Orari-Temuka-Opihi-Pareora (OTOP) Zone

Estimating nitrogen and phosphorus contributions from authorised discharges in five Freshwater Management Units

A report for Environment Canterbury

Barry Loe, Loe Pearce & Associates Ltd
and
Chris Clarke, Clarke Goldie & Partners

August 2017

Executive Summary

Environment Canterbury is developing methods to manage the cumulative effects on Canterbury's freshwater bodies from nitrogen and phosphorus discharges. These methods include setting limits in catchments for nitrogen, and managing activities that discharge phosphorus. Setting limits for a Freshwater Management Unit (FMU) requires a stock-take of the nitrogen and phosphorus inputs from point source discharges authorised by resource consent or permitted activity rules in regional plans. In this report these discharges are described as 'authorised discharges'.

Loe (2012) estimated the regional contribution of nitrogen and phosphorus to water from point source discharges authorised, either by a current discharge permit, or by a permitted activity rule in the applicable regional plan, for each Nutrient Management Zone in the region. Following publication of that report, nutrient input calculations have been refined for specific zones. This report provides revised estimates for nitrogen and phosphorus from discharges authorised by resource consent or permitted activity rules in the Canterbury Land and Water Regional Plan for five FMUs within the Orari-Temuka-Opihi-Pareora (OTOP) Zone.

Estimates of nitrogen and phosphorus that may be discharged from 4089 authorised discharge sources were calculated for the five FMU areas. These estimates are based on information in Environment Canterbury's databases and electronic file record systems, including documents associated with applications for, or changes to, resource consents, and compliance monitoring reports. The table below summarises the total estimated potential annual loads of nitrogen and phosphorus from authorised discharges in the OTOP Zone study area, excluding diffuse discharges from land use activities.

Estimated total annual loads of nitrogen and phosphorus from authorised discharges across the OTOP Zone study area.

Authorised point source Discharges	Number of discharges	N (t/yr)	% of N*	P (t/yr)	% of P*
On-site sewage effluent pre-2006	2834	25.5	3	5.7	2
On-site sewage effluent post-2006	1056	12.3	1	3.1	1
Farm dairy effluent ponds	183	18.3	2	3.7	2
Community sewerage systems	6	13.2	1	3.9	2
Milk processing wastewater	6	797.8	85	203.6	88
Meat processing wastewater	1	56.6	6	11.1	5
Other food processing	3	15.3	2	0**	0**
Totals	**4089**	**939.0**	**100%**	**231.1**	**100%**

* percentage of nutrient load from authorised discharges investigated

** limited data available for P loads from this source

The results of this investigation are consistent with the findings of Loe (2012) for the region. Overall, authorised discharges of wastewater from industrial processing operations of milk, meat and other food products accounted for more than 90% of the potential nitrogen and phosphorus loading from all the authorised discharge sources.

There are a large number of authorised discharges of sewage effluent from domestic on-site systems and leakage from dairy effluent storage ponds across the OTOP Zone study area, but these contributed only 5 to 6% of the annual nitrogen and phosphorus load. Community sewerage systems contributed about 1% and 2% of the respective nitrogen and phosphorous loads from authorised discharges in the Zone.

The estimated potential annual loads of nitrogen and phosphorus from authorised discharges within each of the FMU areas are shown in the following table.

Estimated total annual loads of nitrogen and phosphorus for each FMU in the study area*.

	Orari FMU	Temuka FMU	Timaru FMU	Opihi FMU	Pareora FMU
Total N (t/yr)	829.3	14.4	21.7	10.3	63.3
Total P (t/yr)	207.8	3.0	5.3	2.3	12.6

*from authorised discharges investigated

Within the OTOP Zone study area, the Orari FMU had the highest potential nitrogen and phosphorus load resulting predominantly from discharges of wastewater to land from milk processing operations. Discharges from a meat processing plant is the dominant source of nitrogen (90%) and phosphorus (88%) from authorised discharges in the Pareora FMU.

