DRISCOLL FARM EXPANSION: TECHNICAL WATER QUALITY ASSESSMENT

Date: 23 July 2019 File Ref: 17423

To: Tanya Copeland, Senior Planner

From: Mike Freeman, Senior Scientist/Planner

Subject: **Water quality effects assessment for Driscoll Farm dairy expansion**

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1. Background

T J and J A Driscoll own a 599-cow dairy farm located approximately 5 km south of Winton. They are applying for resource consents to increase the number of milked cows to 700 across an extended dairy platform.

The purpose of this report is to provide information on existing water quality in the vicinity of the proposed expansion in the context of relevant water quality standards and guidelines, to indicate the likely effects of the proposal on existing water quality and to identify if any mitigation may be needed to assist in achieving water quality objectives where water quality guidelines/standards are not being achieved.

This report contributes to the Assessment of Environmental Effects that accompanies the resource consent applications associated with the proposed development.

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2. Soil and physiographic environment

The soils and physiographic zones have been described in detail in the main AEE together with the implications for contaminant loss and are not repeated here.

3. 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 Oreti River. The NIWA/MfE River Environment Mapping layer indicates that the vast majority of the property lies within the Oreti River catchment with a very small proportion of the property within the Tussock Creek or 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.

Figure 1 Location of Driscoll property and catchment above the two key long-term water quality monitoring sites

The ES GIS mapping system identifies that approximately 75% of the property is in the direct Oreti River catchment and 25% of the property in the Tussock Creek catchment. However, 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.

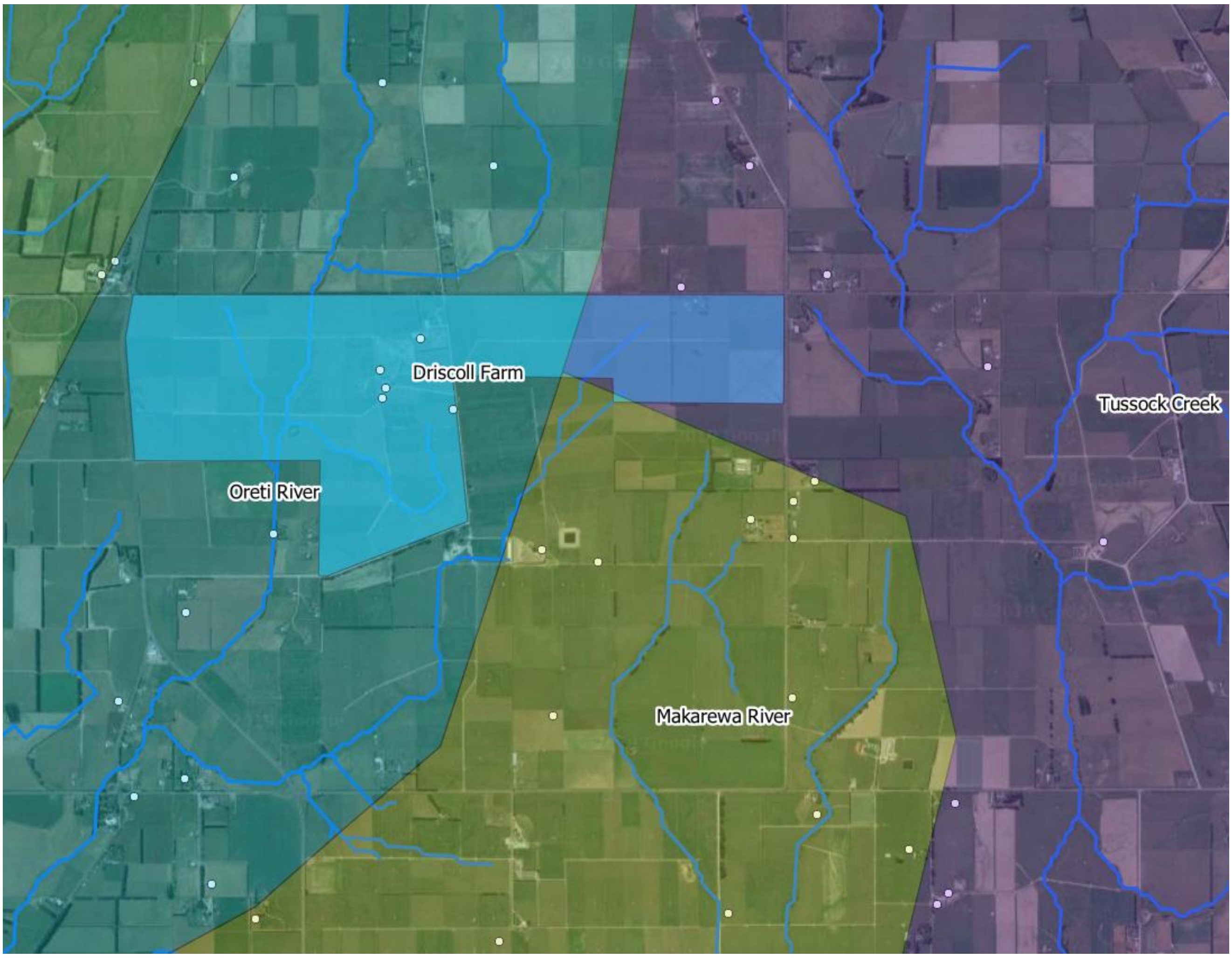


Figure 2 Location of the property relative to NIWA mapped surface water bodies and ES sub-catchment areas.

