Dairy Green Ltd

Practical Engineering Solutions

Consents, Effluent, Stock water, Irrigation

Design through to Installation

Irrigation NZ Accredited Designer

Attn: Alex Erceg

RE: Response to Section 92(1) Request for Further Information

Application: APP-20181917

Applicant: South Pro Maitland Limited

2 April 2019

Dear Alex,

Please find enclosed our response to your request for further information under Section 92(1) of the Resource Management Act for APP-20181917.

A drop test report for the sludge beds, a revised nutrient budget report and an updated Overseer nutrient budget XML file are also submitted as part of this RFI response.

Regards,

Nessa Legg

Consultant for *South Pro Maitland Limited*

Infrastructure - Drop test of sludge beds by a SQP

The sludge beds have been drop tested by a SQP in accordance with Appendix P and passed the drop test. A drop test report prepared by a SQP is appended to this RFI response. Since the sludge beds are not leaking effluent, they are fit for the purpose of containing effluent.

Overseer nutrient budget

Based on the Overseer sense check review prepared by Irricon, a revised proposed nutrient budget has been prepared by a CNMA, which includes an increase in supplement to account for a possible shortfall in feed. The applicants seek to satisfy Environment Southland that modelled N losses will not increase from what is shown in the proposed nutrient budget. The revised nutrient budget XML file and related summary report are appended to this document.

Effects of cultivation and consideration of Rule 25

Except for occasions where the slope may be greater than 20 degrees, cultivation will be carried out in accordance with Rule 25 (a) of the pSWLP and will meet permitted activity rules. It will not take place within 5 metres from the outer edge of the bed of streams and drains. Temporary fences will be erected to ensure a minimum of a 5-metre buffer is maintained if necessary. Typically, cultivation will not take place on land with a slope of greater than 20 degrees over any 20-metre distance. However, in the future steeper paddocks/part paddocks may require cultivation for re-grassing. If and where this occurs, the activity may activate Rule 25 (c) and be classed as a restricted discretionary activity. If this occurs, resource consent will be applied for accordingly. The earliest timeframe for this occurring is the 19/20 season, which leave the applicants approximately six months from the time of writing to apply for resource consent if required.

Cultivation is carried out according to good management practices as defined in Rule 25 in order to minimise contaminant loss via runoff to waterways. Large buffers (5 – 15 m at least) are left uncultivated close to waterways with larger buffers implemented where slopes are greater; this is achieved by not cultivating two tractor passes close to waterways. Major CSAs are left uncultivated when paddocks are cultivated for fodder crops. Contour is used as a guide, with crops cultivated along contour lines on sloping land to slow runoff and reduce down-slope soil loss. Soil tests are carried out on paddocks to ensure the appropriate fertiliser regime is calculated and implemented during cultivation. Re-sowing of grazed fodder crop paddocks is carried out as soon as possible, with fallow periods minimised. This allows growing plants to take up nutrients, which helps to reduce nutrient loss in drainage. Given that the applicants are aware of the risks to surfacewaters from cultivation at their farm and their mitigation of risks through the implementation of good management practice, the effects from cultivation are considered to be no more than minor.

Use of land for farming

- An explanation and assessment of the specific mitigation measures for the use of land for farming and their effectiveness. There needs to be a clear distinction between what is a mitigation measure and what is a GMP. A large number of matters listed as mitigations, are considered to be GMPs and are expected by the plan (and assumed by Overseer) and are also representative of the current practices occurring on farm.

We consider that GMPs can be quite general, but specific mitigation measures are measurable things that are done on farm that go "above and beyond" to mitigate a specific effect.

- An assessment of effects of the use of land for dairy farming. The assessment provided with the application details what activities are occurring currently and what will be occurring moving forward, but it doesn't tell me what this means for the surrounding environment.

Specification mitigation measures proposed for N, P, sediment and microbial contaminant loss at the Garden Gully Road dairy farm.

Table 1. Specific mitigation measures proposed, their effectiveness and assessed level of effectiveness.

No.	Specific mitigation measures proposed for N and P loss at Garden Gully Road dairy farm.	Effectiveness of mitigation measure	Level of effectiveness
1	Continued development of soils and pastures;	Over time this leads to increased soil organic matter content, water holding capacity and improved soil structure, and consequently less N, P, sediment and microbial contaminant loss in artificial drainage and runoff. Gleyed soils further reduce N loss through denitrification processes below the root zone.	High – this measure mitigates N, P, sediment and microbial contaminant loss and is implemented across the entire dairy farm.
2	A maximum of 11 hectares cultivated into fodder crop and intensively winter grazed by 150 cows; Please see the nutrient budget analysis report for fodder crop and IWG areas in previous years. The proposed area is less than in the previous three years.	Nutrient (N and P) loss from fodder crop blocks is high due to mineralisation processes in soils, inputs of nutrients from animal dung and urine and fallow periods. Capping future fodder crop and winter grazing activities at 11 hectares per year is effective at limiting nutrient loss from intensive winter grazing activities via overland flow and artificial drainage in the future. Sediment and microbial contaminant loss from fodder crop blocks is high due to soil compaction, pugging and breakdown of the soil structure, and inputs of faecal microbes from animal dung and urine. Capping future fodder crop and winter grazing activities at 11 hectares per year is effective at limiting sediment and microbial contaminant loss from intensive winter grazing activities via overland flow and artificial drainage in the future.	Moderate – capping the area at 11 hectares is sufficient to ensure that nutrient losses overall do not increase under the proposed system.