The information presented in this report is based on information from Environment Canterbury's consents database of discharges as of 29/09/2016. Some activities may not be exercised to the full extent authorised, so estimates may not represent the current load of nitrogen and phosphorus.

1. Introduction

Environment Canterbury is developing methods to manage the cumulative effects on Canterbury's freshwater bodies from nitrogen and phosphorus discharges. These methods include setting limits in catchments for nitrogen, and managing activities that discharge phosphorus. Setting limits for a Freshwater Management Unit* (FMU) requires a stock-take of the nitrogen and phosphorus inputs from all sources. This report estimates the contribution from existing authorised point source discharges to land and water, plus industrial wastewater discharges to land. In this report these discharges are referred to as 'authorised discharges'.

Loe (2012) estimated the regional contribution of nitrogen and phosphorus from relevant point source discharges authorised, either by a current discharge permit, or by a permitted activity rule in the applicable regional plan, for each Nutrient Management Zone in the region. Following publication of that report, nutrient input calculations have been refined for specific zones.

This report provides estimates of the nitrogen and phosphorus inputs from authorised point source discharges in five Freshwater Management Unit areas of the Orari-Temuka-Opihi-Pareora (OTOP) Zone. For the purpose of this study the Rangitata Green FMU† and catchments where a number of hill-fed tributaries flow directly into the Rangitata River, were excluded as they are situated outside the study area.

Nitrate is one of the main contaminants of interest in Canterbury groundwater and surface water as it can have toxic effects on aquatic biota (Hickey and Martin 2009), pose a risk to human drinking water (MoH 2008), and in combination with phosphorus it enhances aquatic plant growth (Bidwell and Norton 2009). Discharges to land can result in nitrogen entering groundwater, and discharges to surface water are direct pathways for the nutrients to enter the aquatic environment with little or no attenuation. Relatively little attenuation of nitrate occurs once it enters groundwater.

Although phosphorus leaching has not been considered a significant issue in New Zealand soils, analysis of the vulnerability of Canterbury soils to leaching of phosphorus shows moderate vulnerability over extensive areas of the Canterbury plains (Webb et al 2007, Webb et al 2010). In some soils, phosphorus can be mobilised and lost in soil drainage water particularly under high application rates and high hydraulic loads (Toor et al 2004). Even very small increases in phosphorus concentrations in surface water can have ecological consequences for fresh water bodies (Bidwell and Norton 2009).

---

* "Freshwater management unit (FMU)" 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 (National Policy Statement – Freshwater Management 2014).

† At the time of writing, the 'Rangitata Green' Freshwater Management Unit had not been integrated with the Orari FMU.

