes all strategic facilities. Note: "strategic facilities" are not defined by the pSWLP.

[182] If the plan was amended to include the definition of "regionally significant infrastructure" the objective could be simplified by omitting critical infrastructure. This is a matter on which we seek submissions.

Outcome

[183] We will direct the parties to file submissions that:

(i) identify the resource management issues addressed by this objective;

(ii) respond to the court's proposition that properly constructed, Objective 9B is to be interpreted and applied in a manner that gives effect to Te Mana o te Wai and can be implemented in accordance with ki uta ki tai; and

(iii) comment on the court's proposed wording for Objective 9B at paragraph [179] including the amending of the pSWLP to include the term "regionally significant infrastructure" and consequential deletion of "critical infrastructure" from the objective.

Objective 10

Objective 10 (notified version)

The national importance of the existing Manapōuri Power Scheme in the Waiau catchment is provided for, and recognised in any resulting flow and level regime.

Objective 10 (DV)

The national importance of existing hydro-electric generation schemes, including the Manapōuri hydro-electric generation scheme in the Waiau catchment, is provided for, recognised in any resulting flow and level regime, and their structures are considered as part of the existing environment.

[184] For ease of reference we have set out above both the notified version and decision-version of the objective, noting that Objective 10 (DV) has two parts:

(a) a requirement that the national importance of existing hydro-electric generation schemes are provided for, and recognised in any resulting flow and level regime; and

(b) a direction that the structures of existing hydro-electric generation schemes are considered as part of the existing environment.

[185] Whereas the notified version of the objective referred only to the Manapōuri hydro-electric generation scheme, the Hearing Panel amended the scope of the provision to include all hydro-electric generation schemes. Meridian submitted that the scale and significance of the Manapōuri hydro-electric generation scheme ("Scheme") is such that it warrants particular provision, and that this follows from the RPS.[205] Other renewable energy in the catchment, such as the Lake Monowai hydro-electric scheme, would come within Objective 9B.[206]

[205] Meridian, opening submission [18b].
[206] Meridian, closing submissions [10].

[186] Meridian also sought that a new objective, Objective X, be included in the plan as follows:

> **Objective X**
>
> Recognise and make provision for the national significance of renewable electricity generation activities.

[187] We understand Meridian does not pursue Objective X, if Objective 9B is retained in the plan.[207] We have earlier confirmed the retention of Objective 9B.

[188] Our decision proceeds on the basis, therefore, that the scope of Objective 10 is limited to the Manapōuri hydro-electric generation scheme and secondly, that Meridian no longer pursues Objective X.

The issues

[189] Of all the objectives before us Objective 10 generated the greatest level of uncertainty for the parties. Despite the evidence presented by Meridian and by the other parties our sense is that no party has a proper understanding of the outcomes being pursued under this provision.

[190] Part of the activities that make up the Scheme are enabled by s 4 of the Manapōuri Te Anau Development Act 1963 (MTADA) which – amongst other matters – provides the state enterprise with full power and authority to raise or lower the levels of:

> (i) Lakes Manapōuri and Te Anau;
> (ii) the Waiau and Mararoa Rivers and their tributaries; and
> (iii) all other rivers flowing into the said lakes and their tributaries.

Further, the MTADA authorises the Scheme's land use activities for all purposes (albeit the Building Act 2004 still applies).[208] Unless otherwise provided for, MTADA does not extend to activities requiring resource consent under ss 12, 14 or 15 RMA.

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[207] Whyte, in response to s 274 parties at [11(d)].

[208] *Meridian Energy Ltd v Southland District Council* [2014] NZHC 3178 at [38] and [45].

[191] In general terms, we understand Meridian to be seeking the greatest level of flexibility under the RMA to generate hydro-electricity.[209] By *providing* for something in the objective – specifically, the opportunity for Scheme enhancement – Meridian is seeking that appropriately worded policies be included in the plan. Whereas, other parties seek clarity in the objective for the outcomes for natural and physical resources were the Scheme to be enhanced. This basic difference in plan drafting and interpretation underlies their dispute.

[192] We will set out the issues as we understand them to be.

Issue 1: what outcome is Meridian seeking through amending the objective to provide that the Scheme[210] is considered part of the environment?

[193] Meridian appealed Objective 10 being concerned, *inter alia*, that the provision failed to adequately recognise the importance of allowing for enhancement of the scheme where adverse effects are able to be appropriately managed in a way that gives effect to the RPS and the NPSREG.[211]

[194] In the notice of appeal, Meridian sought to amend Objective 10 as follows:[212]

> The national importance of the existing ~~hydro-electric generation schemes, including the~~ Manapōuri hydro-electric generation scheme in the Waiau catchment~~,~~ is provided for, ~~recognised in any resulting flow and level regime, and opportunities for enhancement of the scheme are provided for where the effects can be appropriately managed;~~ and
>
> 1. is recognised in any resulting flow and level regime, and
> 2. the Scheme and its components and activities is considered as part of the existing environment, including that water takes, use, diversions and discharges are an integral part of the scheme; and
> 3. allows for enhancement of the scheme where the effects of these can be appropriately managed.

[195] Sub-clause 2's recognition of the Scheme as part of the existing environment, was hotly contested. Counsel for Meridian said the motivation for the amendment was

[209] Transcript (Whyte) at 1165.

[210] When referred to in the context of Objective 10, "Scheme" is referred to in its widest sense and includes all lawfully established activities whether authorised under the RMA, MTADA or by any other legislative instrument.

[211] Notice of appeal at [9].

[212] Whyte, in response to s 274 parties at [60].

because his client "... does not want to find itself in the position where it is asked to compare the effects of the ongoing operation of the [Scheme] against a fictional and uncertain pre-Scheme environment"[213]. Furthermore, many aspects of the Scheme are authorised under MTADA and not the RMA, and the interaction between activities authorised under the different legislation means assessing applications for resource consent (coastal, discharge or water permits)[214] on a with and without the Scheme basis, is "unrealistic, fanciful, and speculative".[215] Counsel for Meridian, Mr S Christensen, submitted:[216]

> ... it is entirely unrealistic and artificial to expect Meridian or the council to proceed in the reconsenting on the basis that you have to imagine what the world would be like if the scheme wasn't there and against that, to assess the effects. So in other words, [to] create an artificial environment and then overlay what's already there on top of that is fanciful and unrealistic.

[196] Mr S Christensen's 'starting point' for what constitutes the existing environment when assessing a future consent application is "the environment as it exists at the time replacement consents are considered, including the effects of activities undertaken pursuant to existing water and discharge permits".[217]

[197] Ms Whyte, giving planning evidence on behalf of Meridian, drew a distinction between the Scheme and the environment. Her view of the objective was more nuanced than counsel. We understand that it was <u>not</u> her purpose, in supporting amendments to the objective, for the effects of the Scheme – including the exercise of any consent – to be deemed part of the environment. Rather her purpose was simply to describe the Scheme, i.e. that it is a diversionary scheme authorised by certain permits etc. The actual volume or flow of water consented is immaterial to the description of the Scheme.[218]

[198] In supporting the amendments Ms Whyte did not want to – as she put it:[219]

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[213] Meridian, closing submissions at [45].
[214] Meridian, opening submissions at [10].
[215] Meridian, closing submissions at [48].
[216] Transcript (Christensen) at 1920.
[217] Meridian, closing submissions at [45].
[218] Transcript (Whyte) at 1160-1161. Noting that for other purposes under the Act, while the Scheme is operating under existing authorisations, the effects of its activities on the environment would be considered part of the existing environment (see Transcript (Whyte) at 1162).
[219] Transcript (Whyte) at 1162. See also transcript (Whyte) at 1161.

> ... convolute this objective ... at the time of reconsenting or at the time of anything else, the fact and circumstances around the existing environment may be different or may have changed and so my objective is to ensure that that can be considered at the appropriate time...

[199] It was her opinion that the effects of the take and discharge of water need to be considered on reconsenting, but that the options available to respond to effects may depend on what the rules say.[220]

[200] During the course of the hearing Meridian proposed alternative relief, the final iteration being:[221]

> The national importance of the existing Manapōuri hydro-electric generation scheme in the Waiau catchment is provided for, recognised in any resulting flow and level regime, and opportunities for enhancement of the scheme are provided for where the effects can be appropriately managed.

[201] The key difference between this iteration and the relief sought in the notice of appeal, is that the physical components of the Scheme together with coastal, discharge and water permits are no longer "considered as part of the existing environment". We understand this relief was advanced by way of alternative to the notice of appeal.[222]

Discussion

[202] Meridian's position is that any evaluation of the environment without the Scheme is neither realistic nor appropriate. If Meridian is correct, it would follow that there is no need to include the scheme as part of the existing environment, as it is ineluctable that it is.

[203] This was not the view of the Hearing Panel who found that the structures only, are part of the environment and recommended they should be included in the objective. Evidently, this was to give better effect to the NPS REG and the RPS. They did not consider it appropriate to refer to the Scheme takes and discharges in Objective 10 as those activities will be revisited when new consents are applied for in 2031.[223]

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[220] Transcript (Whyte) at 1163.
[221] Exhibit 1.
[222] See discussion in Meridian, closing submissions at [11].
[223] Report and Recommendations of the Panel, 29 January 2018 at [143].

[204] We recall Justice Fogarty has cautioned practitioners and judges against the use of the term "existing environment" as it is not a term appearing in the RMA. He regarded the term as a "shorthand" reference certain Court of Appeal decisions about the range of activities to be taken into account when examining any actual or potential effects of allowing the activity that is the subject of an application. He disagreed with the application of one of those decisions – *Hawthorn*[224] to every case as if were statute; per *Royal Forest and Bird Protection Society of New Zealand Inc v Buller District Council & ors* [2013] NZHC 1324, (2013) 18 ELRNZ 540, [2013] NZRMA 275 at [13]–[14] and [23].

[205] We gained no real sense of how Meridian would apply "existing environment" in any future FMU process or in the reconsenting of its activities or applications to consent new or varied activities.

[206] We agree with the Court of Appeal's reflection in *Far North District Council v Carrington Farms Ltd* [2013] NZCA 221 at [80] that the "environment" is not a static concept and "[it] is constantly changing, often as a result of implementation of resource consents for other activities in and around the site and cannot be viewed in isolation from all operative extraneous factors". This, of course, is the point made by Ms Whyte in her evidence.

[207] "Environment" is defined in s 2 of the RMA and includes physical resources and the term is used extensively throughout the Act's provisions. It may well be that the Scheme's structures are properly regarded as part of the environment in the sense that they are physical resources.[225] The linking of the Scheme to the "existing environment" in Objective 10 could, however, be interpreted as extending the meaning of "environment" in the administration of the pSWLP. If that were to happen it may have unintended or unforeseen consequences. Several parties addressed the court on this potential.

[208] Meridian does not support limited reference in the objective to its structures (only) being part of the existing environment.[226] It submits the objective should either be silent as the existing environment or it should specify all parts of the Scheme as comprising part of the existing environment.[227] Given our uncertainty as to the meaning and

[224] *Queenstown Lakes District Council v Hawthorn Estate Ltd* [2006] NZRMA 424.
[225] Section 2 RMA.
[226] Meridian, closing submissions at [11].
[227] Meridian, closing submissions at [11].

application of the "existing environment", we would approve the former outcome and amend Objective 10 (DV) by deleting, "and their structures are considered as part of the existing environment".