3	No fallow period after crops (re-sowing occurs in October);	This allows mineralised N and P in soils to be taken up by growing plants or attenuated in the root zone rather than being lost to water in drainage events via runoff and artificial drainage when soils are bare. This measure also reduces sediment loss through erosion/runoff of bare soils and allows microbes to be attenuated rather then being lost to water in drainage events via runoff and artificial drainage when soils are bare.	Moderate – the measure applies only to cropped paddocks where it is effective at reducing N and P loss, and sediment and microbial contaminant loss.
4	Optimising the fertiliser regime leading to a lower application rate of N in fertiliser than in recent years (from 264 kgN/ha to 246 kgN/ha) and excluding application of N fertiliser in May, June and July;	This is effective at reducing N loss to water in drainage events following fertiliser application.	Moderate – the reduction in N loss will be seen across the entire dairy farm
5	Maintenance of wide, well protected and vegetated riparian buffers, as well as the implementation of a riparian planting programme starting in 18/19 (see figures 1 & 2); For paddocks where IWG occurs, a temporary fence is set up outside the permanent riparian fence close to waterways to ensure a buffer of 5 -10 metres to the waterway is maintained while the paddock is undergoing IWG. This ensures that Rule 20 (a) (iii) (4) of the pSWLP will always be met.	Given the contour at the dairy farm, this is effective at reducing nutrient loss (particularly P) to water via runoff. Sediment, P and microbial contaminants are attenuated as water passes through the vegetated riparian buffer area to the waterway. This is effective at minimising runoff where a laneway runs adjacent to a waterway. Buffer sizes depend on the contour and risks. The objective is to have a buffer of at least 3 metres in place, with larger buffers in place as necessary (see figures 1, 2 and 4) and for IWG paddocks (5 metre minimum). Small native shrubs and native grasses are planted as part of the riparian planting programme.	High
6	Major CSAs are identified, fenced off and well vegetated (see figures 3 & 4)	Given the contour at the dairy farm, this measure reduces P, sediment and microbial contaminant loss in runoff; contaminants	High – a disproportionately high quantity of P, sediment and microbes reach surfacewaters via CSAs. The

		are attenuated by the soil or are filtered by plants rather than being transported to waterways. The areas regarded as major CSAs are fenced off and allowed to establish long grass cover. See figures 2 and 3 for examples. No buffers outside the fenced off area are established, since the aim is to protect the area within the CSA from grazing, pugging etc. rather than protecting the area around it. Areas directly adjacent to IWG paddocks will be IWG lastly.	targeted protection of major CSAs reduces loss of P, sediment and microbial contaminants.
7	Increasing the FDE area from 30.6 ha to 68.4 hectares;	This leads to a lower application rate of N from effluent and consequently less N loss in drainage.	Moderate – this effect relates to the effluent block only
8	Selective FDE application; FDE is not applied over tile drains;	In conjunction with the use of low rate irrigation, this further reduces N, P and microbial contaminant loss via artificial drainage (tiles)/bypass drainage channels. As new tiles are installed or discovered, these are also excluded.	Moderate – this effect is seen where tile drains are found
9	Selective FDE application; FDE is not applied in paddocks or part paddocks where the contour is steeper;	See figure 5 for the proposed FDE area, showing topography. Steeper areas within land where slopes are between 8 and 15 degrees are avoided. It is estimated that this accounts for less than 10% of the modelled FDE area and should have minimal effect of the modelled N loss as per Overseer. In conjunction with the use of low rate irrigation, this further lowers the risk of N, P and microbial loss via runoff to surfacewater drainage.	Moderate – FDE application to steeper areas is avoided
10	Optimising stock drinking water reticulation; placement of a second trough in hilly paddocks (c.40% of paddocks);	In hilly paddocks, a second trough has been placed at a high point. The original trough is generally at the bottom of the hill. As well as ensuring that cows have good access to water, installing a second trough at a high point modifies cow behaviour; the tendency of cows to stand close to the trough at the low point is reduced. Also,	Moderate – areas close to troughs can act a CSAs for N and P, sediment and microbial contaminants, particularly where they are found at the

	Note: To meet Rule 20 (a) (iii) (3) (c) transportable troughs will be provided in or near the area being grazed in situations required under the rule. These are distinct from additional permanent troughs referred to in this mitigation meaasure.	soil tread damage caused by cows walking down to the trough is reduced. Less soil damage and pugging at the low point occurs, and less nutrients (N, P) from dung and urine accumulate at the low point. Less runoff of nutrients, sediment and microbial contaminants occurs.	bottom of hills. This measure reduces the risk of this occurring.
11	Olsen P levels are slightly below optimum level. Once target Olsen P levels are achieved, P fertiliser will be applied to maintain Olsen P levels within optimum range. Target Olsen P levels are lower for easy hill terrain (25) than for the rest of the farm (35 and 40 for non-effluent and effluent respectively);	This will avoid the loss of excess P to water in runoff, especially where the risk is higher (i.e. easy hill);	Moderately effective for mitigating P loss across farm.
12	Tracks/lanes managed to reduce runoff to streams;	Overseer assumes that 30% of P that lands on all tracks/lanes ends up in waterways. Given the farm layout (only one lane runs adjacent to a waterway) and management of track/lanes (contour) and associated buffers, P loss as assumed by Overseer is reduced. The farm has been operated as a dairy farm for many years and already has a well-developed lane network that satisfactorily serviced a herd size of 600 cows up until 2016. Some flexibility to improve the existing network of farm lanes is needed as part of operating and managing the dairy farm. Any future lane development will be very minor in scale with the purpose of eliminating soil compaction and pugging issues as they arise over time due to the normal operation of the farm. Being able to make minor improvements to the lane network to leads to better environmental outcomes (less runoff to waterways from problem areas that arise over time). Only one existing lane runs adjacent to a waterway; its contour is maintained to drain away from the waterway and prevent runoff.	Highly effective for mitigating P, sediment and microbial contaminant loss.