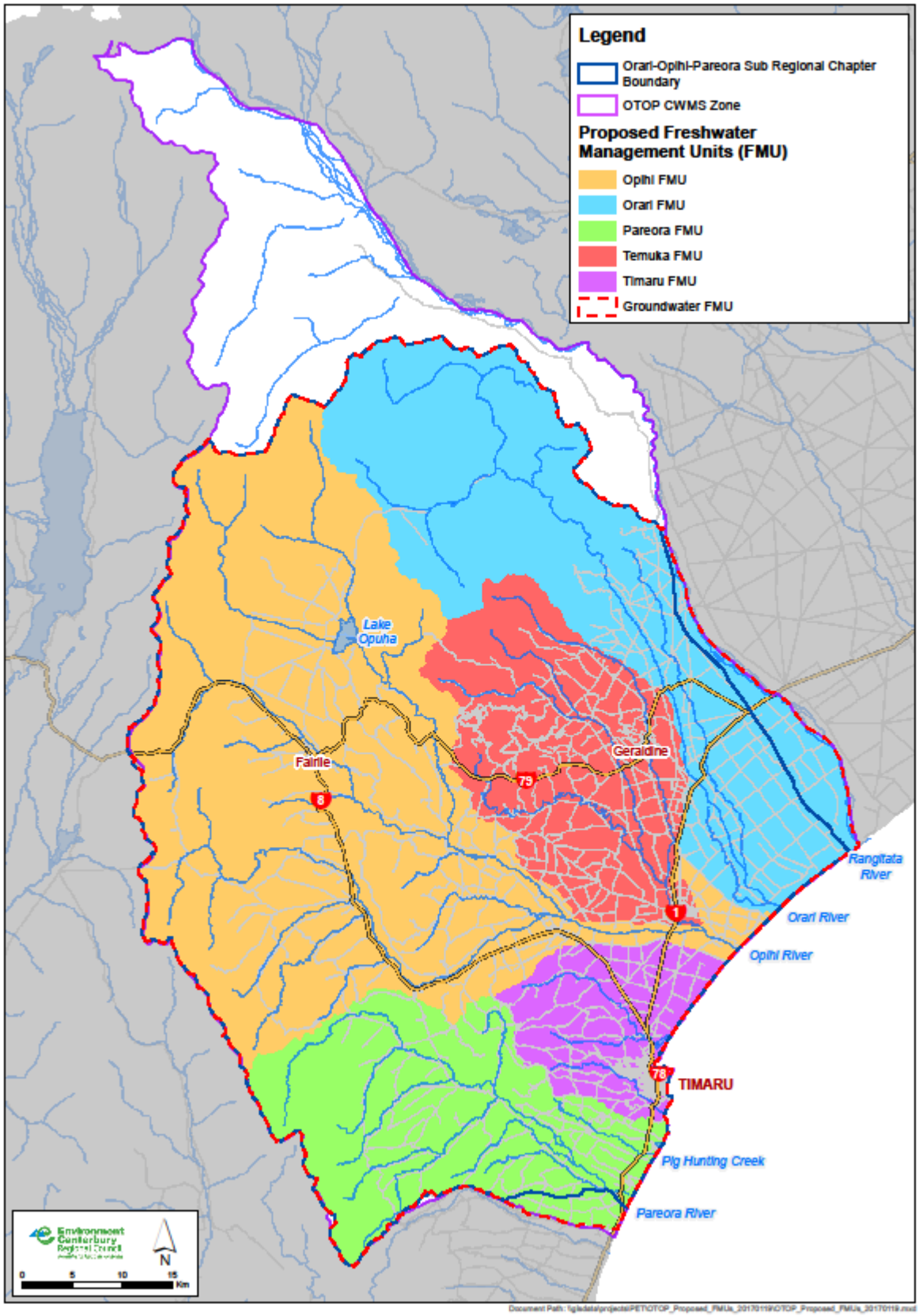

Figure 1 Orari-Temuka-Opihi-Pareora Zone

3 Methodology

Identifying discharge sources of nitrogen and/or phosphorus.

Environment Canterbury provided spreadsheets from their consents database of discharges to land or water, and land uses, such as effluent storage with potential for nutrients to enter water, that are currently authorised in the Orari-Temuka-Opihi-Pareora Zone. Records consisted of resource consents or activities approved as permitted activities. Activities that were identified as potentially significant contributors of nitrogen and/or phosphorus in this zone were:

- Discharges to land or water of sewage effluent from domestic and larger scale (e.g. school, factory or camping ground) treatment and disposal systems (3890 sources);
- Discharges to land or water of sewage effluent from community sewage treatment and disposal systems, including leakage from storage or infiltration ponds (6 sources);
- Discharges in the form of leakage from farm dairy effluent storage ponds (183 sources);
- Discharges to land from milk processing (6 sources), meat processing (1 source) and other industrial food processing (3 sources).

Estimating nitrogen and phosphorus contributions

The basis for estimating nitrogen and phosphorus contributions, including methodology used, is detailed in Loe (2012). The following is an overview of the methodology used in this report to calculate nutrient loading for each source. Detailed information is presented where the methodology differs from that used in Loe (2012).

The estimates of nitrogen and phosphorus discharged are based on what is authorised to be discharged and doesn't take into account any transformation or attenuation of nutrients that may occur, due to discharge method or physical or biological processes. These estimates are not an indication of potential nitrogen or phosphorus contributions to groundwater or surface water concentrations.