Issue 2: what is to be "enhanced" – is it the Scheme, the Scheme's electricity generating capacity or something else?

[209] The Hearing Panel did not consider it necessary to include any provision of enhancement opportunities.

[210] Meridian disagrees with the Hearing Panel for the reasons outlined in the evidence of Ms Whyte. She acknowledges that water within the Waiau catchment is fully allocated. If enhancement of the Scheme requires resource consent(s) to take, dam, divert or use water from the catchment, the enhancement would be assessed as a non-complying activity. This activity status, in combination with the objectives and policies addressing over-allocation of water, would render the obtaining of such consents challenging. From Meridian's perspective it needs to be in a position to respond to changes in circumstance, including future hydrological conditions.

[211] We were told enhancement could:[228]

- allow the Scheme to make better or more efficient use of its available water;
- provide greater flexibility in the storage of water; but not necessarily make more water available for generation;
- result in a change in the amount of water used and also change the manner of resource use; but without necessarily increasing the amount of water taken.

Enhancement may also require new resource consents or a change or cancellation of one or more of the existing conditions under s 127 of the RMA. The relevant objective and policy framework in the pSWLP will be a consideration in any such application.[229]

[212] Ms Whyte set out the provisions of the RPS that support recognition of enhancement opportunities, as below:

[228] Transcript (Whyte) at 1164-1165.
[229] Whyte, in response to s 274 parties [29]-[33].

Objective ENG.3 – Generation and use of renewable energy
Generation and use of renewable energy resources is increased.

Objective ENG.4 – National significance
Recognise and make provision for the national significance of renewable electricity generation activities.

Policy ENG.2 – Benefits of renewable energy
Recognise and make provision for the development of renewable energy activities, and their benefits, which include:

- maintaining or increasing electricity generation capacity while avoiding, reducing or displacing greenhouse gas emissions;
- maintaining or increasing security of electricity supply at local, regional and national levels by diversifying the type and/or location of electricity generation;
- using renewable natural resources rather than finite resources;
- the reversibility of the adverse effects on the environment of some renewable electricity generation technologies;
- avoiding reliance on imported fuels for the purposes of generating electricity;

while appropriately addressing adverse effects.

Policy WQUAN.3 – regional plans
Recognise the finite nature of water resources and catchments and identify management regimes in accordance with the National Policy Statement for Freshwater Management 2014 that:

(a) provide for the freshwater objectives for surface water and groundwater that derive from flows and levels of water;

...

(h) recognise the need for availability of water to enable the Monowai and nationally significant Manapōuri hydro-electricity power generation activities in the Waiau catchment to continue, and be enhanced where over-allocation will not occur;

...

[213] Ms Whyte summarised Policy WQUAN.3(h) this way:[230]

> Clause (h) of this policy explicitly requires that the opportunity for the enhancement of the MPS generation activities on the basis that overallocation not occur be recognised.

[214] Ms Whyte explained that the "enhancement" and "upgrading" of the Scheme are different. Upgrading concerns changing physical *things* whereas enhancement relates to the resource itself and the way that is it used.[231] That interpretation makes sense if MTADA, not the RMA, authorises the use of land.

[215] Other salient points of evidence are accurately summarised by counsel for Aratiatia who we quote next:[232]

> Importantly, Meridian's witnesses agreed with the proposition that enhancement involves improvements to the efficiency and effectiveness of the Power Scheme but without increasing the water take.[233] Ms Whyte went on to agree that if a provision that enabled "enhancement" is to be addressed in an objective or policy it should be defined in that provision;[234] that a provision that enabled enhancement if no further allocation occurs would involve taking a precautionary approach pending knowledge as to what the true allocated state of the catchment is;[235] and that she would support that approach.[236]

Discussion

[216] It is not pedantry to observe that the subject matter or focus of Policy WQUAN.3(h) is on the need for water to be available for power generation – and not the Scheme *per se*. Water is to be available so that power generation activities can continue. Power generation activities may be enhanced where this does not result in over-allocation of water. Couched in the language of the NPS-FM, Policy WQUAN.3 is addressing FMU processes.

[217] Objective 10, as proposed to be amended by Meridian, becomes "... opportunities

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230 Whyte, in response to s 274 parties at [36].
231 Transcript (Whyte) at 1164-1165.
232 Aratiatia closing submissions at [4.20].
233 Transcript (Feierabend) at 1122 to 1123; Transcript (Whyte) at 1171-1172.
234 Transcript (Whyte) at 1173.
235 Transcript (Whyte) at 1173.
236 Transcript (Whyte) at 1173.

for enhancement of the scheme are provided for where the effects can be appropriately managed"[237] or "... and allows for enhancement of the scheme where the effects can be appropriately managed and overallocation does not result".[238]

[218] We wish to have more clarity around the ambit of this objective. Mr Feierabend's understanding is that Meridian intends Objective 10 be a "one stop shop". The purpose of the objective was to encapsulate all matters that would pertain to the Scheme, rather than also addressing the Scheme under Objective 9B.[239] By that we think he means that Objective 10 applies to activities requiring resource consent under the RMA, and not to activities – such as land use activities – authorised under the MTADA or under other legislative instruments. Inferentially the objective is limited to coastal, discharge and water permits granted under the RMA. Objective 9B does not apply to the Scheme, as Mr Feierabend interprets it.

[219] Meridian is to confirm whether, from its perspective, we have correctly understood Objectives 9B and 10 outlined in the previous paragraph. Secondly, Meridian will make clear what is "enhancement". The objective does not talk about the use of the water resource being, for example, to increase electricity generating capacity (RPS Objective ENG.3 and Policy ENG.2). Lack of clarity around what is meant by "opportunities for enhancement" caused confusion and uncertainty during the hearing.

[220] Recalling the first part of the objective which is that the national importance of the Manapōuri hydro-electric generation scheme is provided for and "recognised in any resulting flow and level regime", the pSWLP has a flow and level regime for the Waiau catchment in which the Scheme is situated.[240] The Waiau catchment is fully allocated. Mr S Christensen confirmed on behalf of his client, that it is not seeking to "step outside" the FMU processes[241] and that any application for future resource consent will be subject to the regime established under the FMU process.[242] If that is not the case then we tend towards the outcome advocated by the Regional Council and Ngā Rūnanga who caution against providing for an enhancement outcome where there is uncertainty over the

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[237] Whyte, in response to s 274 parties at [39] and Exhibit 1.
[238] Whyte, in response to s 274 parties at [41].
[239] Transcript (Feierabend) at 1144-1145.
[240] Transcript (Christensen) at 1917. The Waiau Catchment is fully allocated. While the pSWLP does not prohibit applications for water or discharge permits within a fully allocated catchment, an application for resource consent has the status of a non-complying activity.
[241] Transcript (Christensen) at 1917-1918.
[242] Transcript (Christensen) at 1917.

allocation of water.

[221] Finally, we are unclear by what yardstick the *appropriate* management of effects is to be judged if it is not Te Mana o te Wai, which we will come to shortly.

Issue 3: is its Meridian's position that under the pSWLP, the Scheme is to acknowledge and protect the mauri of water?

[222] The court put to Meridian's counsel, Mr S Christensen, Ngā Rūnanga's submission that Te Mana o te Wai was a new paradigm or way of approaching planning for water resources and that the court is to bear in mind Te Mana to te Wai when evaluating each objective and indeed all of the plan provisions. Mr Christensen agreed, although in his submission that did not "translate though to needing to say something different in the objectives from what's there now".[243]

[223] Acknowledging Te Mana o te Wai 's "broad and overarching nature" he said the "paradigm is going to be necessarily reflected through the rest of the plan". More particularly, Te Mana o te Wai is implemented through the policies, as it is the policies that are to give effect to the objectives.[244] The Regional Council has considered and recognised Te Mana o te Wai in the management of fresh water (Objective AA1 and Policy AA1), but, Mr Christensen submits, the design of the plan is not to rank objectives. Instead Te Mana o te Wai fits alongside all other objectives and – as we have noted – is to be reflected *appropriately* through the provisions of the plan.[245]

[224] Constructing the plan's scheme this way bears one of two implications. On the one hand, Te Mana o te Wai – while always relevant – is only one of 18 objectives to be considered, weighed and balanced against the benefits of renewable energy resources and the national significance of renewable electricity generation activities (RPS Objectives ENG.3 and ENG.4). In which case, the proposed amendment would likely support an interpretation giving relative greater weight to Scheme enhancement than the acknowledgement and protection of the mauri of water.[246] On the other hand, Meridian may be saying the policies are to articulate how any enhancement of the Scheme will acknowledge and protect the mauri of the waterbodies. For reasons that we have given

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[243] Transcript (Christensen) at 1934.
[244] Transcript (Christensen) at 1934.
[245] Transcript (Christensen) at 1936-1937. Meridian, closing submissions at [6].
[246] Waiau Rivercare Group Ltd, closing submissions at [12].

earlier, this is not the same as saying that the effects will be *appropriately managed* or will *be avoided, remedied or mitigated*. Rather, within the allocative regime, the needs of water are to be at the forefront of all discussions and decisions on fresh water.

Outcome

[225] We will direct Meridian to file submissions and evidence in response to the court's discussion above and also to address directly the following matters:

(a) with reference to the outcomes sought under Objective 10, is the opportunity sought to increase electricity generation capacity by using water more efficiently or effectively?

(b) is an outcome of using water more efficiently or effectively that the mauri of the water is acknowledged and protected?

(c) does Objective 9B apply to any of Meridian's activities and if so which?

[226] As recorded above at paragraph [208], we amend Objective 10 (DV) by deleting "and their structures are considered as part of the existing environment".

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Objectives 13, 13A and 13B

Objective 13 (DV)

Enable the use and development of land and soils to support the economic, social, and cultural wellbeing of the region.

Objective 13A (DV)

The quantity, quality and structure of soil resources are not irreversibly degraded through land use activities or discharges to land.

Objective 13B (DV)

The discharges of contaminants to land or water that have significant or cumulative adverse effects on human health are avoided.

[227] The above objectives concern the outcomes of land and soil use. Together with water, land is also an enabler of economic, social and cultural wellbeing (Objective 2).

[228] As notified, the objective was contained in a single provision and the use of land and soils was subject to an important proviso controlling when those resources could be used. The Hearing Panel recommended dividing the objective into three separate provisions and in the course of doing so lost the proviso.[247] While we may have overlooked the same, again we could not find the Hearing Panel's reasons for recommending the change to the notified version of Objective 13. At the conclusion of the hearing all parties proposed, and we agree, to reinstate the proviso and have the three objectives remerged.

[229] We address next three specific issues arising in relation to the wording of the remerged objective.

Soil Resources (proposed sub-clause (a))

[230] This sub-clause addresses the quantity, quality and structure of soil resources. All parties agree the soil resource should not be irreversibly degraded by land use or

[247] The objective commenced "Enable the use and development of land and soils, provided".

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discharges. We find this outcome well-stated, and not needing of any amplification as proposed by Forest and Bird, Fish and Game and Heritage NZ.

[231] We approve the wording tendered by the Regional Council and others:

> (a) the quantity, quality and structure of soil resources are not irreversibly degraded through land use activities or discharges to land; and

Human Health (proposed sub-clause (b))

[232] Objective 13B (notified version) provides that significant or cumulative adverse effects on human health are to be avoided.