Figure 1. Fenced off, well vegetated riparian buffer along a stream. Note: when IWG occurs, a temporary fence is set up to ensure a minimum buffer of 5 metres to the waterway is always maintained. Typically, a protected buffer of approximately 10 metres to the waterway is maintained.

Figure 2. Fenced off, well vegetated riparian area.

Figure 3. Fenced off paddock CSA in foreground.

This photo shows a gateway area at the bottom of rolling paddock. Formerly the area protected by fencing in this photo was wet, pugged and prone to runoff to the lane below. A culvert and fencing were installed to protect the soil in and around the gateway area, the outcome of this has reduced the risk of runoff significantly. Any further fencing off in the area would block access to the paddock and require a new gateway to be installed elsewhere, with the same issues the arising due to the nature of the landscape. The applicants have achieved the best possible outcome, while still allowing it to operate as a gateway and not simply transferring the issue to another location. If this paddock is sown in crop and IWG in the future, stock will be progressively grazed (break-fed or block-fed) from the top of the slope to the bottom and a “last bite” strip will be left at the base of the slope.

The CSA in the foreground and area close to it will not be sown in crop to be IWG.

Figure 4. Fenced off stream with wide, well vegetated buffer.

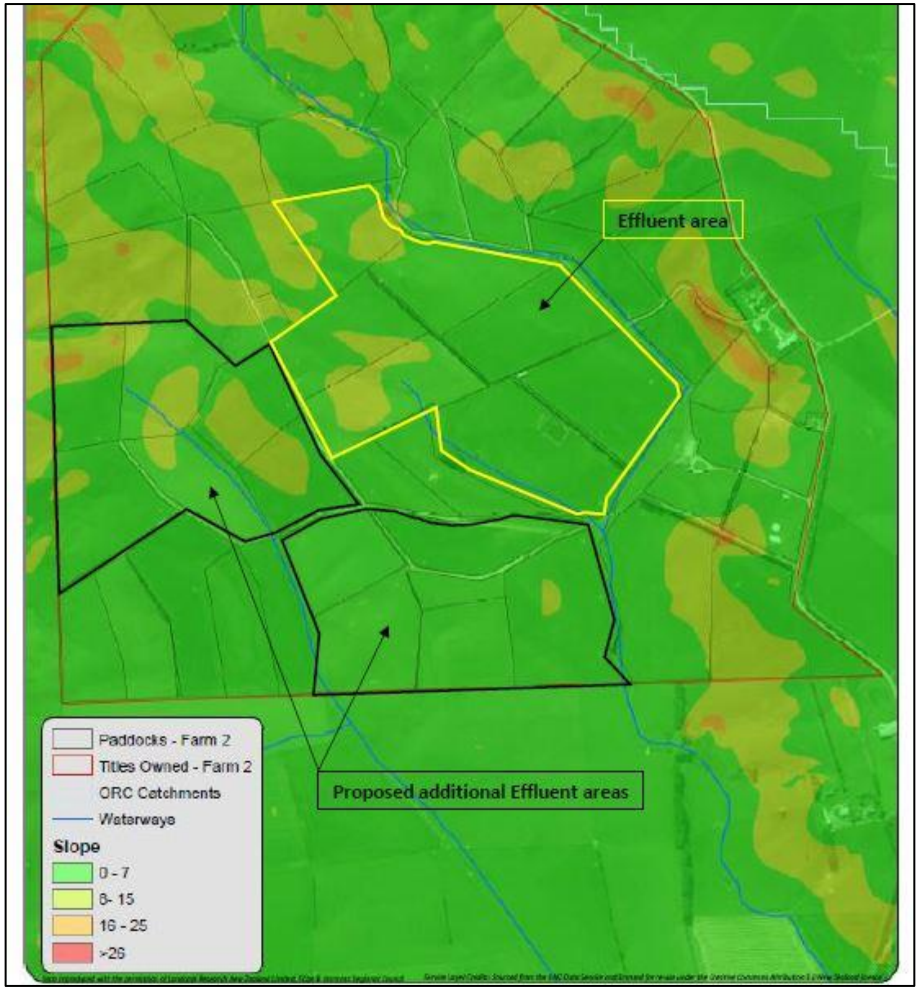

Figure 5. Proposed FDE area with topography overlain.

Summary of GMPs and their effect at the Garden Gully Road dairy farm.