Sewage effluent from on-site systems:
On-site sewage systems installed before 2006 were assumed to discharge:

Nitrogen: 55 g/m^3 or 9 kg N/dwelling/year
Phosphorus: 12 g/m^3 or 2 kg P/dwelling/year

Data from Loe (2012) provided the number of sewage discharges prior to 2006. The boundaries have been adjusted to align the discharges with the relevant FMU area.

On-site sewage systems installed since 2006 were assumed to have discharge concentrations of 20 g/m^3 of nitrogen and 5 g/m^3 of phosphorus. An annual discharge of each nutrient was calculated (tonnes per year) using daily discharge volumes obtained from individual resource consents or the maximum allowed by permitted activity rules in the regional plan.

Sewage effluent from community systems and industrial wastewater:
The details of each record were analysed to determine, where possible:

- the annual volume of wastewater or effluent authorised to be discharged;
- any limits on the seepage rate from effluent or wastewater storage facilities;
- any limits in the discharge permit on loadings of nitrogen or phosphorus;

- the area of land over which the effluent or wastewater is discharged.

In many instances some of this information could not be obtained from the resource consent, or Environment Canterbury's consents database. Limits relating to nitrogen, and particularly phosphorus, were often not specified in consent conditions.

The discharge area was not always specified on the consent document, attached plan or on the database. In such cases, it was necessary to refer to the application for resource consent or to calculate the area using the ECan online GIS. If available, compliance reports were also examined to determine nutrient concentrations in discharges and other relevant information.

In the OTOP Zone, community sewerage treatment systems are operated by Timaru District Council and Mackenzie District Council. In Timaru District, the system comprises township reticulation to local treatment and storage facilities at Pleasant Point, Temuka and Geraldine. Sewage effluent is conveyed from these facilities via a pipeline to effluent treatment ponds at Washdyke, Timaru, prior to discharge via an ocean outfall. In Mackenzie District, reticulated sewerage systems for Burkes Pass and Fairlie comprise treatment, storage and discharge to land at each township.

The discharge from community sewerage systems includes seepage from storage ponds and the discharge to land of treated effluent. The seepage from storage facilities, unless limited by conditions in a resource consent, was assumed to be 1 millimetre per day based on regional plan permitted activity rules for effluent storage.

Where discharge concentrations for nitrogen and phosphorus in community sewage effluent were not able to be calculated from resource consent conditions or monitoring reports, default concentrations of 17 g/m^3 nitrogen and 5 g/m^3 phosphorus in the sewage effluent were used (Potts and Ellwood 2000).

Milk processing wastewater discharges to land were conservatively estimated to operate for 320 days per year, to reflect the seasonal nature of milk production. Appendix 2 details the calculation of nitrogen and phosphorus loads for discharges of industrial wastewater from milk and meat processing.

Seven resource consents authorise discharges of wastewater from milk processing in OTOP. All are located in the Orari FMU. Of these, one resource consent (CRC121209) was excluded from the estimations due to the apparent very small scale, and lack of information.

Farm effluent storage ponds:

There are 191 resource consents that authorise discharges of collected animal effluent in the OTOP Zone. Of these, 183 are discharges from farm dairy effluent systems. For the purpose of this investigation, it was assumed that each of these systems included a storage facility with potential to leak at the rate authorised by regional plan rules. For the remaining eight discharges, it was not possible to determine if there was an associated storage facility for animal effluent, therefore due to the lack of information, these were not included in the estimation of nutrient load.

Enquires made to Dairy NZ and Synlait Milk Limited indicated that almost all milk suppliers comply with the industry requirement for adequate dairy effluent storage. Therefore, the number of dairy farm effluent storage ponds was assumed to equate to the number of resource consents granted for the discharge of farm dairy effluent in each FMU area. The annual load of nutrients leaking from a dairy farm effluent storage pond is estimated to be 0.1 tonnes per year of nitrogen, and 0.02 tonnes per year of phosphorus (Loe, 2012).