[233] The parties proposed several variations of this provision, and the version that finds favour with the court is as follows:

> (b) the health of people and communities is safeguarded from the adverse effects of discharges of contaminants to land or water; and

[234] While the Regional Council and territorial authorities preferred wording couched in the language of effects, the question is not whether the discharge(s) will have a more than minor effect but what is the *probability* of a discharge occurring and the *consequences* to human health were the discharge to occur. The determination of this follows a risk-based assessment. The term "safeguard" is an appropriate standard against which the acceptability of risk can be measured.[248]

[235] We agree with the Regional Council that the clause should not be limited to the health of people and communities as they may be affected by contact with fresh water.[249] The adverse health effects may be experienced through discharges to both land and water.[250]

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[248] Forest and Bird, closing submissions at [50]-[51].
[249] Sub-clause (b) as proposed to be amended by the primary sector.
[250] Regional Council, closing submissions at [70].

Safeguarding of ecosystems (proposed sub-clause (c))

[236] All parties agree to reinstate provision for the safeguarding of ecosystems, amended to refer to "indigenous biological diversity" as per s 30(1)(ga) of the Act.

[237] Fish and Game and Forest and Bird propose a new sub-clause to the effect that adverse effects on ecosystems are to be avoided, remedied or mitigated to ensure that ecosystem values are safeguarded or enhanced. The phrase "avoid, remedy or mitigate" is an unnecessary adjunct to the direction that ecosystems are to be safeguarded.[251] How ecosystems are safeguarded is/should be the subject matter of policy.

[238] We approve the wording preferred by the other parties:

> Ecosystems (including indigenous biological diversity and integrity of habitats), are safeguarded.

A chapeau and proposed sub-clause (d)

[239] The Hearing Panel recommended the deletion of Objective 13(c) (notified version). This provision made the use of land and soil contingent upon the maintenance or enhancement of ecosystems, amenity values, cultural values and historic heritage values.[252] Forest and Bird, Fish and Game, and Heritage NZ seek reinstatement of the provision as sub-clause (d) expanding the same to include recreational values. The relief they seek follows:[253]

> Enable the use and development of land and soils, provided:
>
> a) ...
>
> b) ...
>
> c) ...
>
> d) adverse effects on amenity values, recreation [sic] values, cultural values and historic heritage values are avoided, remedied or mitigated to ensure these values are maintained or enhanced.

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[251] See Transcript (Farrell) at 878–888, where their planning witness also agreed the phrase adds an unnecessary layer of complexity that could be avoided.

[252] Objective 13(c) of the pSWLP as notified.

[253] Forest and Bird, Fish and Game and Heritage NZ.

[240] The other parties take a very different tack. They propose to refer to recreational opportunities and historic heritage (only) as aspects of social and cultural wellbeing in a chapeau to the objective. Under this formulation, the maintenance or enhancement of recreational or historic heritage values are not outcomes *per se* but aspects of social and cultural wellbeing which land and soil use are to support. No mention is made of amenity or cultural values. They propose the following:[254]

> Enable the use and development of land and soils to support the economic, social (including through recreation) and cultural (including through recognition of historic heritage) wellbeing of the region provided that:

Or:

> Enable the use and development of land and soils to support the economic, social and cultural wellbeing of the region (including recreational opportunities and historic heritage) provided that: [255]

[241] The evidence raised the following issues:

(a) whether the use of land and soil is contingent on maintaining an existing level of amenity[256] or if the maintenance of amenity is an outcome of the use and development of land and soils; and

(b) if maintenance of amenity is an outcome of use and development, is the "support" for this in the objective's chapeau sufficiently clear as to the desired outcome?

The two issues are addressed in the discussion following.

[242] The Regional Council's concerns over the reinstatement of the deleted sub-clause were not clearly articulated except in cross-examination and we draw principally on that. Counsel for the Regional Council put to two planning witnesses supporting the reinstatement of the deleted sub-clause, that the word "provided" means amenity values

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[254] Regional Council and Ngā Rūnanga.

[255] Primary Sector and the Director-General of Conservation.

[256] For brevity of expression, we refer to "amenity" meaning "amenity values, recreational values, cultural values and historic heritage values.

(etc.) would be "prioritised" ahead of the use of land and soils.[257] Counsel questioned Ms Davidson, who gave planning evidence on behalf of Ngā Rūnanga, this way:[258]

> Q. Was it your intention in seeking to include those values in your clause (d) that they were to be elevated above the use of land and soils so they were to be dealt with first as a matter of priority?
>
> A. No because I only sought them to be avoided, remedied or mitigated so they weren't to be elevated above, they were to be considered within the suite of considerations as well.
>
> Q. This objective uses the words "provided that" so these things are elevated above the use?
>
> [The response to the last question was inaudible].

[243] Similarly, questions were put to the Director-General of Conservation's planning witness, Ms Kirk:[259]

> Q. ... Perhaps I'll put my question a different way. What's your basis for elevate or prioritising amenity values over the use and development of soils?
>
> A. So I'm not trying to prioritise them over and above the use of the land and soils. This needs to – you need to consider as part of using the land and soils what is the effect of that on those other values that I've listed.
>
> Q. So if you look at your clauses B and C, is it fair to say that the matters contained in there should be clearly prioritised prior to use and development occurring?
>
> A. You need to consider how that use and development of the land and soils is safeguarding the human health, so how are the effects of that land use and development.
>
> [Emphasis added]

[244] The Regional Council's planning witness gave evidence that amenity should not be elevated above enabling people and communities to use land and soils to provide for their economic, social and cultural wellbeing.[260] Even so, he was critical of the limited provision for amenity and cultural values in the plan[261] and sought to address this by identifying recreational and historic heritage values as aspects of economic, social and cultural wellbeing in the proposed chapeau.

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[257] See Transcript (Davidson) at 1452; Transcript (Kirk) at 1292.
[258] Transcript (Davidson) at 1452.
[259] Transcript (Kirk) at 1292–1293.
[260] Transcript (McCallum-Clark) at 349–350; Regional Council, opening submissions at [159]–[160]; Regional Council, closing submissions at [66].
[261] McCallum-Clark, EiC at [65] and [156].

[245] None of the planning witnesses explained how a remerged Objective 13 demonstrates Te Mana o te Wai or the management philosophy of ki uta ki tai. The court received little evidence by way of policy analysis of the higher order planning documents or the Act.

Discussion

[246] Forest and Bird and others seek the reinstatement of Objective 13(c) that was deleted on the recommendation of the Hearing Panel. Sub-clause (c), as notified, provided "adverse effects on ecosystems (including diversity and integrity of habitats), amenity values, cultural values and historic heritage values are avoided, remedied or mitigated to ensure these values are maintained or enhanced".

[247] If Forest and Bird and others were intending to address the control of discharges of contaminants into or onto land or water (s 30(1)(f)), an outcome that amenity and cultural values (including recreational and historic heritage values) are to be maintained or enhanced would reasonably follow.

[248] It would be a surprising result if this plan did not in some way address historic heritage values given that they are matters of national importance.[262] Amenity values (which we note includes recreational values)[263] are matters to which we are to have particular regard (s 7).

[249] The relief pursued by all parties is problematic. On the one hand a proposed chapeau favoured by the Regional Council and others, to "support" of economic, cultural and social wellbeing is uncertain, and it is this uncertainty that lies at the heart of the parties' dispute. On the other hand, while not intended, the new sub-clause (d) proposed by Forest and Bird *et al.* makes amenity a pre-condition of land and soil use. Whereas what is intended is that the use and development of land and soils maintain amenity.

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[262] See RMA, s 6(e) and (f).

[263] Section 2 of the RMA defines "amenity values" as those natural or physical qualities and characteristics of an area that contribute to people's appreciation of its pleasantness, aesthetic coherence, and cultural and recreational attributes.

[250] We have noted Mr Maw's line of cross-examination suggesting that the objective is to secure certain environmental outcomes before land and soils may be used.[264] In other words the three sub-clauses are conditions that must be satisfied before land and soils may be used. This has the effect that:

> Provided that
>
> > Sub-clause (a);
> > Sub-clause (b); and
> > Sub-clause (c)
>
> Then *something …*

[251] Consistent with Objective 2, should not the focus of the enabling element be on economic, social and cultural wellbeing? If correct, the objective read would read:

> Provided that
>
> > Sub-clause (a);
> > Sub-clause (b); and
> > Sub-clause (c)
>
> then land and soils are used and developed to enable the economic, social and cultural wellbeing of the region.

[252] Addressing the concerns raised by all parties, we suggest the use and development of land and soils to enable wellbeing – as opposed to activities that depend on the resources – has greater resonance with Te Mana o Te Wai and ki uta ki tai than the alternatives proposed. This focus brings more clarity around the outcomes for wellbeing than the proposed chapeau which is simply to "support" wellbeing. If the objective were amended this way there would be no need to address amenity, recreation, cultural and historic heritage values in the text of the objective, as these are aspects of social and cultural wellbeing and the policies can be left to address how these aspects of wellbeing are to be enabled.

[264] Ms Ruston gave similar evidence at [66].

Outcome

[253] We would approve the wording for the following sub-clauses:

(a) the quantity, quality and structure of soil resources are not irreversibly degraded through land use activities or discharges to land; and

(b) the health of people and communities is safeguarded from the adverse effects of discharges of contaminants to land and water; and

(c) ecosystems (including indigenous biological diversity and integrity of habitats), are safeguarded.

[254] Otherwise, we will seek further submissions/evidence responding to the structure of the objective as set out at paragraph [251].

Objective 14

Objective 14 (DV)

> The range and diversity of indigenous ecosystem types and habitats within rivers, estuaries, wetlands and lakes, including their margins, and their life-supporting capacity are maintained or enhanced.

[255] Fish and Game and Forest and Bird support an amendment to the objective to refer to ecosystem types and habitats within dryland environments, rivers, estuaries, wetlands and lakes.[265]

[256] The parties' planning witnesses see a gap in the provisions pertaining to the management of critical source areas. Critical source areas[266] include dryland environments which can become wet or flood during rainfall events. These areas are very likely pathways for contaminants to enter waterbodies.[267]

[257] The importance of integrated management is accepted.[268] There does not, however, appear to be a policy gap because under Objective 13(c) the use and development of land and soil is only enabled provided that "ecosystems (including indigenous biological diversity and integrity of habitats) are safeguarded". We interpret "safeguarding" in Objective 13(c) as a more protective outcome than "maintaining" or "enhancing" ecosystems under this objective particularly in circumstances where the system is already deleteriously affected by land use.

Outcome

[258] Given this, we would decline to amend the objective as sought by Fish and Game and Forest and Bird.

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[265] The Director-General of Conservation was also in support of the amendment, later withdrawing the same. See Transcript (Williams) at 1278.

[266] "Critical source area" is defined in the pSWLP and means:

> (a) a landscape feature like a gully, swale or a depression that accumulates runoff (sediment and nutrients) from adjacent flats and slopes, and delivers it to surface water bodies (including lakes, rivers, artificial watercourses and modified watercourses) or subsurface drainage systems; and
> (b) areas which arise through land use activities and management approaches (including cultivation and winter grazing) which result in contaminants being discharged from the activity and being delivered to surface water bodies.

[267] Farrell, EiC at [117].

[268] NPS-FM, Objective C1; RPS, Policy BIO.7 and Policies WQUAL.12, WQUAN.8.

[259] In relation to the retention of "life supporting capacity" in this objective we will reconsider that in the light of any submissions made on that term in Objectives 9 and 9A.