Table 2. Summary of good management practices (GMPs) implemented at the Garden Gully Road dairy farm:

Transport Pathway	Effect of GMP	Summary of Management Practices
Artificial drainage, Overland flow	Protect soil structure (especially near streams)	Match stock management to land use capability, e.g. avoid grazing cows on more vulnerable soils, especially when wet. Fence off waterways and protect CSAs. Stock will not graze riparian strips. Young stock is grazed off farm from weaning; Implement good management practice winter grazing. Please see page 76/table 6.7 of the application for details of IWG GMPs. These meet Rule 20 (a) (iii) of the pSWLP. In addition to GMPs described in table 6.7, mob sizes will be no more than 120 cows, stock will be progressively grazed from the top of the slope to the bottom, CSAs including swales within the area being grazed that accumulate runoff from adjacent flats and slopes, will be grazed last. Over and above Rule 20, the applicants avoid IWG major paddock CSAs by leaving them in pasture and fencing them off; When appropriate use minimum or no-till cultivation practices such as direct drilling; Re-sow areas of bare or damaged soil as soon as is practical;
Artificial drainage, Overland flow	Reduce P use or loss	Prepare a nutrient budget; Soil test regularly; Maintain Olsen P values at agronomic optimum and no higher; Apply P fertiliser outside of high-risk months in autumn and winter;
Artificial drainage, Deep drainage	Reduce accumulation of surplus N in the soil, particularly during autumn and winter	Maintain sustainable stocking rate; Reduce inputs of N where possible through optimal fertilizer application on farm, use little and often approach;

		Young stock is grazed off farm from weaning; Optimize timing and amounts of effluent irrigation input applications; Substitute autumn diets with low-N feed when practical; Time N application to meet pasture demand using split applications and when pastures are actively growing (>6 degrees Celsius); Control the duration of grazing pastures; Cut and carry feed where practical;
Artificial Drainage Deep drainage	Avoid preferential flow of effluent through artificial drainage channels	Defer irrigation to effluent storage pond when soil conditions are unsuitable; Low rate and low depth effluent application is primarily used; A sufficiently large FDE area is available for effluent; Observe buffer zones and placement guidelines; Observe discharge consent conditions;
Overland flow	Manage CSAs; gullies, low points at the bottom of slopes, close to watereways and/or overlying tiles	Fence off major CSAs and maintain good vegetation cover; Restrict grazing of pasture CSAs when soils are near saturation; Avoid working pasture CSAs and their margins; Reduce runoff from tracks and races by using cut offs and shaping to direct surface drainage to paddocks, where it can be filtered by pasture plants before reaching waterways. Cows spend most of their time grazing in paddocks where they defecate/urinate on pasture and standing at the dairy shed/yard where effluent is collected and stored as per consent conditions. Minimal effluent collects on tracks and lanes so most surface

	drainage from lanes is rainwater. Lane effluent sludges do not form point source discharges by flowing off tracks into paddocks. Lane sludges at the dairy shed/yard are collected to the effluent storage system; Carry out remedial work to reduce runoff as required;

Potential effect of nutrient N in receiving waters: local streams, Waikaka Stream, Mataura River, Toetoes Estuary and coastal waters.

Table 3. Potential effect of N in receiving waters, related effects, likelihood of effect and assessment of risk.

Potential effect of N in receiving surfacewaters	Related effects	Specific mitigations proposed at Garden Gully Road dairy farm	Likelihood of effect due to proposed dairy farming activity at Garden Gully Road	Risk of effect due to proposed dairy farming activity at Garden Gully Road
Increased algal growth in the water column of streams, river and estuary: • Degrades water quality and blocks light (increases turbidity and reduces clarity)	Ecological: exclusion of macrophytes, reduced visibility for fish and other aquatic organisms, loss of habitat, decreased suitability for recreational activity	As per table 1. Measures 1, 2, 3, 4, 7, 8, 9 and 10 are main mitigation measures for N loss, with measures 5 and 6 also being effective albeit to a lower level.	Low likelihood due to nature and scale of activity and implementation of proposed mitigation measures	No more than minor
Increased algal growth in the water column of streams, river and estuary: • Potentially increasing BOD	Ecological: reduced DO causing stress on aquatic organisms, loss of species and habitat	As per above	Very low likelihood since point source discharges affect BOD rather than diffuse sources (i.e. the proposed dairy farming activity). Although the discharge of FDE is a point source discharge, it is to land rather than water and uses best management practice (deferred storage and low rate irrigation).	Less than minor – point source discharges affect BOD rather than diffuse sources
Increased periphyton growth in streams and river:	Ecological: loss of habitat, effects on invertebrates and organisms in associated food webs, reduced biodiversity	As per above	Low likelihood due to nature and scale of activity and implementation of proposed migration measures	No more than minor

• Smother streambed				
Increased periphyton growth in stream and river: • Promote the growth of toxic matts of cyanobacteria (blue green algae)	Toxic effects on biota including domestic animals. Also, people using waterways for recreational activities are at risk of adverse health effects	As per above	Low likelihood due to nature and scale of activity and implementation of proposed migration measures	No more than minor
N toxicity effects in streams and river if N concentration is high enough	Ecological: loss of habitat, fish kills Animal and human health due to nitrate toxicity	As per above	Very low likelihood since N concentration in receiving waters is much lower than toxicity level, and the scale of the activity and implementation of proposed migration measures further reduce the likelihood of the effect occurring.	Less than minor

Potential effect of nutrient P in receiving waters: local streams, Waikaka Stream, Mataura River, Toetoes Estuary and coastal waters.