4. Results

The results of this investigation are consistent with the findings of Loe (2012). Discharges from milk, meat and food processing operations make up the largest proportion of the nutrient load from authorised point source discharges in the OTOP Zone. Of the 4089 authorised activities, 10 discharges of wastewater from industrial processors accounted for more than 90% of the nutrient loading from authorised discharges (Table 1).

Discharges of sewage effluent from on-site systems and leakage from dairy effluent storage ponds, while the most numerous authorised discharges, contributed only about 5% to 6% of the total point source nutrient load.

Table 1: Total estimated annual loads of nitrogen and phosphorus from authorised point source discharges in the OTOP study area.

Authorised point source Discharges	Number of discharges	N (t/yr)	% of N*	P (t/yr)	% of P*
On-site sewage effluent pre-2006	2834	25.5	3	5.7	2
On-site sewage effluent post-2006	1056	12.3	1	3.1	1
Farm dairy effluent ponds	183	18.3	2	3.7	2
Community sewerage systems	6	13.2	1	3.9	2
Milk processing wastewater	6	797.8	85	203.6	88
Meat processing wastewater	1	56.6	6	11.1	5
Other food processing	3	15.3	2	0**	0**
Totals	**4089**	**939.0**	**100%**	**231.1**	**100%**

* percentage of nutrient load from authorised discharges investigated

** limited data available for P loads from this source

The annual loading of nitrogen and phosphorus from milk processing wastewater discharges is 85% or more of the total point source load of each of nitrogen and phosphorus from the authorised discharges. Within the study area, the Orari FMU has the highest potential loading of nitrogen and phosphorus from authorised discharges due to milk processing wastewater discharges to land (Table 2). The potential loading of nutrients from each of the six authorised milk processing discharges is often equal to, or exceeds, the total loading from other discharge sources (Table 3). Wastewater discharges from the meat processing plant made up the bulk of the point source nutrient load (89%) in the Pareora FMU, with 56.6 t/yr of nitrogen and 11.1 t/yr of phosphorus (Appendix 1).

Table 2: Estimated total annual loads of nitrogen and phosphorus for each FMU*.

	Orari FMU	Temuka FMU	Timaru FMU	Opihi FMU	Pareora FMU
Total N (t/yr)	829.3	14.4	21.7	10.3	63.3
Total P (t/yr)	207.8	3.0	5.3	2.3	12.6

*from authorised discharges investigated in this report

Table 3: Nutrient load from Fonterra's Clandeboye milk processing wastewater discharges in the Orari FMU.

Resource Consent cumber	Daily Volume (m^3)	Discharge Area (ha)	Consent Limit (kg/ha/yr)		Estimated Load (t/yr)	
			N	P	N	P
CRC156512	*14,000	542	600	NL	325.2	91.7
CRC156516	12,900	**8,700	200	NL	298.8	84.5
CRC093262	8,100	280	***300	NL	84.0	0.5
CRC156514	35		200	NL	35.8	3.0
CRC143036	2,500	114	***300	NL	34.2	16.4
CRC144568	1,150	66	***300	NL	19.8	7.5

NL = No limit

* Daily maximum of 15,000 m^3 but limited to an average of 14,000 m^3.
** Estimated using Environment Canterbury's online GIS, from plans provided with application.
*** Annual maximum limit of 350 kg/ha/yr but limited to a 3-year average of 300 kg/ha/yr.

Detailed estimates of annual nitrogen and phosphorus loading from authorised discharges in each of the FMU areas investigated are presented in Appendix 1. Appendix 2 describes the methods used to estimate nitrogen and phosphorus loads for discharges of industrial wastewater from milk and meat processing.

The estimates of nitrogen and phosphorus loads are based on what is authorised to be discharged and does not take into account any transformation or attenuation of nutrients that may occur, due to discharge method or physical or biological processes. These estimates are not an indication of potential nitrogen or phosphorus contributions to groundwater or surface water concentrations.