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.

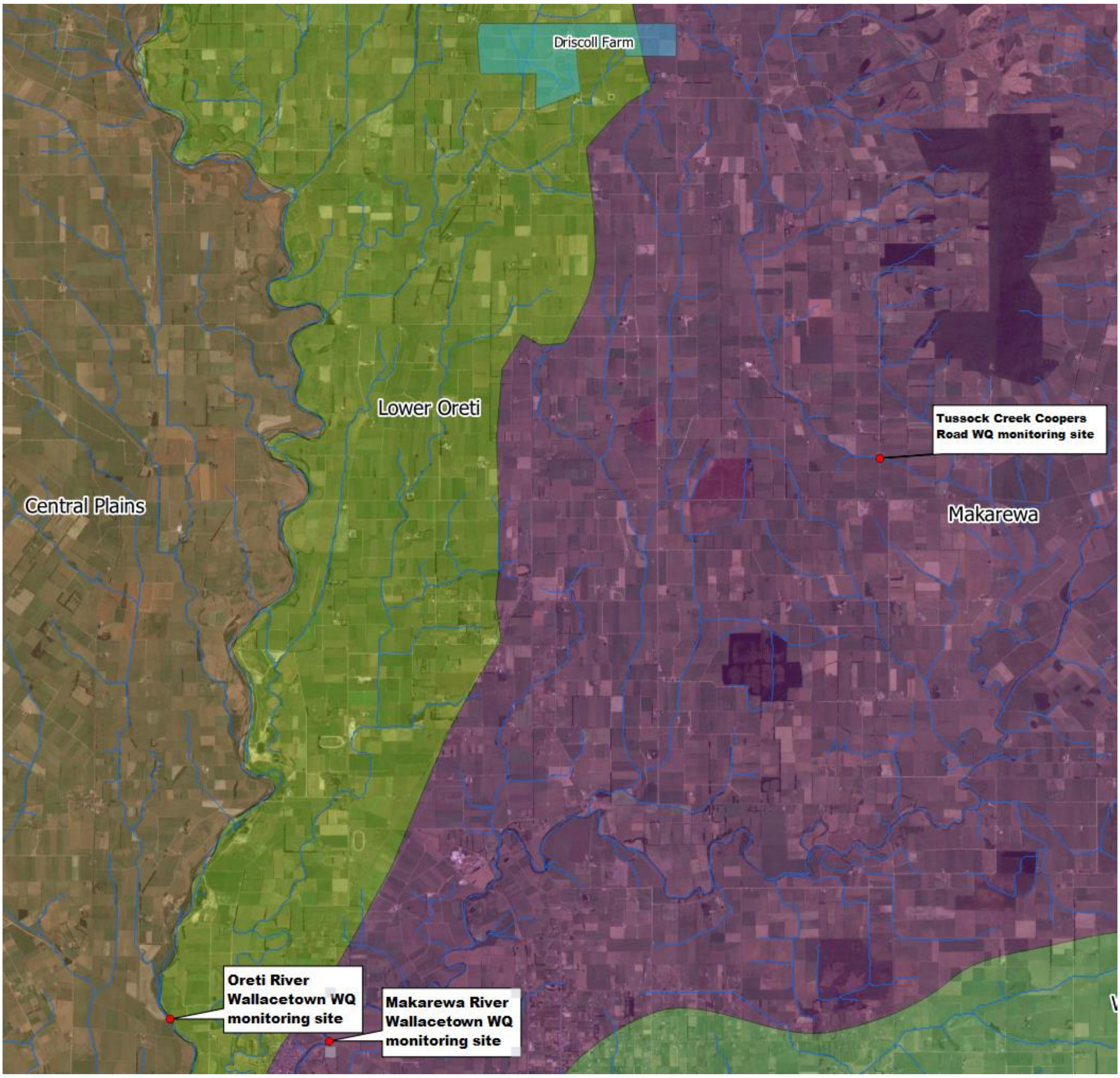


Figure 3 Location of Driscoll property relative to the PSWLP groundwater management zones

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[1]) 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.

4. Statutory water quality objectives and standards

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.

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

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 1 Summary of key regional plan surface water values & objectives for water in the two locations

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.

The detailed policy assessment is contained in the AEE. However, the critical point for this report is the context that many relevant statutory objectives are not being achieved.

While activities on one individual property will generally only have an extremely small influence on catchment water quality, it is recognised that within the detailed policy framework discussed in the AEE, an appropriate level of contaminant loss mitigation will be required at the property level (See Section 6 of this report).

5. Existing water quality in the vicinity of the proposal

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 2: 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	Indeterminate	≥ 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) (see page 9 comments)		<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. Frequent poor water clarity, and
3. Raised nutrient concentrations leading to plant growth in the stream and further downstream, and

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.