Table 4. Potential effect of P in receiving waters, related effects, likelihood of effect and assessment of risk

Potential effect of P in receiving surfacewaters	Related effects	Specific mitigations proposed at Garden Gully Road dairy farm	Likelihood of effect due to proposed dairy farming activity at Garden Gully Road	Risk of effect due to proposed dairy farming activity at Garden Gully Road
Increased algal growth in the water column in streams, river and estuary: • Degrades water quality and blocks light (increases turbidity and reduces clarity)	Ecological: exclusion of macrophytes, reduced visibility for fish and other aquatic organisms, loss of habitat, decreased suitability for recreational activity	As per table 1. Measures 5, 6, 9, 10, 11 and 12 are main mitigation measures for P loss, with measures 1, 2, 3, 7 and 8 also being effective albeit to a lower level.	Low likelihood due to nature and scale of activity and implementation of proposed migration measures	No more than minor
Increased algal growth in the water column in streams, river and estuary: • Potentially increasing BOD	Ecological: reduced DO causing stress on aquatic organisms, loss of species and habitat	As per above	Very low likelihood since point source discharges affect BOD rather than diffuse sources (i.e. the proposed dairy farming activity). Although the discharge of FDE is a point source discharge, it is to land rather than water and uses best management practice (deferred storage and low rate irrigation).	Less than minor – point source discharges affect BOD rather than diffuse sources
Increased periphyton growth in streams and river: • Smother streambed	Ecological: loss of habitat, effects on invertebrates and organisms in associated food webs, reduced biodiversity	As per above	Low likelihood due to nature and scale of activity and implementation of proposed migration measures	No more than minor

Increased periphyton growth in streams and river: • Promote the growth of toxic matts of cyanobacteria (blue green algae)	Toxic effects on biota including domestic animals. Also, people using waterways for recreational activities are at risk of adverse health effects	As per above	Low likelihood due to nature and scale of activity and implementation of proposed migration measures	No more than minor
Increased nuisance plant growth on bed of Toetoes Estuary: • P sorbed to soil particles is deposited in sediment and then released from estuary bed into the water column	Weed-driven habitat modification and loss; effects on invertebrates and organisms in associated food webs leading to reduced biodiversity	As per above	Low likelihood due to nature and scale of activity and implementation of proposed migration measures	No more than minor

Potential effect of sediment and microbial contaminants in receiving waters: local streams, Waikaka Stream, Mataura River, Toetoes Estuary and coastal waters.

Table 4. Potential effect of sediment and microbial contaminants in receiving waters, related effects, likelihood of effect and assessment of risk.

Potential effect of sediment and/or microbial contaminants in receiving surfacewaters	Related effects	Specific mitigations proposed at Garden Gully Road dairy farm	Likelihood of effect due to proposed dairy farming activity at Garden Gully Road	Risk of effect due to proposed dairy farming activity at Garden Gully Road
Increased turbidity and reduced water quality in streams, river and estuary.	Ecological: exclusion of macrophytes, reduced visibility for fish and other aquatic organisms, loss of habitat, decreased suitability for recreational activity	As per table 1. Measures 1, 2, 3, 5, 6, 8, 9, 10 and 12 are the main mitigation measures for sediment and microbial contaminant loss.	Low likelihood due to nature and scale of activity and implementation of proposed migration measures	No more than minor
Increased deposition of sediment in streams, river and estuary: • Smother streambed	Ecological: loss of habitat and increased anoxic conditions (estuary), effects on invertebrates and organisms in associated food webs, reduced biodiversity	As per above	Low likelihood due to nature and scale of activity and implementation of proposed migration measures	No more than minor
Elevated levels of microbial contaminants in streams, river and estuary: • Exposure to pathogens	People using waterways for recreational activities and food gathering are at risk of adverse health effects (gastroenteritis)	As per above	Low likelihood due to nature and scale of activity and implementation of proposed migration measures	No more than minor

AEE on receiving surfacewaters due to proposed dairy farming activity

This section provides an assessment of effects from the farming activity in its entirety, in accordance with Schedule 4 of the RMA. Based on advice from Environment Southland, it has been structured to answer three broad questions:

1. What are the effects from the whole activity on the receiving environment?
2. What are the effects from the additional cows over and above what is already in place?
3. What are the broad scale cumulative effects from farming on the receiving environment?

Effects from whole activity on the receiving environment

Introduction

When considering expansion applications, Environment Southland understand Policy 39 of the pSWLP to direct that the farming activity is not the permitted baseline and as such, actual or potential effects from the "whole activity" as proposed, on the receiving environment must be assessed. This section aims to provide such an assessment in accordance with Schedule 4 of the RMA.

The "whole activity" is understood to mean the sum of all proposed activities at the Garden Gully Road dairy farm, which includes a 600-cow dairy platform, and the range of activities such as IWG, fertiliser application, pasture management and supplement. The discharge of agricultural effluent is also part of the "whole activity." Activities also include site-specific GMPs and mitigation measures that will be implemented across the operation. Within the assessment of the whole activity, individual activities and mitigation measures are highlighted and discussed where appropriate.