Domestic on-site sewage system discharges comprise the largest number of authorised discharges in the OTOP study area, with 3890 sources identified, but the nitrogen and phosphorus loads discharged from these systems represent only 4% and 3%, respectively, of the total point source nutrient loading in the study area (Table 1). The relatively high loads of nitrogen and phosphorus from on-site systems installed post-2006 compared with pre-2006 estimates, reflects differences in methods used to calculate the volume of effluent discharged from the older and newer systems. Estimates of post-2006 discharges used maximum daily discharge volumes specified as a condition of resource consent, or permitted activity rules. Pre-2006 systems, which are estimated to make up about 73% of domestic on-site sewage systems in the study area, are not subject to these limits, and the estimate of their contribution to the nutrient load is based on typical average sewage flow volume from domestic dwellings. The pre-2006 values may underestimate the potential nutrient loading from these sources. However, it is possible that the authorised daily volumes (used to estimate post-2006 discharge loading) may never be realised, or only for short periods, and therefore overestimate the actual discharge load.

There are about 180 storage ponds for farm dairy effluent in the OTOP Zone, with over 75 of these located in the Orari FMU (Appendix 1). Seepage from farm dairy effluent storage ponds contributed 2% of the total potential load of nitrogen and phosphorus from authorised discharges in the study area.

Timaru District Council holds four resource consents authorising discharges of sewage effluent to ground via seepage from storage ponds from their community sewerage

systems. These systems are located in the Temuka FMU (2 systems), Timaru FMU (1 system) and Opihi FMU (1 system) areas. These systems all combine to discharge sewage effluent via an ocean outfall near Timaru. Mackenzie District Council holds two resource consents to discharge sewage effluent via infiltration basins at Burkes Pass and at Fairlie. These systems are both in the Opihi FMU area.

The estimated contribution from community sewerage systems is 1% of the nitrogen load and 2% of the phosphorus load in the OTOP study area (Table 1). The volume of seepage from storage ponds or infiltration basins is directly related to the size of the pond or basin and as the largest sewage effluent storage ponds are located at Washdyke, 75% of the estimated nutrient discharge from community sewerage systems in the study area is attributed to these ponds (Table 4).

Table 4: Details of discharges from community sewerage systems

Resource Consent number *	Location	FMU	Daily Volume (m^3)	Discharge Area (ha)	Estimated Load (t/yr)	
					N	P
CRC163129	Geraldine	Temuka	173	3.5	*1.1	0.32
CRC164345	Temuka	Temuka	183	3.7	*1.1	0.33
CRC071876	Washdyke	Timaru	1,615	32.3	10.0	2.95
CRC164367	Pleasant Point	Opihi	70	1.4	*0.4	0.13
CRC992607	Burkes Pass	Opihi	8.1	0.22	**0.1	0.01
CRC992608.1	Fairlie	Opihi	70	2.6	***0.5	0.13

* none of these resource consents set limits for the annual loading of nitrogen or phosphorus.
** resource consent conditions require groundwater sampling for the analysis of nutrients, including nitrate nitrogen and total nitrogen.
*** nitrate nitrogen is limited to a concentration of 5 mg per litre in effluent.
**** total nitrogen in effluent is limited to a concentration of 25 g per cubic metre at the 50th percentile.

5. Summary

The nitrogen and phosphorus loads presented in this report are the best estimates based on available information from Environment Canterbury's databases for authorised point source and large industrial wastewater discharges. This report does not consider nutrient loads from diffuse discharges from land uses such as agriculture.

The estimates are based on what is authorised to be discharged and do not take into account any transformation or attenuation of nutrients that may occur, due to discharge method or physical or biological processes. Some activities may not be exercised to the full extent authorised, so estimates may not represent the current load of nitrogen and phosphorus. The estimates reported are of the potential nutrient loading authorised and are not intended as an indication of potential nitrogen or phosphorus contributions to groundwater or surface water concentrations.

The dominant authorised point source discharges of nitrogen and phosphorus in the OTOP study area are wastewater discharges onto land from milk and meat processing industries. Domestic on-site wastewater discharges and farm dairy effluent storage are the most numerous discharges but the contribution to the total load from authorised discharges load from these sources is small. Community sewerage systems, via pond seepage, also make a relatively small contribution to the total potential nitrogen and phosphorus load.