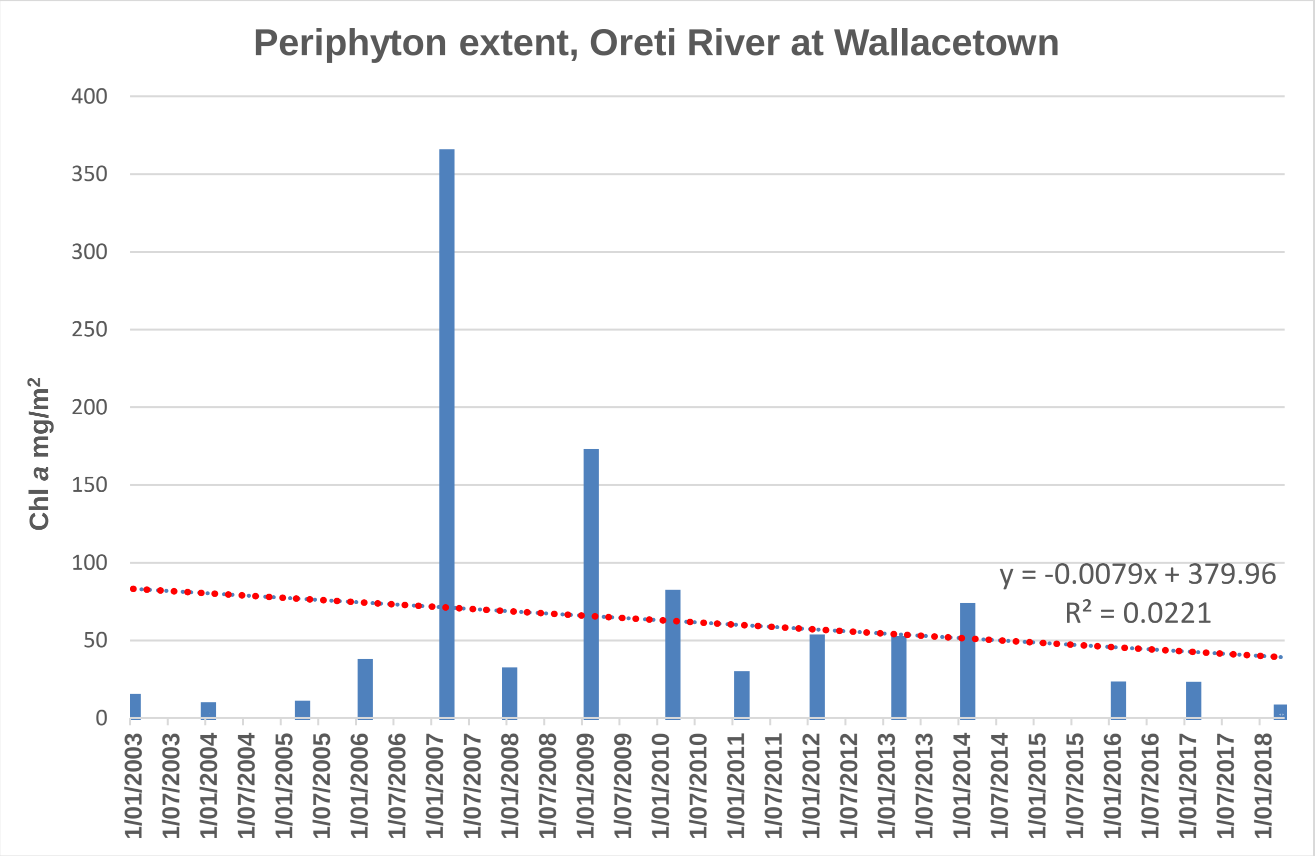


Figure 4 Periphyton extent at the Oreti River water quality monitoring site, 2003 - 2018

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.

The NOF attributes are also not simple pass/fail results with the exception of the National Environmental Bottom line of 200 mg/m^2 that has been exceeded once at this site. 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[2] 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 is also a regular annual winter/autumn increase of nitrate N concentrations seen in the Oreti River. This is likely to be driven by the increase in drainage during winter as illustrated in the groundwater levels in the relatively close long-term groundwater monitoring site at Heddon Bush. This is indicated in the following two figures.