Objective 17

Objective 17 (DV)

> The natural character values of wetlands, rivers and lakes and their margins, including channel and bed form, rapids, seasonably variable flows and natural habitats, are protected from inappropriate use and development.

[260] As the objective ultimately derives from s 6(a), Forest and Bird and Fish and Game would amend the objective to require natural character values to be both preserved and protected from inappropriate use and development in line with the language of the Act. Pursuant to s 6, the pSWLP is to both recognise and provide for:

> The preservation of the natural character of the coastal environment (including the coastal marine area), wetlands, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use, and development.

[261] It is the Regional Council's view that "preserve" does not add to the objective's protective outcome and indeed, Mr Maw submits there is no material difference in meaning between "preserved" or "protected" – at least as the objective is proposed to be amended by the appellants.[269]

[262] Mr McCallum-Clark, citing in support Meridian's notice to become an interested party in the Forest and Bird appeal, said that he *tended* towards the view that the:[270]

> ... decision version of the Objective allows for reasonable decisions to be made on a case by case basis as to the level of appropriate protection of natural values to be applied, ranging from preservation where the values are very high, to little protection where the natural character values are very low.

We do not recall Meridian calling evidence in support of its notice.

[263] Ms Kirk, giving planning evidence on behalf of the Director-General of Conservation, points out that under s 6(a) it is not the natural character in and of itself that is subject to use and development, rather it is the environment. The use and development of the environment may impact natural character. In her opinion, without

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[269] Regional Council, opening submissions at [169]-[170].
[270] McCallum-Clark, EiC at [179].

the "preserve" element, the objective lacks direction as to what is to be protected from inappropriate development.[271]

Discussion

[264] The planning witnesses do not address the provision within the context of the higher order planning documents and so we have had recourse to the s 32AA report to understand the import of this provision. The s 32AA report states that Objective 17 is one of four objectives addressing wetlands, the other Objectives being 1, 3 and 14. We set out all four for context.

> **Objective 1 (DV)**
> Land and water and associated ecosystems are sustainably managed as integrated natural resources, recognising the connectivity between surface water and groundwater, and between freshwater, land and the coast.
>
> **Objective 3 (as proposed to be amended by the court)**
> The mauri of water~~bodies~~ will be acknowledged and protected so that it provides for te hauora o te taiao (health and mauri of the-environment) and te hauora o te wai (health and mauri of the waterbody) and te hauora o te tangata (health and mauri of the people).
>
> **Objective 14 (DV)**
> The range and diversity of indigenous ecosystem types and habitats within rivers, estuaries, wetlands and lakes, including their margins, and their life-supporting capacity are maintained or enhanced.
>
> **Objective 17 (DV)**
> The natural character values of wetlands, rivers and lakes and their margins, including channel and bed form, rapids, seasonably variable flows and natural habitats, are protected from inappropriate use and development.

[265] The s 32AA report records that the objective is to achieve the direction in Objective B4 of the NPS-FM that provides:

> **Objective B4**
> To protect significant values of wetlands and of outstanding freshwater bodies.

[271] Kirk, EiC as s 274 party in support at [70]-[71].

[266] The s 32AA report mentions NZCPS Policy 13.[272] This policy helpfully describes natural character in the following way:

> (2) Recognise that natural character is not the same as natural features and landscapes or amenity values and may include matters such as:
>
> a. natural elements, processes and patterns;
>
> b. biophysical, ecological, geological and geomorphological aspects;
>
> c. natural landforms such as headlands, peninsulas, cliffs, dunes, wetlands, reefs, freshwater springs and surf breaks; ...

[267] The natural character of the coastal environment is preserved under the NZCPS when certain adverse effects – *inter alia* – are avoided; per Policy 13(1):

> (1) To preserve the natural character of the coastal environment and to protect it from inappropriate subdivision, use, and development:
>
> a. avoid adverse effects of activities on natural character in areas of the coastal environment with outstanding natural character; and
>
> b. avoid significant adverse effects and avoid, remedy or mitigate other adverse effects of activities on natural character in all other areas of the coastal environment; including by:
>
> c. assessing the natural character of the coastal environment of the region or district, by mapping or otherwise identifying at least areas of high natural character; and
>
> d. ensuring that regional policy statements, and plans, identify areas where preserving natural character requires objectives, policies and rules, and include those provisions.

[268] Policies 11, 14 and 15 of the NZCPS are also said to be relevant and we have had regard to the same.

[269] Finally, RPS Objective WQUAL.2 is noted in the s 32AA report. This objective does not talk about preserving or protecting lowland waterbodies but halting their decline.

> **Objective WQUAL.2:**
>
> <u>Halt</u> the decline in lowland water bodies and coastal lakes, lagoons, tidal estuaries, salt marshes and coastal wetlands.
>
> [our emphasis]

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[272] Section 32AA report at 113.

[270] While not referred to in the s 32AA report (or in evidence), the following RPS objectives and policies also appear relevant:

> **Policy WQUAL.3**
> Identify and protect the significant values of wetlands and outstanding freshwater bodies.
> [our emphasis]
>
> **Policy WQUAN.1**
> Maintain instream values of surface water that derive from flows and levels, while recognising the special circumstances of the Waiau catchment.
> [our emphasis]
>
> **Objective BRL.1**
> All significant values of lakes and rivers are maintained and enhanced.
> [our emphasis]

[271] The Act protects against "inappropriate" use and development. What is "inappropriate" is to be assessed by reference to what it is that is sought to be protected.[273] What is to be protected under s 6(a) is the coastal environment and wetlands, lakes and rivers and the margins of the same. The outcome of the protection is the preservation of the natural character of the coastal environment and the relevant waterbodies.[274]

[272] Fundamentally, we do not agree with the Regional Council and others that there is no material difference in meaning between "preserve" or "protect". The Oxford Dictionary defines "preserve" as being to maintain something in its original or existing state and "protect" as meaning to "defend or guard from danger or injury ...; to keep safe; take care of".[275] Thus, by protecting the coastal environment and the relevant waterbodies, their natural character is kept in its original or existing state.

[273] The higher order planning documents expand, to some limited degree, on what is to be protected (see our emphasis above).

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[273] *Environmental Defence Society Incorporated v New Zealand King Salmon Company Limited* [2014] NZSC 38, [2014] 1 NZLR 593 at [105].
[274] Similarly, the Cambridge Dictionary (Online) defines "preserve" as meaning to keep something as it is, especially in order to prevent it from decaying or being damaged or destroyed and 'protect' as meaning to keep someone or something safe from injury, damage, or loss.
[275] "protect, v." and "preserve, v." *OED Online* (Oxford University Press, September 2019).

[274] The pSWLP defines natural character values as "the qualities of the environment that give it recognisable character". Natural character is said to embrace ecological, physical, spiritual, cultural, intrinsic and aesthetic values, and includes modified and managed environments. Objective 17 would protect these "values" from inappropriate use and development but to what end?

[275] In ordinary parlance, natural character may be understood in terms of being the full expression of the natural environment. Knowing natural character – however it is valued – is essential to understanding the interconnection of water, land and people and consequently managing natural resources in a way that responds to their connectivity (ki uta ki tai).

[276] We have taken note of Mr Dunning's evidence for the territorial authorities, that Objective BRL.1 of the RPS is to maintain and enhance only the "significant" values of lakes and rivers. The definition of "natural character values" in the proposed plan is all encompassing and not limited to values that are of significance to the region.[276] Further, preservation of all natural character values will not assist in giving effect to the direction in Objective INF.1 that infrastructure be appropriately integrated with land use and the environment.[277]

[277] On the other hand we accept Ms Kirk's evidence that Objective 17 lacks direction. Echoing the words of the late Environment Judge J Bollard, there is an ever-present call for environmental compromises and trade-offs at the individual level and of changes that all too often belatedly disclose mediocre environmental qualities, if not irreversible degrading outcomes.[278] Policy-making should be an informed response; one that assists decision-makers on the amount of change the environment can accommodate without substantively altering its natural character. Absent this direction in the pSWLP, natural character values may all too easily be written off or undervalued as being of 'low' quality, whereas even residual values may be worthy of protection if those values are sustaining natural character. Unfortunately, the plan does not appear to identify what is of value and therefore what is to be protected.

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[276] Dunning EiC at [94].

[277] Dunning EiC at [99].

[278] John Bollard "Climate changes issues from the perspective of the Environment Court" (2008) 7 BRMB 127 at 130, cited by the (then) Chief Justice in "Righting Environmental Justice" (Address to Resource Management Law Association: Salmon Lecture, Auckland, 25 July 2013) at 10.

[278] Taking wetlands, by way of example, the experts agreed the loss of wetlands was a critically important issue and that urgent and effective action was required to enhance, restore and increase the extent of wetlands.[279] The area of wetlands in Southland is known to have declined to 11% of its historical extent, and it is continuing with no apparent decrease in the rate of clearance.[280] Clearance and drainage for agriculture is considered the primary cause, along with afforestation, peat mining and horticulture. Activities are focused mainly on the Southland Plains and particularly, near the Awatua-Waituna RAMSAR Wetland of International Significance. To increase and restore wetlands *per* RPS WQUAL2 is likely to require that any remaining marginal wetland land is not subject to new drainage and that some drainage works need to be reversed, even where these areas are not currently classed as being significant. Such wetlands have the potential for restoration and even if not dominated by indigenous species provide additional habitat and connectivity. The Director-General of Conservation's proposed change encourages such an outcome by preserving such areas based on their natural character (which includes the landform, drainage pattern and vegetation pattern of wetlands whether or not they contain significant biodiversity currently).

Outcome

[279] This objective, like many others in the pSWLP, simply restates provisions in the higher order instruments without particularly advancing the same. We would approve the amendment proposed by the Director-General of Conservation as this more clearly draws the distinction between "preserve" and "protect". Bearing in mind that natural character values may be of significance because of their attributes of rarity, representativeness, distinctiveness and ecological context, we invite parties to consider limiting the values to be preserved to those that are of regional significance and in doing so provide substantive direction on the outcome. Thus:

> Preserve the natural character values of wetlands, rivers and lakes and their margins, including channel and bed form, rapids, seasonably variable flows and natural habitats that are of significance to the region, and protect them from inappropriate use and development.

[280] We will direct the parties file further submissions and/or evidence in response to the court's discussion and to address whether the objective, properly directed, is to address natural character values that are significance to the region.

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[279] JWS for Water Quality and Ecology (Rivers and Wetlands) held 7-9 May 2019 at [82].
[280] JWS – Ecology (Rivers and Lakes) at [30]-[33].

Objective 18

Objective 18 (DV)

All activities operate in accordance with "good management practice" or better to optimise efficient resource use, safeguard the life supporting capacity of the region's land and soils, and maintain or improve the quality and quantity of the region's water resources.

[281] Objective 18 is of critical importance to the outcomes for water quality under this plan. Appealed by Alliance Group Limited, Ngā Rūnanga and Fish and Game, the objective attracted considerable debate. We have considered the objective together with policies 4-12A which, for farming activities at least, will implement Objective 18.

[282] Evidently the intent of Objective 18 is to provide a high-level expectation of behaviour for all activities.[281] Beyond this the s 32AA report does not shed much light on the objective, the report simply states that the objective is addressing the purpose of the Act. There is no discussion of the objective in the decision of the Hearing Panel.