Within the study area, the Orari FMU has the highest nutrient load from authorised discharges due to milk processing wastewater discharges to land; and Orari FMU is the only FMU in OTOP with milk processing industry. These milk processing industrial wastewater discharges account for more than 85% of the total nitrogen and phosphorus loading for the five FMU areas. Wastewater discharges from meat processing make up the bulk of the nutrient load in the Pareora FMU, and this meat processing industrial wastewater was the second highest contributor to the total potential loads of nitrogen (6%) and phosphorus (5%) from authorised discharges in these five FMUs of the OTOP Zone.

6. Recommendations

Recommendations for further work have been detailed in previous reports (Loe 2012; Loe, 2013) that continue to be relevant. These include:

- Investigation and assessment of the potential for phosphorus leaching from discharges onto or into land;
- Determining vulnerability of different Canterbury land types to leaching of nitrogen and/or phosphorus under differing land uses;
- For consented discharges to land that contain nitrogen or phosphorus ensure that:
    - applications for discharge permits assess effects of both nitrogen and phosphorus, if relevant;
    - consent conditions specify the concentrations of these contaminants, the volume, land area and application rate for effluent, and require monitoring and reporting of these conditions;
    - monitoring reports are analysed to determine actual application rates;
    - the consents database includes this information from consent conditions

The information presented in this report is limited by the accuracy, and level of detail, of information available in Environment Canterbury's database. The data collected provides a record of authorised discharges within the region, but the detail is variable, and was not collated to support an investigation of potential effects on the environment.

References

Bidwell V, Norton N 2009 *Review of Nutrient and other Contamination Issues* Section 41C Report to the hearing of resource consent applications by the Central Plains Water Trust to the Canterbury Regional Council.

Loe B 2012. *Estimating nitrogen and phosphorus contributions to water from discharges that are consented and permitted activities under NRRP*. Environment Canterbury Technical Report R12/18.

Loe B 2013. *Estimating nitrogen and phosphorus contributions to water from discharges of sewage effluent from community sewerage systems, and milk processing wastewater*. Environment Canterbury Technical Report R13/8.

MoH 2008 Drinking-water standards for New Zealand 2005 (Revised 2008). Ministry of Health, Wellington. October 2008.

MfE 2014. National Policy Statement for Freshwater Management. ME1155.

Potts R and Ellwood B 2000. Sewage Effluent Characteristics. Chapter One in *New Zealand Guidelines for Utilisation of Sewage Effluent on Land.Part 2: Issues for Design and Management*.

Toor GS, Condron LM, Di HJ, Cameron KC, 2004 *Seasonal Fluctuations in Phosphorus Loss by Leaching from a Grassland Soil* Journal of the Soil Science Society of America. 68:1429–1436 (2004).

Webb T, Hewitt A, Lilburne L, McLeod M and Close M 2010. *Mapping of vulnerability of nitrate and phosphorus leaching, microbial bypass flow, and soil runoff potential for two areas of Canterbury*. Environment Canterbury Report No. R10/125.

Webb T, Parfitt R, Bartie P 2007. *Potential for soils to leach phosphorus to groundwater in Canterbury.* Environment Canterbury Report No. U07.

Appendix 1: Estimated annual load of nitrogen and phosphorus for OTOP FMU areas.