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

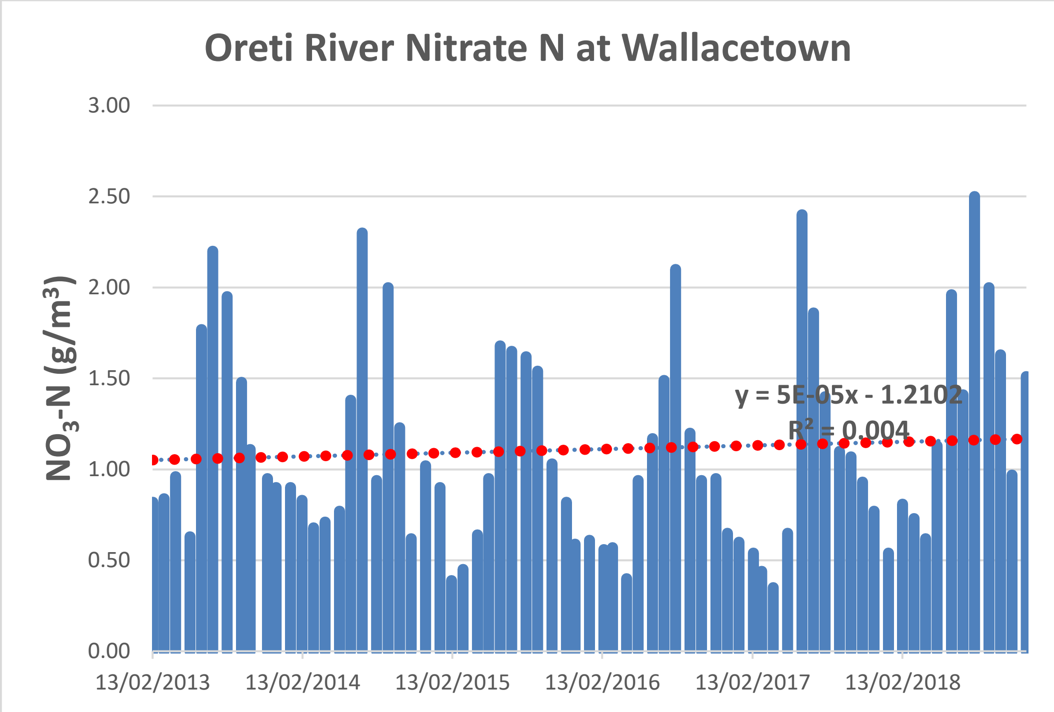


Figure 5 Nitrate N concentrations in the Oreti River at Wallacetown, 2013 - 2018

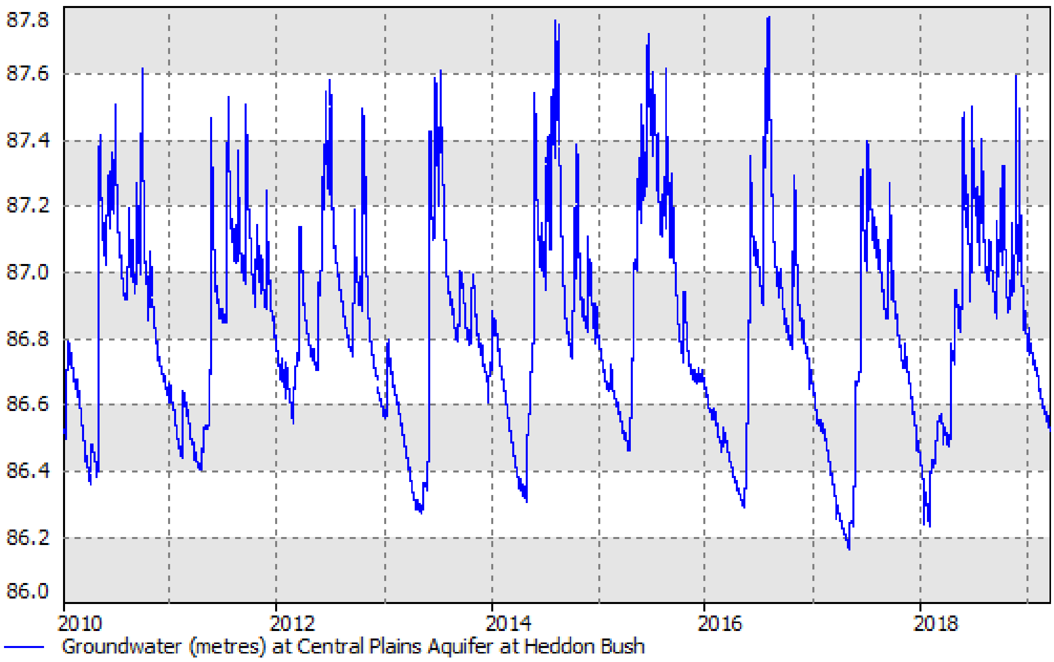


Figure 6 Groundwater level fluctuations at the Heddon Bush groundwater monitoring site 2010 - 2018

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).

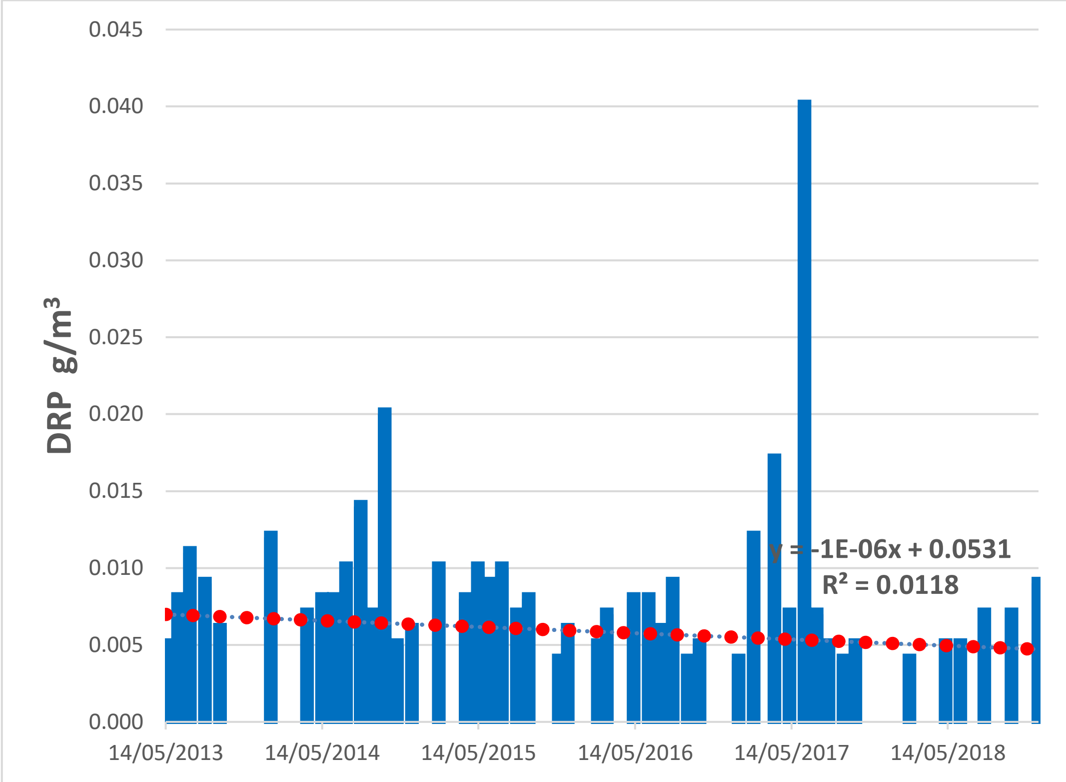


Figure 7 Dissolved reactive phosphorus concentrations in the Oreti River at Wallacetown, 2013 - 2018

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.