[283] The directive that all activities operate in accordance with good management practice is to secure three outcomes; namely efficient resource use, safeguarding of the life supporting capacity of the region's land and soils, and maintenance or improvement of the quality and quantity of the region's water resources. It was Ms Kirk's view the objective could be deleted in its entirety because the outcomes are covered by the other objectives in the pSWLP.[282]

[284] While the objective would have good management practice apply to all activities, it is common ground that "good management practice" is a management approach that is typically applied to farming activities. This guidance has generated uncertainty as to the extent of objective's remit – does the objective apply to all activities or is it to be read down as applying to the agricultural sector?

[285] Beyond what we say above, it is not necessary to traverse the evidence on this objective, as much of it concerned responses to the objective by, for example, amending the term to "good environmental practice" to make clear the approach was of general

[281] McCallum-Clark, EiC at [195] and rebuttal at [27].
[282] Kirk, as a s 274 party in support [9(h)].

application or alternatively, amending the objective to refer to both "good management practice" and "best practicable option" thus drawing in the industrial sector. For the moment, neither approach finds favour with the court as the amendments proposed are addressing matters best left for policy.[283]

"Improve" or "maintain or improve" water quality?

[286] We divert briefly to specific relief proposed by Ngā Rūnanga who sought to amend the objective requiring water quality and quantity to be improved (as opposed to maintained or improved). Ngā Rūnanga is concerned that there be continual striving to improve land use management and thereby improve water quality and quantity.[284] We were told this striving for improvement is typical under a "good management approach". Ms Davidson, giving planning evidence for Ngā Rūnanga, said that by referring to maintaining or improving water quality or quantity, this does not so much support a "good management approach"[285] as it does business-as-usual.[286]

[287] The discretion to "maintain or improve" water quality and quantity better aligns with the objectives. Prior to the FMU processes water quality is to be improved only when water is degraded (Objective 6). We are not aware of any objective or policy that requires users to reduce the volume of water taken where water is presently over-allocated. Over-allocation both in terms of water quantity and quality is to be phased out under the FMU process and the targets, limits and timeframes for achieving this will be set following engagement and discussion with the community (Objective 7).

Discussion

[288] That said, Ngā Rūnanga's concerns resonate with the Regional Council. Counsel for the Regional Council opened the hearing by submitting on behalf of his client that: "The community, both rural and urban, needs to recognise that current practices will need to change if water quality is to be maintained, and improved where it is degraded".[287] We find water quality is unlikely to be maintained – even where it is not degraded – without change. This need for change may well have become lost in the debate over how the

[283] Kirk, EiC as s 274 party in support at [79].
[284] Transcript (Davidson) at 1489.
[285] Transcript (Davidson) at 1453 and 1489.
[286] Transcript (Davidson) at 1488.
[287] Regional Council, opening submissions at [4].

objective is to be implemented – whether under a good management practice or by adopting the best practicable option.

[289] While Objectives 6 and 7 address water quality and/or quantity, there is no objective to safeguard the life-supporting capacity of the region's land and soils or to optimise efficient resource use. How then are people and community to know what is the intended outcome of their behavioural change? Ms Kirk's opinion about this matter is compelling: the objective, as worded, does not add "value, clarity or certainty" and indeed, the objective could be deleted in its entirety.[288]

[290] If the goal of the objective is to bring about behavioural change, this outcome is not made certain by rephrasing inaccurately some – but not all – objectives. Assuming Objective 18 is to give effect to Te Mana o te Wai (Objective 3) and implementing ki uta ki tai (Objective 1) if change is the desired outcome, we wonder why the objective just does not say "all persons will demonstrate improved land use and water management practice" or words to that effect? This is not to establish any standard or process for compliance purposes.[289] Acknowledging that the language of "improved" land use and water management is not perfect, we will seek submissions/evidence on whether the objective would be strengthened by focusing on behavioural change outcome.

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288 Kirk, as a s 274 party in support at [9(h)] and [81].
289 See McCallum-Clark, EiC at [195].

Policies 4–12A – Physiographic Zone Policies

Introduction

[291] Policies 4-12A address farming, and possibly other activities, taking place within nine physiographic zones. The pSWLP explains that the physiographic zones were developed to better understand the region's water, how it moves across the landscape and why water quality is better in some places than in others. Each of the nine zones represents areas of the landscape with common attributes that influence water quality, such as climate, topography, geology and soil type.[290]

[292] This understanding is expanded upon by Dr Snelder, who developed a model of the physiographic zones:[291]

> 14 The Physiographic Zones are based on an underlying conceptual model that postulates that physiographic characteristics (topography, geology and soils) broadly control transport, dilution and attenuation processes at landscape scales. This conceptual model is also the basis for mapping the distribution of the Physiographic Zones across the region. I note that the approach taken to developing the Physiographic Zones is similar to that taken for other environmental classification systems including the REC.
>
> 15 Statistical testing indicates the Physiographic Zones are a robust description of the broad (i.e., landscape-scale) variation in water composition and water quality risk across the Southland region...
>
> [Note: REC means River Environment Classification system]

[293] The s 32AA report records that the physiographic zone policies are to implement Objective 18. The Director-General of Conservation and Ngā Rūnanga submit, and we could accept, that the policies also implement Objective 1 and generally ki uta ki tai[292] and Objective 3 (Te Mana o te Wai).[293] The policies may implement other objectives as well.

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[290] pSWLP, Physiographic Zones at 19.
[291] Snelder, EiC at [14]-[15].
[292] Director-General of Conservation, closing submissions at [59].
[293] Ngā Rūnanga, closing submissions at [50].

Physiographic maps

[294] As noted, the policies address nine physiographic zones. Maps showing the location of the zones were included in the notified version of the pSWLP but were removed on the recommendation of the Hearing Panel. The maps' removal appears to follow from a finding that physiographic zones are not a suitable tool with which to inform the activity status of land use for farming activities at a property level.[294]

[295] Several parties seek reinstatement of the maps, together with a description of the characteristics of each zone in an appendix to the plan.[295] Maps are important if plan users are to ascertain whether these policies apply to them, however, the Regional Council opposes their inclusion.[296]

[296] The physiographic zones are principally a tool to manage the risk to water quality from land use.[297] Dr Snelder considered the maps a useful starting point for identifying the dominant flow paths, water quality risks and potential objectives for mitigation. While the pSWLP has some information about the characteristics of individual zones, more information is held by the Regional Council.[298] The crux of the problem appears to be that were farmers to rely solely on a property's membership in a particular physiographic zone, this may result in inappropriate or inadequate actions being taken in response to contaminant flow paths. The modelling used to derive the zone maps has limitations which will not be obvious to plan users,[299] the principal limitations being:[300]

(a) the level of resolution of detail and spatial accuracy of the map boundaries means zone membership does not describe all sources of water quality risk at the scale of an individual property;

(b) the zones are not distinctive entities, but instead are a coarse subdivision of continuously varying physiographic conditions. Physiographic zone boundaries are indicative of areas where there is a transition from one set

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[294] Hearing Panel report at [123]-[124]. Regional Council, opening submissions at [202].

[295] Director-General of Conservation, closing submissions at [69]; Forest and Bird, closing submissions at [65].

[296] McCallum-Clark, rebuttal at [34].

[297] Regional Council, opening submissions at [2]; Transcript (Snelder) at 314.

[298] Transcript (Snelder) at 314.

[299] Snelder, EiC at [16]-[17].

[300] Snelder, EiC at [15].

of conditions to another and confirmation of those conditions requires on the ground judgment and interpretation; and

(c) the boundaries of the physiographic zone may be inappropriate at a property scale.

[297] Dr Snelder was clear that the maps could not be relied on exclusively when assigning a property to a given zone.[301] In his view the risk of contaminant flow within / from each individual property must be considered together with the generic risks described for the assigned zone.[302] Dr Snelder thought Policy 12A (not under appeal) would require all applicants for resource consent to provide information that better identifies or delineates zone boundaries or contaminant loss pathways.[303]

Discussion

[298] Policies are to implement objectives (s 67(2) RMA); they set out the course of action to achieve the outcomes set out in the plan objectives and their relationship to the objectives they are to implement should be readily discernible.

[299] The physiographic zones do not ascribe outcomes for water quality in terms of limits or targets over a period of time.[304] Rather, the value of the physiographic zones lies in their identification of broad-scale risks to water quality for each zone. Land use practices,[305] at the scale of the individual property, also present risks to water quality. Risks at the scale of the individual property may overlap with, but are not the subject matter of, the physiographic zones.

[300] The policies do not use the language of risk but instead refer to avoiding, remedying or mitigating adverse effects. This effects-based language assumes an adverse effect can be directly attributed to the activities occurring on an individual property,[306] whereas the evidence does not support this. While the language of effects is familiar to planners, is it appropriate in context and will it invite inquiry into the contaminant pathways which exist within the receiving environment?

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[301] Transcript (Snelder) at 301.
[302] Snelder, EiC at [53-57]; Transcript (Snelder) at 307.
[303] Transcript (Snelder) at 311 and elsewhere.
[304] Transcript (Snelder) at 313-314.
[305] By "land use" we are referring generally to all aspects of farming activities including the discharge of contaminants.
[306] Transcript (McCallum-Clark) at 450-451.

[301] As presently worded Policies 4-12 are weighted towards consideration of contaminant risk within the nine physiographic zones. It seems doubtful that site-specific risk will be considered under these policies. Moreover, in our view Policy 12A is unlikely to be applied to require each applicant for resource consent to address site-specific risk. It will only be applied where information better defining the physiographic zones or contaminant pathways is available. Put another way Policy 12A does not oblige an applicant to investigate site-specific risks.

[302] If the need to address risk at the level of the physiographic zone and at the individual property level is addressed in the policies, the maps could confidently be reinstated into the plan. Plan users will be considerably assisted by the inclusion of the maps together with comprehensive description of risks arising in each zone. We give provisional approval for the inclusion of the physiographic zone maps in the plan, with the detail of those maps and the method of inclusion to be a matter referred to mediation/expert conferencing.

[303] If all risks are relevant, then the chapeau to the policies will need to be amended to make this clear. For example, Policy 4 could read:

> In the Alpine physiographic zone:
>
> 1. Avoid where practicable risk to water quality from erosion and contaminants by:
>   i. identifying contaminant pathways to ground and surface water bodies;

[304] For both the risk-based or effects-based version we would accept the thrust of Ms Kirk's evidence that "in the first instance" adverse effects are to be avoided. We would rephrase the chapeau of each policy to say that where it is practicable to do so adverse effects are to be avoided.

Dairy farming or dairy farming of cows?

[305] Each policy refers to "dairy farming" and not "dairy farming of cows". "Dairy farming of cows" is a term broadly defined in the pSWLP and includes farming, grazing and milking of cows. The parties will confirm whether "dairy farming of cows" is intended.

Gleyed, Bedrock/Hill Country and Lignite-Marine Terraces Physiographic Zones

[306] Policy 6 addresses three physiographic zones; being Gleyed, Bedrock/Hill Country and Lignite-Marine Terraces. The plan originally notified separate policies for each zone, but the policies being the same in each case, the Hearing Panel recommended they be rolled into a single provision.

[307] While the Regional Council supported this,[307] we find it will assist the users of the plan that they remain separate in common with other zones.

"Good management practice" or "good farming practice"?