Artificial drainage and overland flow are pathways by which contaminants (nutrients N and P, sediment and microbes) present in dung, urine, effluent and silage leactate may reach receiving waters such as surfacewater streams, Waikaka Stream, Mataura River, Toetoes Estuary, and coastal waters. The major risk to surface waters is from contaminant loss via overland flow and subsurface drainage that occurs following periods of heavy rain. Where P is assessed, it can generally be used as a proxy for sediment and microbial contaminants. To comply with the discharge permit granted in 2016, a monitoring bore has been installed and is available to monitor groundwater quality as required.

In the context of assessing actual and potential effects from the whole activity, it is recognised that all dairy farms lose contaminants (nutrients, sediment and microbes) to some degree. So long as losses are minimised through the implementation of effective GMPs and mitigation measures, and effects on receiving ground and surfacewaters are no more than minor, then land at the Garden Gully Road dairy farm can be used and developed by the applicants to provide for their social, economic and cultural wellbeing in accordance with policy 13 of the pSWLP. The applicants will provide certainty to the consent authority regarding activities and effects through operating under a land use consent for farming.

In operating an economically viable dairy farm, the applicants seek to minimise contaminant losses across the whole activity. At the farm scale it is difficult to quantify contaminants being lost to receiving surfacewaters and groundwater, and their contribution to effects on receiving waters; there will be much seasonal and spatial variation in this. Furthermore, measuring the volume of drainage water leaving a sub-catchment and the concentration of nutrients in drainage water would require expensive equipment as well as long term monitoring to allow for temporal and spatial variation; this is not practical given available scientific methods. For these reasons, Overseer is used as a tool to help understand the nutrient interactions of farm systems based on soil properties, rainfall, drainage, feed requirements and other inputs such as fertiliser. The output from Overseer provides an indication of how much nutrient (N and P) may be lost below the root zone but it does not describe how much nutrient ends up in the receiving environment and what the effect of losses is likely to be. Assessing the effect of modelled nutrient losses from individual properties is complex because nutrients travel via different pathways through the receiving environment undergoing attenuation in the vadose zone, processing, mixing, dilution and dispersion processes, which can significantly change the quantity and nature of these nutrients in the receiving water bodies. The assessment here uses knowledge of soil properties, drainage characteristics and rainfall infiltration, hydrology, the receiving environment and Overseer predictions to estimate:

1. The quantity of nutrients (N and P) from the whole activity lost to the receiving waters using Overseer predictions as a starting point, and
2. What the actual or potential effects from the whole activity on receiving ground and surfacewaters are likely to be.

Note: The below calculations are carried out using values for N loss for the dairy platform only, as per Overseer nutrient budget analysis for the proposed 600 cow system.

Nitrogen

PROPOSED 600 COW FARM – N CONCENTRATION IN SURFACE DRAINAGE WATERS

Since the property lies in an unmapped groundwater zone, no mean annual land surface recharge rate is readily available for it. An estimation for the N concentration in drainage waters is calculated below based on rainfall, evapotranspiration and the land surface area. The nearest site for which data is available is at Gore.

(1) Average rainfall (959 mm) – average ET (mm) = drainage (mm)

where drainage is all losses including runoff, tile drainage and deep drainage;

where average ET is the average annual evapotranspiration rate;

According to NIWA, the mean annual potential evapotranspiration (PET) at Gore = 768mm

According to MfE, the average of annual PED 2000-2016 for Gore = 170 mm

where the PED (potential evapotranspiration deficit) accounts for factors such as soil moisture deficit and plant water uptake;

(2) *Actual evapotranspiration = PET – PED* = 768 mm – 170 mm = 598 mm

Using equation (1) above:

the Average rainfall (959 mm) – average ET (598 mm) = drainage (361 mm)

Based on these calculations, drainage is expected to be approximately 38% of rainfall.

To calculate the drainage volume for the 205-hectare dairy farm:

(3) *Area (m^2) X drainage (m) = drainage volume (m^3)*

2,050,000 m^2 x 0.361 m = 740,050 m^3 per year.

This includes runoff, artificial drainage and deep drainage. Most drainage will go to surfacewaters via runoff or artificial drainage, or via the discharge of groundwater to surfacewater in the longer term. For the purpose of these calculations, the value for drainage volume is used to calculate the concentration of N in surfacewater drainage.

If all 9,979 kg of N lost to water annually according to Overseer, is transported to surfacewater drainage then an approximation of the N concentration of water draining to surfacewaters is:

9,839 kg/740,050 m^3 = 13.3 g/m^3 = 13.3 ppm

13.3 ppm is a crude estimate as it assumes all N lost below the root zone ends up in surface drainage water. In fact, some N will be lost to the atmosphere via denitrification (attenuation) processes, particularly in ~119 hectares of Gleyed soils (Claremont/Waikoikoi and Eureka/Jacobstown), which account for 58% of the total land area. A small quantity of N will be held in the groundwater resource. Assuming an overall attenuation rate of 34% in line with an estimate for the wider catchment[1], on average the concentration of N in water draining to surfacewaters is expected to be 8.7 ppm. A higher attenuation rate from 119 hectares of Gleyed soils would be expected to further reduce the N concentration in drainage water.