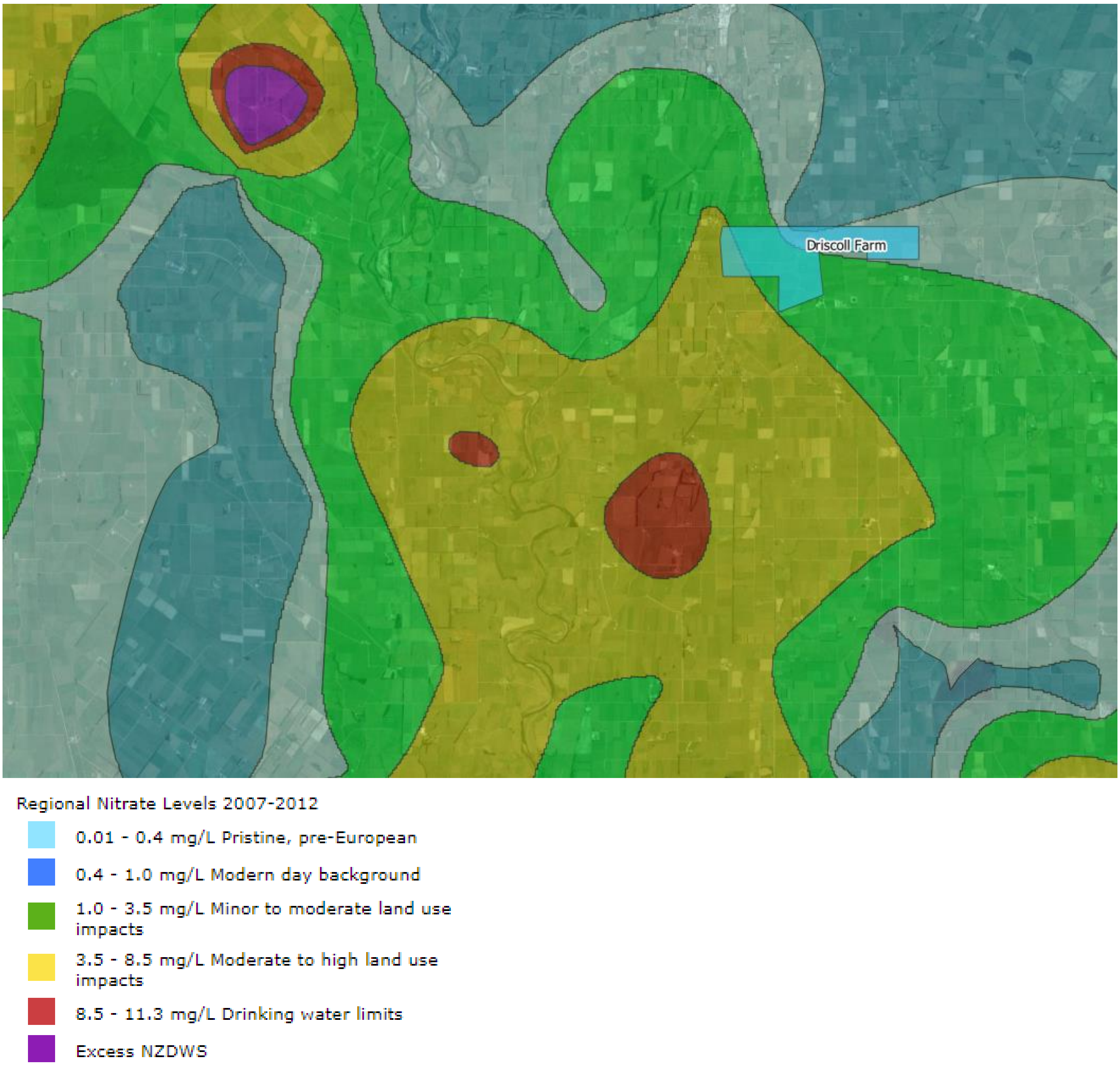


Figure 8 Environment Southland groundwater nitrate N concentration contour estimates for the period 2007 – 2012

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 10 – 25 m depth).

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. The data shown below are the maximum nitrate N values found for groundwater from bores that appear to fully penetrate the aquifer and have data available for approximately 10 years from 2008 to 2018.

Figure 9 Peak nitrate N concentrations for groundwater from bores in the general area, post-2012 overlaid onto the 2007-2012 nitrate N concentration contour estimates

Groundwater from two bores (peak values 8.7 (14.5 km west) and 10.3 g/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.