[308] If a risk-based approach is not adopted, an issue arises as to whether the policies should refer to "good management practice" or "good farming practice". To make clear that the policies apply to farming activities only, the Regional Council would amend the term to read "good farming practice".[308] Fish and Game and the Director-General of Conservation promote the use of "good management practice or the best practicable option to avoid as far as practicable" instead.[309]

[309] The term "best practicable option" is problematic not least because it is usually applied to point source discharges whereas "good management practices" is applied to diffuse source (non-point source) discharges.[310] Ms Kirk agreed in cross-examination that the reference to "best practicable option" could be deleted if Policies 4-12 were intended to apply to farming activities only. Further to this, she accepted that limiting the policies to farming activities would not leave a lacuna in the plan as other policies addressed industry and other non-farming activities.[311] Counsel for Forest and Bird advocated for both techniques to apply to farming activities as these activities may involve both point source and non-point source discharges. Forest and Bird is particularly concerned that good management practice does not typically allow for the consideration of the receiving environment.[312]

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[307] Regional Council, opening submissions at [200]; closing submissions at [114].
[308] Regional Council, closing submissions at [107].
[309] Kirk, EiC as s 274 party in support at [93] and Farrell, EiC at [156.3].
[310] Whether "best 'practicable option" it is intended to be limited this way under Policy A3 of the NPS-FM is a live question for the Topic B hearing.
[311] Transcript (Kirk) at 1298-1300.
[312] Forest and Bird, closing submissions at [56].

[310] While the definition of "good management practice" in this plan has been criticised and is a matter to be addressed in the Topic B hearing, we agree with the primary sector that the term should be retained. The term is reasonably well understood as applying to farming activities.[313] If Policies 4-12A apply to farming activities only, as was contended by some of the parties, would this be made clearer by amending the section heading to Policies 4-12 to read "Physiographic Zone Policies for Farming Activities"?

[311] Importantly, there is nothing of which we are aware that would preclude consideration of the receiving environment of point and non-point source agricultural discharges under a good management practice approach.

"Good management practice or better"

[312] Both the notified and decision versions of Objective 18 were concerned that all activities operate in accordance with "good management practice or better" to achieve certain outcomes. We recall that Ms Ruston's evidence was that she was unclear what "or better" was meant to achieve beyond adopting good management practice.[314] One purpose of Forest and Bird's proposal to amend the policies by referring to both "good management practice or the best practicable option to avoid as far as practicable" was to reinforce that land management was to improve under "good management practice".[315] As noted in our discussion of Objective 18, this also accords with Ngā Rūnanga's understanding.[316] The Director-General of Conservation, for similar reasons, proposed to amend the chapeau of Policy 4 to provide "In the Alpine Physiographic Zone, avoid in the first instance, remedy or mitigate erosion and adverse effects on water quality from contaminants…".[317]

[313] Again, the witnesses are addressing an important issue for these proceedings concerning the direction of travel under this plan – is it "holding the line" or is it seeking improvement in the existing state of the environment? It is our view the issue is better addressed under Objective 18 and is one reason why we have proposed amendments to the Objective.

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313 Taylor, EiC at [4.2].
314 Ruston, EiC at [92].
315 Transcript (Farrell) at 896-897, 977. See also Davidson, EiC at [123].
316 Transcript (Davidson) at 1489.
317 Transcript (Kirk) at 1299-1300.

Clause 3 of Policies 4-12 and "Strongly discouraging", "generally not granting", "not grant"

[314] The decision version of the policies adopts a position of "generally not granting" applications for resource consent in circumstances where there will be increased contaminant losses from additional dairy farming of cows or additional intensive winter grazing. Policy 4(3) (DV) is the exception. Applying to the alpine physiographic zone, this policy would prohibit dairy farming and intensive winter grazing while "generally not granting" applications for cultivation.[318]

[315] Generally speaking, policies are to guide people and communities as to the matters the consent authority will consider when deciding an application for resource consent. In each instance, the relevant sub-clause applies in narrow circumstances and provides direction on how the objective is to be implemented, addressing either substantive outcomes and/or the acceptability of certain activities occurring.

[316] The appeals on this clause sought relief that would make the policies more or less directive. With the primary sector supporting "generally not granting"; the Regional Council, Ngā Rūnanga and the Director-General of Conservation preferring "strongly discouraging" and Forest and Bird and Fish and Game advocating for "not grant", the court was left with the strong impression that the phrases, not being well understood, would very likely become the stalking horse for future debate and may lead to unintended outcomes in the administration of the plan.[319]

[317] The integrity of the policies will not be undermined if the phrasing is deleted altogether. Indeed to do so would provide clear direction on how the objectives are to be achieved. In that regard we would approve the alternative wording put forward by Forest and Bird.

[318] Finally, we note the legal submission on behalf of Wilkins Farming Co Limited seeking to delete reference to particular activities in sub-clause 3.[320] We accept the submission of several parties that the policies have a deliberate and appropriately

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[318] Under the pSWLP "cultivation" means the "Preparing land for growing pasture or a crop by mechanical tillage, direct drilling, herbicide spraying, or herbicide spraying followed by over-sowing for pasture or forage crops (colloquially referred to as 'spray and pray'), but excluding any spraying undertaken solely for the control of pest plant species."

[319] Forest and Bird, closing submissions at [57].

[320] Wilkins Farming Company Ltd, closing submissions at [6].

narrowed focus on those activities with a high risk of discharging contaminants to the environment[321] and would not approve this amendment.

Outcome

[319] The final determination of these policies is subject to Objective 18. Our analysis has proceeded on the basis that Objective 18 is directed (at least) towards improving existing land use and water management practice.

[320] Subject to confirmation that the policies apply only to farming activities, amend the heading to Policies 4-12 to read "Physiographic Zone Policies for Farming Activities".

[321] Subject to confirmation, amend "dairy farming" to read "dairy farming of cows".

[322] If policies are to retain their effects-based language, then restructure Policies 4-5 and 9-12 to make clear the chapeau applies to clauses (i) and (ii) only. Address separately those activities/effects that are to be prohibited or effects avoided. See Annexure 1 to this decision for suggested wording.

[323] Alternatively, if policies adopt risk-based language, likewise restructure Policies 4-5 and 9-12 to make clear the chapeau applies to clauses (i) and (ii) only. Address separately those activities/effects that are to be prohibited or effects avoided. See Annexure 1 to this decision for suggested wording.

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[321] Director-General of Conservation, closing submissions at [66].

Policy 3 (DV) Ngāi Tahu ki Murihiku taonga species

To manage activities that adversely affect taonga species, identified in Appendix M.

[324] Fish and Game have appealed this policy, seeking that it be amended to refer to taonga species and their related habitats. The Regional Council, together with Forest and Bird and Ngā Rūnanga, supports this relief. This policy implements Objective 15 which also refers to taonga species and their habitats.

[325] Federated Farmers is an interested party in this appeal, opposing the relief sought by the appellant. While it is possible that we have overlooked the same, Federated Farmers did not call evidence or make any submission in support of the decision version of the policy.

Outcome

[326] If the court's interpretation and implementation of Te Mana o te Wai and ki uta ki tai is accepted, we could accept the amendment as being the most appropriate way to achieve Objective 15. Thus:

Policy 3 Ngāi Tahu ki Murihiku taonga species

> To manage activities that adversely affect taonga species, identified in Appendix M, and their related habitats.

If not, more fulsome wording articulating how the outcomes are to be provided is required.

Policies 45 – 46

[327] These policies concern the FMU processes. As the parties' positions were generally aligned at the end of the hearing, and we agree with the reasons given for their alignment, we will approve the amendments proposed.

[328] Where there is any difference in substance remaining, we will indicate our findings on the same.

Policy 45 – Priority of FMU values, objectives, policies and rules

[329] Policy 45 addresses the content of FMU provisions to be introduced into the pSWLP by way of plan change.

[330] The Hearing Panel recommended that any provision on the same subject matter in a future FMU plan change may prevail over the region-wide objectives and policies. Forest and Bird appealed the policy, amending their relief during the course of the hearing to the effect that any provision on the same subject matter in the relevant FMU section (including freshwater objectives) must:[322]

> (i) give effect to the region-wide objectives; and
> (ii) safeguard ecosystem health and human health for recreation.

[331] At the beginning of the hearing Fish and Game's relief included numeric attributes for the two national values.[323] They are no longer pursing this relief,[324] but ask the court to intervene in the FMU process by "providing strong guidance in the pSWLP on the 'bottom line' for freshwater outcomes..."[325] in particular, that the national compulsory values are 'safeguarded' under future FMU plan changes.

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[322] Fish and Game, closing submissions at [42]-[45], [47] and [52]; Forest and Bird, closing submissions at [8].
[323] Farrell, EiC at [7.2], [10.3], [80] and [165]; Death, EiC at section 8.
[324] Fish and Game, closing submissions at [24]. Similarly, Forest and Bird, closing submissions at [8].
[325] Farrell, EiC at [170].

[332] Counsel for Fish and Game submit the NPS-FM allows consideration of other values that may compete with the compulsory national values.[326] Consequently, Fish and Game is concerned to ensure that the compulsory national values are secured under a future FMU and not "traded off" for other values identified following engagement and discussion with the community.[327] Fish and Game does not say that the compulsory national values will not be provided for, but that other values may impact the *level* of their provision. To address this, they would amend the policies to say the national compulsory values are safeguarded.[328]

Discussion

[333] We were unsure whether Fish and Game is claiming standing to purse this relief as an appellant (the notice of appeal does not address the proposed amendment) or as a s 274 party.

[334] No party responded to the substance of the issue raised by Fish and Game and that may be because they were not anticipating the proposed amendment. The Regional Council, for example, interpreted the proposed amendment as being an example of poor drafting – one which merely repeats the provisions of the superior document.[329] Thus while the Regional Council changed its position to one of supporting an outcome that any provision on the same subject matter in the FMU section of the plan must give effect to the region-wide objectives, it does not go as far as to include reference to safeguarding the national compulsory values. The Council's preferred wording of the policy is supported by the primary sector.[330]

Outcome

[335] The arguments are complex and, as a matter of natural justice, we decline to give our finding on the matter without hearing further from interested parties.

[336] It may be the parties' view that Objectives A1 and B1 of the NPS-FM already direct the safeguarding of the compulsory national values. Likewise, they may take the

326 Fish and Game, closing submissions at [46.3].
327 Fish and Game, opening submissions at [15].
328 Fish and Game, closing submissions at [45].
329 Regional Council, closing submissions at [120].
330 Ballance Agri-Nutrients Limited, closing submissions at [26].

view that the safeguarding of the compulsory national values in a future plan change is secured through Objective 9 (at least for ecosystem health and human health for recreation).

[337] That said, with minor changes to improve clarity, we would approve the amendments proposed by the Regional Council and Forest and Bird clarifying what is to occur where the FMU provisions are progressed in stages. Likewise, the advice notice. We make no decision whether to include a new provision sought by Forest and Bird to safeguard ecosystem health and human health for recreation.

[338] Thus, we would approve the following amendments to Policy 45:

> In response to Ngāi Tahu and community aspirations and local water quality and quantity issues, FMU sections of this Plan may include additional catchment-specific values, objectives, policies, attributes, rules and limits which will be read and considered together with the Region-wide Objectives and Region-wide Policies.
>
> Any provision on the same subject matter in the relevant FMU section of a plan (including Freshwater Objectives) must give effect to the Region-wide Objectives.
>
> FMU provisions developed for a specific geographical area will not initiate a plan change to the Region-wide objectives or Region-wide policies.
>
> Advice Note: It would be unfair if changes are made to Region-wide objectives and policies~~,~~ based on decisions for individual FMUs in specific parts of Southland, ~~which apply in other parts of Southland~~, without the involvement of the wider Regional ~~ese wider~~ community~~ies~~.