FATE OF N IN RECEIVING WATERS

Water reaching the receiving surfacewaters undergoes mixing and nutrients are diluted. Due to mixing, dilution and dispersion processes occurring on a catchment scale, this cumulatively gives a concentration of no more than 1.33 ppm for the Waikaka Stream catchment, which is the five-year median Total Nitrogen for SOE site at *Waikaka Stream at Gore*.

Phosphorous, sediment and microbial contaminants

Following heavy rainfall, water flows down slopes into waterways via overland flow or artificial drainage, carrying P, sediment and microbes with it. In this case, sloping topography gives rise to risk of contaminant loss from CSAs at the bottom of slopes close to waterways. Locations where tiles have outfall to waterways and where tracks cross surface waterways at culverts also behave as CSAs.

Concentration of P in drainage waters

Overseer predicts moderate P losses of 1.0 kg/ha/year or 199 kg/year due to the proposed dairying activity. Using the annual drainage volume as calculated in the previous section, the average concentration of P in drainage waters to the Mataura catchment is estimated at $2.68*10^{-4}$ ppm.

P loss is split between "Other Sources," which is loss from tracks, lanes and infrastructure to waterways via overland flow, and "Blocks," which is P loss from paddocks due to dairy farming. "Other sources" P loss is estimated by Overseer to be 87 kg/year, with "Block" loss estimated to be 112 kg/year. "Other sources" P loss is calculated by a sub-model, which assumes that 30% of P that lands on tracks, lanes, yards and other infrastructure, ends up in waterways[2]. Overseer does not account for

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

[2] Gray, Wheeler and McDowell (2016). Review of Phosphorous submodel in Overseer. Report prepared for AgResearch.

individual farm layout, however, and in this case only one lane runs parallel to a waterway. This is expected to reduce the quantity of P reaching waterways from tracks and lanes via runoff and will reduce the concentration of P in drainage waters below the figure calculated above. Additionally, by appropriately managing locations where overland flow from tracks and lanes etc. can potentially reach waterways, loss of “Other sources” P can be further reduced although once again, Overseer does not recognise this. Given available tools, it is very difficult to accurately quantify this reduction at the farm scale.

Fate of P in receiving streams

Due to physical interactions, P tends to be adsorbed by soil particles in surfacewaters and is taken out of solution to a large extent. A small portion of P, however, will remain soluble and available for uptake by aquatic plants in receiving water bodies. Some adsorbed P will subsequently be released from sediments as soluble P to be taken up by plants in the future. Mixing of drainage and receiving waters should result in dilution of soluble P, which should off-set potential adverse effects in receiving waters to an extent. A combination of adsorption, mixing and dilution processes occurring on a catchment scale, cumulatively gives a median P concentration of 0.024 ppm for the lower Waikaka catchment (5-year median Total Phosphorous for SOE site at Waikaka Stream at Gore).

Actual or potential effects from the whole activity on receiving surfacewaters

Since surfacewater drainage is to the Waikaka/Lower Mataura/Toetoes catchment, actual and potential effects due to contaminants N, P, sediment and microbes from the whole activity may be seen for the catchment and estuary.

Table 1 describes key measures, which will be implemented over and above GMPs, to mitigate effects from the whole activity on receiving waters, including the Waikaka Stream, Mataura River and Toetoes Estuary, and on the groundwater resource (unmapped aquifer). The effectiveness and level of effectiveness is also assessed.

Table 3 describes actual or potential effects from the whole activity on receiving waters. Further comment is also provided on actual or potential effects from the whole activity.

Further comment on actual and potential effects on Toetoes Estuary

Due to the nature of drainage from the whole activity, actual and potential effects described in table 3 apply to the estuary. Toetoes Estuary is a sensitive environment that is adversely affected by nutrients, sediment and microbial contaminants from land use in the catchment, such as dairy farming. Contaminant losses from the whole activity are minimised due to the implementation of site-specific GMPs and key mitigations that reduce N accumulation, N mineralisation processes, protect soil structure and reduce runoff. These are described in tables 1 and 2. These measures are complemented by the general strategy of good nutrient and soil management at the dairy farm. Since contaminant losses from the whole activity to receiving waters are low, and undergo attenuation, mixing and dilution in receiving waters, effects from the whole activity on Toetoes Estuary are expected to be low. Broad scale cumulative effects on Toetoes Estuary are discussed in a later section.

Actual and potential effects from the whole activity on groundwater

An AEE on groundwater was provided in the main consent application. The assessment concludes that there is minimal risk of adverse effects on groundwater due to the proposed activity.

Actual and potential effects from activities at third-party grazier locations

An AEE at third-party grazier locations of the proposed dairy farming activity was provided in the consent application. The assessment concludes that there is minimal risk of adverse effects on groundwater and surfacewater due to third-party grazier activities.