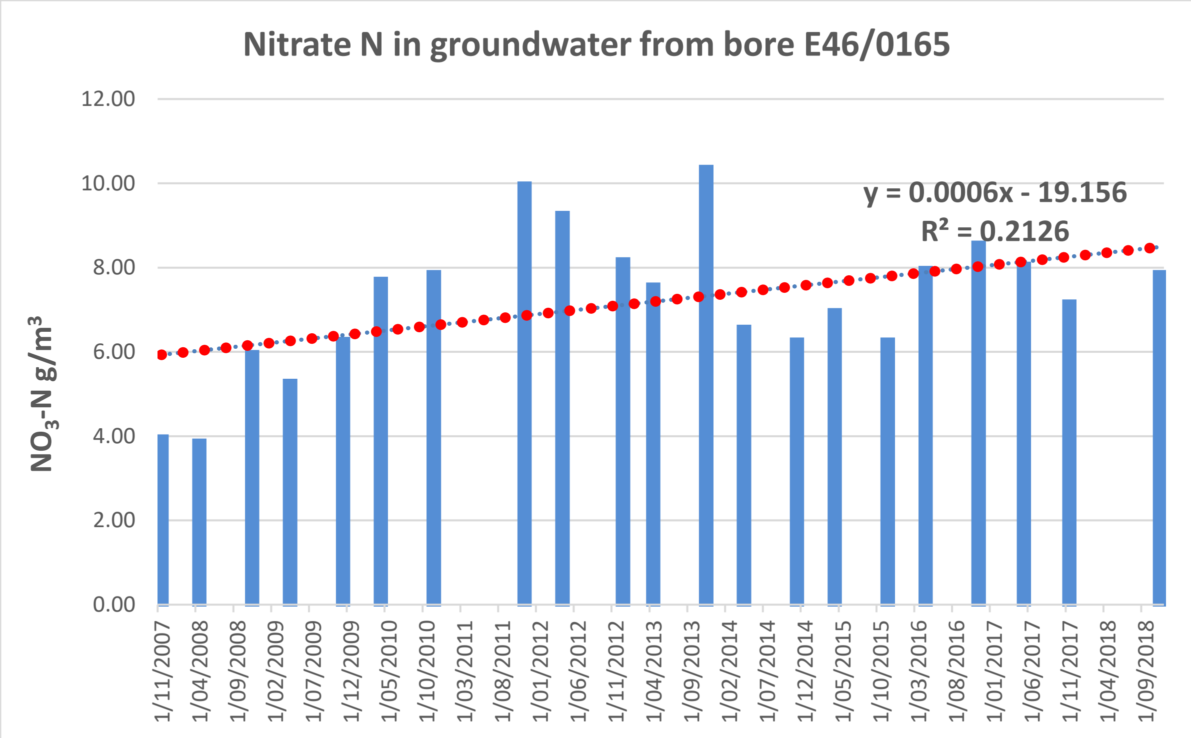


Figure 10 Nitrate N concentrations from bore E46/0165, ~8.5 km south south west of Driscoll property

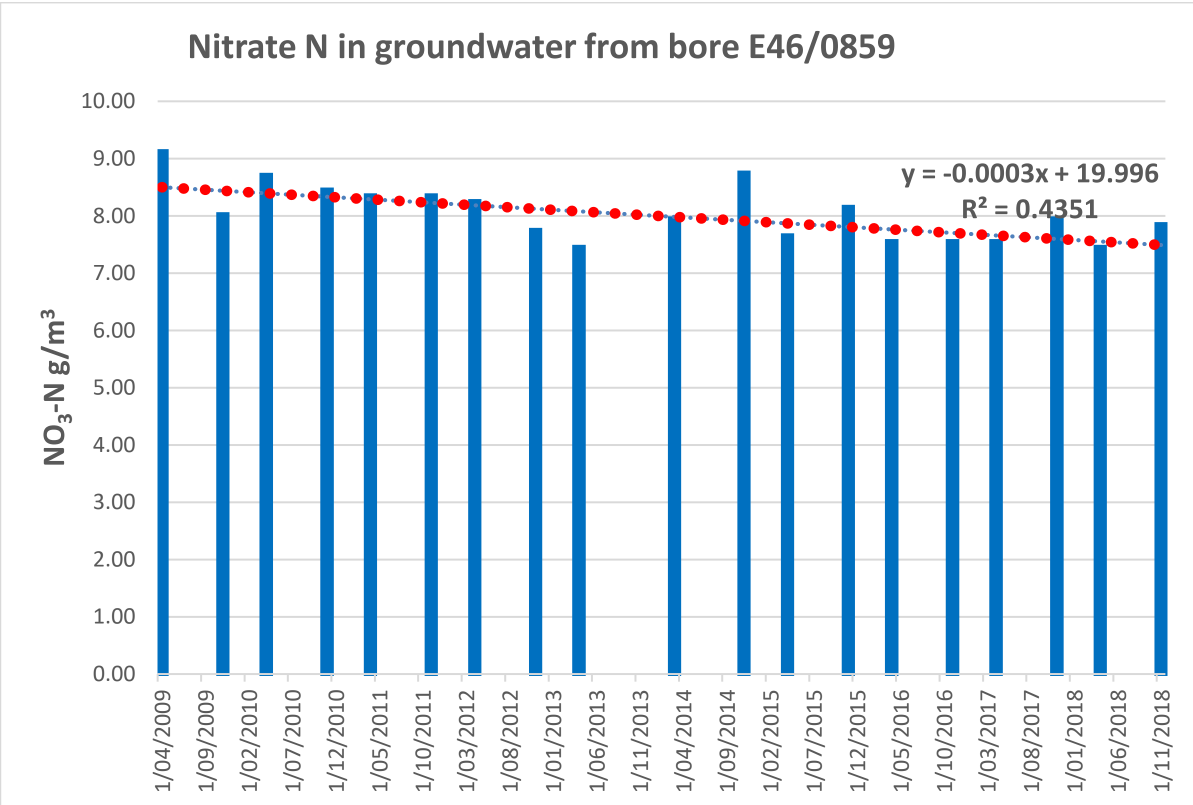


Figure 11 Nitrate N concentrations from bore E46/0859, ~14.5 km west of Driscoll property