Policy 46 – Identified FMUs

[339] The notified version of the plan contains five freshwater management units. We assume freshwater management unit or "FMU" has the same meaning as in the NPS-FM – "the water body, multiple water bodies or any part of a water body determined by the regional council as the appropriate spatial scale for setting freshwater objectives and limits and for freshwater accounting and management purposes".[331]

[340] The Council had determined that the Waituna Lagoon catchment should be a sub-unit of the Mataura FMU. This decision was appealed by Forest and Bird who sought to

[331] NPS-FM, Interpretation at 8.

make the catchment subject to its own separate FMU process.[332] Waituna Lagoon forms part of the Ramsar Waituna-Awarua Wetland of International Importance.

[341] Forest and Bird, together with Ngā Rūnanga and the Director-General of Conservation, is concerned that the values of Waituna Lagoon may be lost were it to remain in the wider Mataura catchment FMU.[333] Indeed the court was directed to evidence that Waituna Lagoon has become increasingly vulnerable to regime shift in the last 10 to 15 years.[334] This is despite the Crown's acknowledgment in the Ngāi Tahu Claims Settlement Act 1998 of Ngāi Tahu's status as tangata whenua and its association with Waituna.[335] Within Waituna are urupā and wāhi tapu, and the:[336]

> ... mauri of Waituna represents the essence that binds the physical and spiritual elements of all things together, generating and upholding all life. All elements of the natural environment possess a life force, and all forms of life are related. Mauri is a critical element of the spiritual relationship of Ngāi Tahu Whānui with the area.

[342] At the end of the hearing no party opposed the Waituna Lagoon being separately identified as an FMU. While the Council is "cognisant of the urgent need to improve the health of Waituna",[337] and has been aware of the degraded state of the Waituna catchment since 2011, it intends notifying a single plan change for all FMUs and for the plan change process to be completed by 2025.[338] The Regional Council adopts a neutral position to signal its view that recognition of Waituna Lagoon as a separate FMU does not imply any alteration to its programme of work. On this basis the Regional Council no longer maintains there is a jurisdictional bar to the court amending the plan accordingly.[339]

Outcome

[343] We accept the reasons put forward in support of amending Policy 46 to include Waituna Lagoon as a separate FMU. The Waituna Lagoon has international and national significance, is in a degraded state, and is at risk of further degradation. We further

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[332] Forest and Bird, opening submissions at Issue 8.

[333] Davidson, EiC at [150]-[151]; Farrell, EiC at [180] and Kirk, EiC as s 274 party in support at [108].

[334] Forest and Bird, closing submissions at [70]; Transcript (Gepp) at 1786-1787 and Exhibit Ngāi Tahu 2.

[335] Ngāi Tahu Claims Settlement Act 1998, s 6 and Schedule 73.

[336] Ngāi Tahu Claims Settlement Act 1998, Schedule 73; pSWLP, Appendix B – Ngāi Tahu Statutory Acknowledgement Areas at 137.

[337] Regional Council, closing submissions at [132].

[338] Transcript (Maw) at 2084-2085.

[339] Transcript (Maw) at 2085-2086.

accept that the protection of ecosystems in the wider Awarua-Waituna complex is urgently required.[340] A management programme is already in place for Waituna Lagoon and a body of research has developed specific to the lagoon and its catchment, with a process for involving the community also well established.[341] The recognition of Waituna Lagoon as a separate FMU is consistent with Policy 11 of the NZCPS which requires protection of indigenous biodiversity in the coastal environment. Given this, we would approve the amendment to Policy 46 as follows:

> The FMU sections of this Plan are based on the following identified Freshwater Management Units for Southland, as shown on Map Series 6: Freshwater Management Units:
>
> - Fiordland and the islands;
> - Aparima;
> - Mataura;
> - Ōreti;
> - Waiau; and
> - Waituna.

Policy 47 – FMU processes

[344] All parties agree to amend Policy 47 such that the FMU sections will give effect to the region-wide objectives. We would approve their proposed amendments and in line with other policies further amend the policy to clarify that "The FMU sections "of this Plan" will give effect to ...".

[345] We would approve:

> The FMU sections of this Plan will give effect to the region wide Objectives – and:
>
> 1. identify values and establish freshwater objectives for each Freshwater Management Unit, including where appropriate at a catchment or sub-catchment level, having particular regard to the national significance of Te Mana o te Wai , and any other values developed in accordance with Policies CA1-CA4 and Policy D1 of the National Policy Statement for Freshwater Management 2014 (as amended in 2017); and
> 2. set water quality and water quantity limits and targets to achieve the freshwater objectives; and
> 3. set methods to phase out any over-allocation, within a specified timeframe; and
> 4. assess water quality and quantity taking into account Ngāi Tahu indicators of health.

[340] Farrell, EiC at [178] and [179]; and McArthur, EiC at [97]-[101].
[341] Farrell, EiC at [178] and [179]; and McArthur, EiC at [97]-[101].

Directions

[346] We have in mind to refer the objectives and policies to either mediation or expert conferencing. No referral will be made until there is a settled view on the scheme of the plan.

[347] We expect that parties will be taking a break over Christmas. On their return we will direct the Regional Council to liaise with them over the filing of submissions and evidence (if required) in response to this Interim Decision. Specifically, the parties are to address the interpretation and implementation of Te Mana o te Wai and ki uta ki tai in this plan and any other matter they consider relevant to the scheme of the plan in general. Secondly, the parties are to address how the plan is to take into account the principles of the Treaty. Finally, they will indicate whether they wish to be heard on these matters.

[348] If parties prefer, the court will convene a pre-hearing conference in Invercargill to discuss forward directions. If a pre-hearing conference is preferred, this will occur in the week commencing **Monday 10 February 2020.**

[349] We direct:

(a) by **Monday 3 February 2020**, the Regional Council, having conferred with the parties, will file and serve a reporting memorandum setting out a proposed timetable for the exchange of evidence and submissions as discussed at paragraph [347] or request the proceedings be set down for a pre-hearing conference in the week commencing 10 February 2020.

For the court:

____

J E Borthwick
Environment Judge

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List of appellants

ENV-2018-CHC-26	Transpower New Zealand Limited
ENV-2018-CHC-30	Wilkins Farming Co
ENV-2018-CHC-36	Director-General of Conservation
ENV-2018-CHC-37	Southland Fish and Game Council
ENV-2018-CHC-38	Meridian Energy Limited
ENV-2018-CHC-39	Alliance Group Limited
ENV-2018-CHC-40	Federated Farmers of New Zealand
ENV-2018-CHC-41	Heritage New Zealand Pouhere Taonga
ENV-2018-CHC-47	Waihopai Rūnaka, Hokonui Rūnaka, Te Rūnanga o Awarua, Te Rūnanga o Oraka Aparima and Te Rūnanga o Ngāi Tahu
ENV-2018-CHC-50	Royal Forest and Bird Protection Society of New Zealand Incorporated

Annexure 1

In this attachment the court sets out its findings on the individual provisions. If a provision has been "confirmed" or "amended", subject to submissions on the scheme architecture, the decision is final.

For some provisions the court has proposed alternative wording, in which case we indicate that the provision is "proposed to be amended." The parties are invited to respond to the same while respecting the court's findings in relation to the wording proffered by the parties.

To assist the parties, substantive changes in wording are underlined.

Objective 2 (notified version) is confirmed with minor grammatical corrections

> Water and land are recognised as enablers of the economic, social and cultural wellbeing of the region.

Objective 3 is amended

> The mauri of water~~bodies~~ will be acknowledged and protected so that it provides for te hauora o te taiao (health and mauri of the environment) and te hauora o te wai (health and mauri of the waterbody) and te hauora o te tangata (health and mauri of the people).

Objective 6 is proposed to be amended

> Water quality in each freshwater body will be:
>
> (a) maintained where the water quality is not degraded; and
> (b) improved where the water quality is degraded by human activities.

Objective 7 is proposed to be amended

> Following the establishment of freshwater objectives, limits, and targets (water quality and quantity) in accordance with the Freshwater Management Unit processes:

(a) where water quality objectives and limits are met, water quality shall be maintained or improved;

(b) any further over-allocation of freshwater is avoided; and

(c) any existing over-allocation is phased out in accordance with freshwater objectives, targets, limits and timeframes.

Objectives 9 and 9A is proposed to be amended

The quantity of water in surface waterbodies is managed so that:

(a) ~~the~~ aquatic ecosystem health, life-supporting capacity,[1] the values of outstanding natural features and landscapes, the natural character and historic heritage values of waterbodies and their margins are safeguarded;

(b) there is integration with the freshwater quality objectives ~~and values~~[2] (including the safeguarding of human health for recreation); and

(c) provided that (a) and (b) are met, surface water is sustainably managed~~,~~ in accordance with Appendix K to support the reasonable needs of people and communities to provide for their economic, social and cultural wellbeing.[3]

Objective 9B is proposed to be amended

The importance of Southland's regionally and nationally significant infrastructure is recognised and its sustainable and effective development, operation, maintenance and upgrading enabled.

Objective 10 is decided in part and amended

The national importance of the existing ~~hydro-electric generation schemes, including the~~ Manapōuri hydro-electric generation scheme in the Waiau catchment~~,~~ is provided for and recognised in any resulting flow and level regime.~~, and their structures are considered as part of the existing environment.~~

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[1] Seeking further submissions on meaning of life-supporting capacity.

[2] Submissions are sought on sub-clause (b) introduced by the primary producers. "Values" does not appear to imply "freshwater quality objectives".

[3] Reordered in line with Objective 2.

Objective 13 is proposed to be amended

Provided that

(a) the quantity, quality and structure of soil resources are not irreversibly degraded through land use activities or discharges to land; and

(b) the health of people and communities is safeguarded from the adverse effects of discharges of contaminants to land and water; and

(c) ecosystems (including indigenous biological diversity and integrity of habitats), are safeguarded:

then land and soils are used and developed to enable the economic, social and cultural wellbeing of the region.

Objective 14 (DV) is confirmed

The range and diversity of indigenous ecosystem types and habitats within rivers, estuaries, wetlands and lakes, including their margins, and their life-supporting capacity are maintained or enhanced.

Objective 17 is proposed to be amended

Preserve the natural character values of wetlands, rivers and lakes and their margins, including channel and bed form, rapids, seasonably variable flows and natural habitats that are of significance to the region, and protect them from inappropriate use and development.

Objective 18 is proposed to be amended

All persons will demonstrate improved land use and water management practice.

Policy 3 is amended

To manage activities that adversely affect taonga species, identified in Appendix M, and their related habitats.

Policy 4 is proposed to be amended

Risk-based

In the Alpine physiographic zone:

1. avoid where practicable risk to water quality from erosion and contaminants by:
   i. identifying contaminant pathways to ground and surface water bodies;
   ii. requiring implementation of good management practices to manage erosion and adverse effects on water quality from contaminants transported via overland flow;
   iii. having particular regard to adverse effects of contaminants transported via overland flow when assessing resource consent applications and preparing or considering Farm Environmental Management Plans; and

2. prohibiting dairy farming of cows and intensive winter grazing and avoiding cultivation where contaminant losses will increase as a result of the proposed activity.