Number of Discharge Sources		Orari FMU	Temuka FMU	Timaru FMU	Opihi FMU	Pareora FMU
On-site sewage effluent - pre 2006*	2834	1124	400	650	200	460
On-site sewage effluent - post 2006	1056	134	242	303	281	96
Farm effluent ponds	183	77	38	12	45	11
Community sewerage systems	6	0	2	1	3	0
Milk processing	6	6	0	0	0	0
Meat processing	1	0	0	0	0	1
Other processing	3	1	1	1	0	0
Total	**4089**	829.3	14.4	21.7	10.3	63.3
		207.8	3.0	5.3	2.3	12.6
Nitrogen Loads	**N (t/yr)**					
On-site sewage - pre 2006	25.5	10.12	3.60	5.85	1.80	4.14
On-site sewage - post 2006	12.3	1.51	3.01	3.36	3.01	1.40
Farm effluent ponds	18.3	7.70	3.80	1.20	4.50	1.10
Community sewerage systems	13.2	0.00	2.21	10.02	0.99	0.00
Milk processing	797.8	797.8	0.00	0.00	0.00	0.00
Meat processing	56.6	0.00	0.00	0.00	0.00	56.65
Other processing	15.3	12.24	1.83	1.22	0.00	0.00
TOTAL Nitrogen (t/yr)	**939.0**	**829.3**	**14.4**	**21.7**	**10.3**	**63.3**
Phosphorus Loads	**P (t/yr)**					
On-site sewage - pre 2006	5.7	2.25	0.80	1.30	0.40	0.92
On-site sewage - post 2006	3.1	0.38	0.75	0.84	0.75	0.35
Farm effluent ponds	3.7	1.54	0.76	0.24	0.90	0.22
Community sewerage systems	3.9	0.0	0.6	2.9	0.3	0.0
Milk processing	203.6	203.6	0.0	0.0	0.0	0.0
Meat processing	11.1	0.0	0.0	0.0	0.0	11.1
Other processing	0.0	n/a	n/a	n/a	0.0	0.0
TOTAL Phosphorus (t/yr)	**231.0**	**207.8**	**3.0**	**5.3**	**2.3**	**12.6**

*figures from Loe (2012)

Appendix 2: Methods used to estimate nitrogen and phosphorus loads from industrial wastewater discharges from milk and meat processing.

Resource Consent	Estimated Load N (t/yr)	P (t/yr)	Nitrogen	Phosphorus
Discharges from milk processing				
CRC156512	325.2	91.7	Discharge area (542 ha) x maximum annual load (600kg N/ha/yr) specified in resource consent	Average concentration of phosphorus (20.5 g/m^3) in wastewater discharged under CRC156512 from compliance reports X daily volume (14,000 m^3) discharged for 320 days
CRC156516	298.8	84.5	Average concentration of nitrogen (72.4 g/m^3) in wastewater discharged under CRC156512 from compliance reports X daily volume (12,900 m^3) discharged for 320 days	Average concentration of phosphorus (20.5 g/m^3) in wastewater discharged under CRC156512 from compliance reports X daily volume (12,900 m^3) discharged for 320 days
CRC093262	84.0	0.5	Discharge area (280 ha) x average maximum annual load (300kg N/ha/yr) specified in resource consent	Average concentration of phosphorus in DAF sludge wastewater discharged under CRC093262 from compliance reports X daily volume (8,100 m^3) discharged for 320 days
CRC156514	35.8	3.0	Average concentration of nitrogen (72.4 g/m^3) in DAF sludge discharged under CRC156514 from compliance reports x daily volume (35 m^3) discharged for 320 days	Average concentration of phosphorus (20.5 g/m^3) in DAF sludge discharged under CRC156514 from compliance reports X daily volume (35 m^3) discharged for 320 days
CRC143036	34.2	16.4	Discharge area (114 ha) x average maximum annual load (300kg N/ha/yr) specified in resource consent	Average concentration of phosphorus (20.5 g/m^3) in wastewater discharged under CRC156512 from compliance reports X daily volume (2,500 m^3) discharged for 320 days
CRC144568	19.8	7.5	Discharge area (66 ha) x average maximum annual load (300kg N/ha/yr) specified in resource consent	Average concentration of phosphorus (20.5 g/m^3) in wastewater discharged under CRC156512 from compliance reports X daily volume (1,150 m^3) discharged for 320 days
Discharges from meat processing				
CRC163704	56.6	11.1	From 2014 compliance monitoring report: 80 gm N/m^3 x 708,076 m3 discharged to ground	From 2014 compliance monitoring report: 15.7 gm P m3 708076 m^3 discharged to ground