The information illustrated in figures 10 and 11 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 11 still has a relatively low R^2 value (0.43) but is significantly higher than that for the trendline in Figure 10. This indicates that there is a higher level of confidence about the downward trend indicated in Figure 11 compared to the upwards trend indicated in Figure 10.

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 raised concentrations discharging into connected surface waters, specifically the Oreti River (See Figure 5).

6. 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[3] 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.

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

Table 3: Summary of intertidal opportunistic macroalgal cover, New River Estuary, February 2018[4]

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' 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[5]. These are outlined in the following table.

Table 4: 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.

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

Table 5: 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 6: Description of mitigations assumed to apply under each mitigation level

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.

As a proportion of the estimated catchment loads, the overall loads from this property is understandably extremely small. On a modelled catchment source load basis, the overall load would amount to approximately 0.2% (11,345/4,969,000 or 11,345/5,513,000) 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.

7. Off-site wintering and grazing

Tables 7 and 8 summarises the overall number of young stock and cows grazed on land which is not part of the applicant's landholding over winter compared to the numbers which are grazed on the landholding. The tables show the proposal results in:

- No change in the number of mixed age/R2 cows intensively wintered off-site
- A reduction in the number of R1 calves intensively wintered off-site
- An increase in the number of mixed age/R2 cows grazed on pasture/baleage on-farm over winter
- An increase in the number of R1 calves grazed on pasture/baleage off-farm over winter.
- An increase in the total number of R1 calves raised

Table *7*: Summary of current off-site intensive winter grazing and young stock grazing activities for 2018

	Off-site Intensive winter grazing	Off-site Pasture/baleage grazing over winter	On-farm Pasture/baleage grazing over winter
Mixed age/ In-calf heifers	516	0	83
R1	160	0	0

Table 8: Summary of proposed off-site intensive winter grazing and young stock grazing activities

	Off-site Intensive winter grazing	Off-site Pasture/baleage grazing over winter	On-farm Pasture/baleage grazing over winter
Mixed age/ In-calf heifers	516	0	216
R1	0	187	

Table 9 below provides information for previous off-site grazing locations and crop type. The applicant does not sign contract or lease agreements with any specific grazier, preferring to maintain optimum flexibility in grazing decisions especially considering climatic conditions and *M. bovis* considerations. The applicant is happy to provide information on previous grazing practices on the properties they have used for grazing but is not able to formally detail what future cropping practices will be on any of these properties given they have no direct control or influence over decisions.

Table *9*: Current and previous off-site grazing locations and crop type

Season	Description of Activity	Location
2017	R1 calves intensively winter grazed on Fodder Beet R1/R2 grazed all year round Mixed age cows/R2s intensively winter grazed on Fodder Beet	Various locations from 2013 including Tapanui, Mataura, Forest Hill Various locations from 2013 including Tapanui, Mataura, Forest Hill 298 Fortrose Otara Road
2018	R1 calves intensively winter grazed on Fodder Beet R1/R2 grazed all year round	Various locations from 2013 including Tapanui, Mataura, Forest Hill

	Mixed age cows/R2s intensively winter grazed on Swedes	Various locations from 2013 including Tapanui, Mataura, Forest Hill 298 Fortrose Otara Road
2019	R1 calves intensively winter grazed on pasture/baleage R1/R2 grazed all year round Mixed age cows/R2s intensively winter grazed on Fodder Beet	226 Norman Road and 298 Cooper Road 226 Norman Road and 298 Cooper Road 298 Fortrose Otara Road

An assessment of environmental effects relating to current/previous winter grazing practices

The proposed changes to the farm system detailed in the application result in two main consequential changes to activities located off-site i.e. on land not part of the applicant's landholding. These consequential changes include the substitution of off-site R1 intensive winter grazing with off-site pasture/baleage wintering and the addition of 27 additional R1 calves to off-site grazing all year round.

The substitution of off-site intensive winter grazing with off-site pasture/baleage wintering will result in positive environmental effects as wintering young stock on pasture generally results in lower N. P, sediment and microbial contaminant losses to the environment compared to intensive winter grazing on fodder crop. We do not have quantitative information to assess the extent to which 27 additional R1s grazing on pasture would 'take away' from the reduced environmental effects of moving from IWG. However, there will be significant environmental benefits in moving 160 R1s from IWG and only very minor effects of an additional 27 R1s grazing. On balance it is highly likely that the overall result will still be a significant reduction in adverse effects.

When cows graze on pasture, soils are left with residual ground cover after grazing. This form of grazing reduces instances of cows treading over bare soils which leads to 'pugging' or structural compaction which in turn accelerates the risk of flushing of excess contaminants to nearby waterways via artificial drainage and overland flow. Good management practices are implemented for pasture/baleage wintering in the same manner as intensive winter grazing such as ensuring stock are back-fenced, grazing from the top to bottom of the slope, and ensuring waterways have a 5-metre buffer zone to mitigate adverse effects of winter grazing towards surface waterways.