Or effects-based

In the Alpine physiographic zone:

1. avoid where practicable, ~~remedy, or mitigate~~ erosion and adverse effects on water quality from contaminants, by:
   i. identifying contaminant pathways to ground and surface water bodies;
   ii. requiring implementation of good management practices to manage erosion and adverse effects on water quality from contaminants transported via overland flow;
   iii. having particular regard to adverse effects of contaminants transported via overland flow when assessing resource consent applications and preparing or considering Farm Environmental Management Plans.

2. prohibit dairy farming of cows and intensive winter grazing and avoid cultivation where contaminant losses will increase as a result of the proposed activity.

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Policy 5 is proposed to be amended

Risk-based

In the Central Plains physiographic zone:

1. <u>avoid where practicable risk to water quality from contaminants by:</u>
   i. <u>identifying contaminant pathways to ground and surface water bodies;</u>
   ii. requiring implementation of good management practices to manage erosion and adverse effects on water quality from contaminants transported via overland flow;
   iii. having particular regard to adverse effects of contaminants transported via overland flow when assessing resource consent applications and preparing or considering Farm Environmental Management Plans.

2. <u>avoid dairy farming of cows and intensive winter grazing where contaminant losses will increase as a result of the proposed activity.</u>

Or effects-based

In the Central Plains physiographic zone:

1. avoid <u>where practicable</u>, ~~remedy, or mitigate~~ adverse effects on water quality from contaminants, by:
   i. requiring implementation of good management practices to manage adverse effects on water quality, from contaminants transported via artificial drainage and deep drainage;
   ii. having particular regard to adverse effects on water quality from contaminants transported via artificial drainage and deep drainage when assessing resource consent applications and preparing or considering Farm Environmental Management Plans.

2. <u>avoid dairy farming of cows and intensive winter grazing where contaminant losses will increase as a result of the proposed activity.</u>

Policy 6 is proposed to be amended

Risk-based

In the Gleyed physiographic zone avoid where practicable risk to water quality from contaminants by:

1. identifying contaminant pathways to ground and surface water bodies;
2. requiring implementation of good management practices to manage erosion and adverse effects on water quality from contaminants transported via overland flow; and
3. having particular regard to adverse effects of contaminants transported via overland flow when assessing resource consent applications and preparing or considering Farm Environmental Management Plans.

Or effects-based

In the Gleyed physiographic zone avoid where practicable ~~remedy, or mitigate~~ adverse effects on water quality from contaminants, by:

1. identifying contaminant pathways to ground and surface water bodies;
2. requiring implementation of good management practices to manage adverse effects on water quality from contaminants transported via artificial drainage, and overland flow where relevant; and
3. having particular regard to adverse effects on water quality from contaminants transported via artificial drainage, and overland flow where relevant when assessing resource consent applications and preparing or considering Farm Environmental Management Plans.

Policy 7 is proposed to be amended

Risk-based

In the Bedrock/Hill Country and Lignite-Marine Terraces physiographic zone avoid where practicable risk to water quality from contaminants by:

1. identifying contaminant pathways to ground and surface water bodies;
2. requiring implementation of good management practices to manage adverse effects on water quality from contaminants transported via artificial drainage, and overland flow where relevant; and
3. having particular regard to adverse effects on water quality from contaminants transported via artificial drainage, and overland flow where relevant when assessing resource consent applications and preparing or considering Farm Environmental Management Plans.

Or effects-based

In the Bedrock/Hill Country and Lignite-Marine Terraces physiographic zone avoid where practicable, ~~remedy, or mitigate~~ adverse effects on water quality from contaminants, by:

1. identifying contaminant pathways to ground and surface water bodies;
2. requiring implementation of good management practices to manage adverse effects on water quality from contaminants transported via artificial drainage, and overland flow where relevant; and
3. having particular regard to adverse effects on water quality from contaminants transported via artificial drainage, and overland flow where relevant when assessing resource consent applications and preparing or considering Farm Environmental Management Plans.

Policy 8 is proposed to be amended

Risk-based

In the Lignite-Marine Terraces physiographic zone avoid where practicable risk to water quality from contaminants by:

1. identifying contaminant pathways to ground and surface water bodies;
2. requiring implementation of good management practices to manage adverse effects on water quality from contaminants transported via artificial drainage, and overland flow where relevant; and
3. having particular regard to adverse effects on water quality from contaminants transported via artificial drainage, and overland flow where relevant when

assessing resource consent applications and preparing or considering Farm Environmental Management Plans.

Or effects-based

In the Lignite-Marine Terraces physiographic zone avoid where practicable, ~~remedy, or mitigate~~ adverse effects on water quality from contaminants, by:

1. identifying contaminant pathways to ground and surface water bodies;
2. requiring implementation of good management practices to manage adverse effects on water quality from contaminants transported via artificial drainage, and overland flow where relevant; and
3. having particular regard to adverse effects on water quality from contaminants transported via artificial drainage, and overland flow where relevant when assessing resource consent applications and preparing or considering Farm Environmental Management Plans.

Policy 9 is proposed to be amended

Risk-based

In the old Mataura physiographic zone:

1. avoid where practicable risk to water quality from contaminants by:
   i. identifying contaminant pathways to ground and surface water bodies;
   ii. requiring implementation of good management practices to manage adverse effects on water quality from contaminants transported via deep drainage;
   iii. having particular regard to adverse effects on water quality from contaminants transported via deep drainage when assessing resource consent applications and preparing or considering Farm Environmental Management Plans.

2. avoid dairy farming of cows and intensive winter grazing where contaminant losses will increase as a result of a proposed activity.

Or effects-based

In the old Mataura physiographic zone:

1. avoid where practicable, ~~remedy, or mitigate~~ adverse effects on water quality from contaminants, by:
   i. identifying contaminant pathways to ground and surface water bodies;
   ii. requiring implementation of good management practices to manage adverse effects on water quality from contaminants transported via deep drainage;
   iii. having particular regard to adverse effects on water quality from contaminants transported via deep drainage when assessing resource consent applications and preparing or considering Farm Environmental Management Plans.

2. avoid dairy farming of cows and intensive winter grazing where contaminant losses will increase as a result of the proposed activity.

Policy 10 is proposed to be amended

Risk-based

In the Oxidising physiographic zone:

1. avoid where practicable risk to water quality from contaminants by:
   i. identifying contaminant pathways to ground and surface water bodies;
   ii. requiring implementation of good management practices to manage adverse effects on water quality from contaminants transported via deep drainage, and overland flow and artificial drainage where relevant;
   iii. having particular regard to adverse effects on water quality from contaminants transported via deep drainage, and overland flow and artificial drainage when assessing resource consent applications and preparing or considering Farm Environmental Management Plans.

2. avoid dairy farming of cows and intensive winter grazing where contaminant losses will increase as a result of a proposed activity.

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Or effects-based

In the Oxidising physiographic zone:

1. avoid where practicable, ~~remedy, or mitigate~~ adverse effects on water quality from contaminants, by:
   i. identifying contaminant pathways to ground and surface water bodies;
   ii. requiring implementation of good management practices to manage adverse effects on water quality from contaminants transported via deep drainage, and overland flow and artificial drainage where relevant;
   iii. having particular regard to adverse effects on water quality from contaminants transported via deep drainage, and overland flow and artificial drainage when assessing resource consent applications and preparing or considering Farm Environmental Management Plans.

2. avoid dairy farming of cows and intensive winter grazing where contaminant losses will increase as a result of the proposed activity.

Policy 11 is proposed to be amended

Risk-based

In the Peat Wetlands physiographic zone:

1. avoid where practicable risk to water quality from contaminants by:
   i. identifying contaminant pathways to ground and surface water bodies;
   ii. requiring implementation of good management practices to manage adverse effects on water quality from contaminants transported via artificial drainage, deep drainage, and lateral drainage;
   iii. having particular regard to adverse effects on water quality from contaminants transported via artificial drainage, deep drainage, and lateral drainage when assessing resource consent applications and preparing or considering Farm Environmental Management Plans.

2. avoid dairy farming of cows and intensive winter grazing where contaminant losses will increase as a result of a proposed activity.

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Or effects-based

In the Peat Wetlands physiographic zone:

1. avoid where practicable, ~~remedy, or mitigate~~ adverse effects on water quality from contaminants, by:
   i. requiring implementation of good management practices to manage adverse effects on water quality from contaminants transported via artificial drainage, deep drainage, and lateral drainage;
   ii. having particular regard to adverse effects on water quality from contaminants transported via artificial drainage, deep drainage, and lateral drainage when assessing resource consent applications and preparing or considering Farm Environmental Management Plans.

2. avoid dairy farming of cows and intensive winter grazing where contaminant losses as a result of the proposed activity.

Policy 12 is proposed to be amended

Risk-based

In the Riverine physiographic zone:

1. avoid where practicable risk to water quality from contaminants by:
   i. identifying contaminant pathways to ground and surface water bodies;
   ii. requiring implementation of good management practices to manage adverse effects on water quality from contaminants transported via deep drainage, and overland flow where relevant;
   iii. having particular regard to adverse effects on water quality from contaminants transported via deep drainage, and overland flow where relevant when assessing resource consent applications and preparing or considering Farm Environmental Management Plans.

2. avoid dairy farming of cows and intensive winter grazing where contaminant losses will increase as a result of a proposed activity.

Or effects-based

In the Riverine physiographic zone:

1. avoid where practicable, adverse effects on water quality from contaminants, by:

    i. identifying contaminant pathways to ground and surface water bodies;
    ii. requiring implementation of good management practices to manage adverse effects on water quality from contaminants transported via deep drainage, and overland flow where relevant;
    iii. having particular regard to adverse effects on water quality from contaminants transported via deep drainage, and overland flow where relevant when assessing resource consent applications and preparing or considering Farm Environmental Management Plans.

2. avoid dairy farming of cows and intensive winter grazing where contaminant losses will increase as a result of the proposed activity.

Policy 45 is proposed to be amended

In response to Ngāi Tahu and community aspirations and local water quality and quantity issues, FMU sections of this Plan may include additional catchment-specific values, objectives, policies, attributes, rules and limits which will be read and considered together with the Region-wide Objectives and Region-wide Policies.

Any provision on the same subject matter in the relevant FMU section of a plan (including Freshwater Objectives) must give effect to the Region-wide Objectives.

FMU provisions developed for a specific geographical area will not initiate a plan change to the Region-wide objectives or Region-wide policies.

Advice Note: It would be unfair if changes are made to Region-wide objectives and policies~~,~~ based on decisions for individual FMUs in specific parts of Southland, ~~which apply in other parts of Southland~~, without the involvement of the wider Regional ~~ese wider~~ communiti~~es~~.

Policy 46 is amended

The FMU sections of this Plan are based on the following identified Freshwater Management Units for Southland, as shown on Map Series 6: Freshwater Management Units:

- Fiordland and the islands;
- Aparima;
- Mataura;
- Ōreti;
- Waiau; and
- Waituna.

Policy 47 is amended

The FMU sections of this Plan will give effect to the region wide Objectives – and:

1. identify values and establish freshwater objectives for each Freshwater Management Unit, including where appropriate at a catchment or sub-catchment level, having particular regard to the national significance of Te Mana o te Wai, and any other values developed in accordance with Policies CA1-CA4 and Policy D1 of the National Policy Statement for Freshwater Management 2014 (as amended in 2017); and
2. set water quality and water quantity limits and targets to achieve the freshwater objectives; and
3. set methods to phase out any over-allocation, within a specified timeframe; and
4. assess water quality and quantity taking into account Ngāi Tahu indicators of health.

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