Conclusions on off-site effects

The above information on the recent off-site locations and the fact that there is also no increase in the number of cows wintering off farm between the current and proposed scenarios strongly indicates that the proposal will result in a small improvement in off-site contaminant losses.

8. 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 (see main AEE) 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.

9. Contaminant loss mitigation proposals

Existing good management practices

The AEE outlines and illustrates the existing good management practices that are currently being implemented on this property. These include existing fencing of waterways expansion of the effluent discharge area and reducing N fertiliser use on the effluent discharge area. Some of these are assumed in the Overseer modelling. However, some practices, such as laneway kickboards and laneway crossing runoff prevention measures are not accounted for in the Overseer modelling and therefore particularly the estimates of P loss are highly likely to over-estimate the actual amounts lost to water.

We do not have enough information about other properties in the catchment to comment on the relative contributions, but if other similar properties in these catchments do not include these contaminant loss reduction practices, they will be contributing proportionally more contaminants particularly sediment, P and faecal indicator organism to surface waters.

Overseer modelling

The Overseer reports prepared by Mo Topham attached to the main AEE summarise the pre and post-development farm systems and the primary contaminant loss mitigation measures proposed.

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.

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. These mitigations are detailed in the Farm Environmental Management Plan (FEMP).

Table 7: Mitigation Plan Outline – refer to AEE and 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.

Mitigation	Timing	Operation	Level of effectiveness
			Effluent spread little and often reduces the risk of losses.
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 an annual basis, preferably at the same time every 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.	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	New lanes to be constructed away from waterways and bridge crossings to be designed to direct runoff to pasture. Increase buffer width on key laneway alongside drain. Gravel used in gateways to avoid tramping damage and runoff directed to pasture. Riparian vegetation to be kept in-situ behind stock exclusion fences.	High level of effectiveness for reducing P losses via “other sources” as modelled in Overseer.

10. Estimates of N and P losses before and after development

The following table provides a summary of current and proposed N and P losses to water, based on a combined three-year average of inputs for the current and proposed dairy farm system. The Overseer modelling has been undertaken by Mo Topham and reviewed by Miranda Hunter (both CNMA qualified).

The N and P losses from the farm systems have been modelled using Overseer Nutrient Budgets (v6.3.0), which indicate that N losses are predicted to decrease slightly. The initial Overseer modelling alone predicts a small increase in P loss. The limited range of P mitigation measures provided for in Overseer is well established[6]. As a consequence, Mo Topham has provided a brief report[7] that identifies additional mitigation measures that cumulatively show that a small reduction in modelled P loss is achievable.

Table 8: Summary of N & P property losses to water for Aerodrome Farm Ltd including wintering block

Nutrient Losses to Water	Combined Current Farm System (3 Year Average)	Proposed Farm System	Difference (%)
N Loss	11,505 kg N/year	11,345 kg N/year	- 160 kg N/year (-1.4)
P Loss Overseer P loss Overseer Plus additional mitigation	262 kg P/year 229 kg P/year	278 kg P/year 226 kg P/year	+ 16 kg P/year (+6) - 3 kg P/year (-1.3)

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[8].

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.
- 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.

There is a tension between these two conclusions. However, there are a number of significant farm system changes and mitigation measures that provide a high level of certainty that the actual loss of N and P will reduce slightly.

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

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[9] 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

[6] Gray, C., Wheeler, D & McDowell, R. (2016) Review of the phosphorus loss submodel in Overseer, Report prepared for Overseer owners under AgResearch core funding contract A21231(A), RE500/2015/050, February 2016

[7] Topham M (2018) Further information: Tand J Driscoll Family Trust consent application

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

[9] 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.

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.

Table 10 below presents 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.

Table 9: Management tools proposed that will reduce P losses to water

Phosphorus Loss Mitigation	Rewarded in Overseer?	Proposed to be implemented
Fencing Streams	*Yes*	✓
Appropriate fertiliser rates	*Yes*	✓
Avoiding high risk times for fertiliser application	*Yes*	✓
Change fertiliser type	*Yes*	✓ *(low solubility P fertiliser)*
Targeting optimum Olsen P (30)	*Yes*	✓
Culverts and bridges	*No*	✓
Managing track runoff	*No*	✓
Manage CSAs	*No*	✓
Spread fertiliser evenly	*Yes – assumed already*	✓
Reducing ability of stock to form camps	*No*	✓

12. Conclusions on the effects of the proposal on water quality

Local and cumulative surface water quality

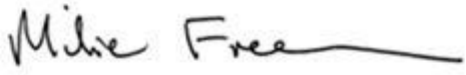
The information outlined above on the quality of surface water downstream of this property combined with the estimates of the current and likely futures losses of sediment, faecal indicator organisms, N and P from the properties provide strong evidence for a real but extremely small overall improvement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

Local and cumulative groundwater quality

The information from the Overseer modelling combined with the specific good management practices provide strong evidence for a real but extremely small 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.

New River Estuary quality

The key water quality issues in the New River Estuary appear to be sediment and nutrient loading. Contaminant losses from this property will be making an almost negligible contribution (<0.2%) to these loadings. 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.



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