Effects from additional cows over and above what is already in place

Introduction

An additional 50 cows will add nutrients to the farming system and can potentially cause treading damage to soils (compaction) and CSAs. In the absence of any other changes/off-sets to the system, additional cows would be expected to increase contaminant losses to the receiving environment with a likely increase in effects on the receiving environment also occurring. To meet requirements set out in council policy, actual and potential effects on the receiving environment from an additional 50 cows must be off-set through changes to the farm system, allowing water quality to be maintained or improved despite additional cows. The addition of 50 cows is one input to the farming system; so long as contaminant losses from the system in its entirety do not increase and adverse effects on receiving waters are avoided or mitigated, there should be no greater effect from additional cows over and above what is already in place. In 2016, cow numbers were erroneously decreased by 50. This proposal seeks to return to the herd size farmed up to 2016, which effectively adds 50 cows and overall is a minor change to the farming system that has been in place at the landholding over the last five years.

Overseer nutrient budgeting has been used to model nutrient losses below the root zone from the proposed system, which includes additional cows and a range of changes to the system that will also occur. The existing system has also been modelled in Overseer and reflects average annual nutrient losses below the root zone over five years of farming at the landholding (and is based on five separate nutrient budgets). While Overseer is useful at modelling long-term average nutrient losses of farming systems, it has limitations. As already mentioned, it does not predict transformations, attenuation or dilution of nutrients between the root zone and the receiving water body. Overseer is one tool, albeit a useful one, used in determining nutrient losses from additional cows over and above what is already in place. By quantifying nutrient losses below the root zone Overseer is a starting point, with knowledge of soil processes, drainage, hydrology, receiving waters and various farming practices also used to assess effects from additional cows over and above what is in place.

By using the same tool (Overseer) to quantify nutrient losses below the root zone for the proposed and pre-expansion systems, consistency is maintained across the analysis and associated assessment of effects. Any limitations of Overseer will occur in all nutrient budgets. This should ensure that comparisons made between respective systems are valid and relative differences are real.

Contaminant losses and effects - over and above what is in place

The average annual N loss for the proposed system with additional cows is predicted by Overseer to be 48 kg/ha; the prior average annual N loss is predicted at 49 kg/ha. Overall N loss for the proposed system with additional cows is 168 kg/year lower than losses for the pre-expansion system. The average annual P loss for the proposed system with additional cows is predicted by Overseer to be 1 kg/ha; the prior average annual P loss is predicted at 0.9 kg/ha. In conclusion, losses of N and P below the root zone are predicted by Overseer remain stable or increase slightly despite additional cows.

Changes to the farming system are off-setting additional nutrients from additional cows and act as mitigation measures that form part of the proposed farming system. Key off-sets that are recognised by Overseer are limiting the area under fodder crop/IWG, managing nitrogen fertiliser application rates and timing, and increasing the liquid effluent application area. Collectively, less N will accumulate in soils at high risk times, less N mineralisation will occur, and greater soil organic matter will be retained despite additional cows. The outcome will be less N lost below the root zone and ultimately to groundwater and/or receiving surfacewaters. The avoidance of fallow periods following IWG of fodder crops will reduce pugging of soils and runoff of N, P, sediment and microbes to receiving waters.

Evidence from trial data measured in two field studies carried out in Southland and summarised in a review[3] show that fodder crop blocks under IWG lose high levels of N in drainage. Particularly, results from the Woodlands trial showed that per hectare N losses from fodder crop (kale) were 4 to 5 times greater than losses measured under dairy pasture on equivalent soil types and land use. Relatively high concentrations of nitrate-N were measured in drainage over three years from IWG forage crops on shallow soil types at the Five Rivers site. Much lower nitrate-N concentrations were subsequently measured in drainage when cropped areas were returned to pasture, then grazed by deer followed by sheep. Comparison of measured trial data (57 kg N/ha/year +/-43) versus Overseer data (48 kg N/ha/year) for fodder cropping/IWG at the Fiver Rivers site showed that Overseer underestimated the quantity of N lost below the root zone somewhat.[4] Overseer has undergone several version changes since the report was published, which has seen predicted N losses increase from fodder crop/IWG blocks in particular. By limiting the area under IWG to 11 hectares annually, control over the quantity of N lost below the root zone at the farm is achieved, as supported by the above trials.

Overseer predicts that there will be a small increase in P loss associated with the expansion (24 kg/year). Soils underlying steeper land classed as “rolling” have higher risk of P loss, and by proxy loss of sediment and microbes. A key driver of the modelled increase in P loss is Olsen P values that have been entered for proposed system. Target Olsen P values of 40, 35 and 25 (for effluent, non-effluent and easy hill blocks respectively) have been entered in the proposed system. These are somewhat higher than Olsen P levels in pre-expansion years but are consistent with levels required for high producing dairy farms, and with realistic target Olsen P levels for the farm. Approximately 10 kg P/year of the modelled increase in P loss originates from “Other sources” P loss. The modelled increase in average annual P loss from “Other sources” will be mitigated by the implementation of practices on farm that target the contaminant pathway (overland flow/runoff) from tracks and lanes to waterways.

Given the range of GMPs and key mitigation measures that will be implemented in conjunction with the addition of 50 cows to the milking herd (relative to the last 2 years), no realised increase in N or P loss is predicted relative to the prior system. The proposed system is expected to have less accumulation of N at high risk times, generate less mineral N in soils and greater soil organic matter content, less pugging of soils and reduced runoff. Potential effects from additional cows such as increased treading damage causing compaction and runoff will be avoided by good stock management such as avoiding high risk paddocks during wet conditions and always providing stock with enough

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[3] Monaghan (2012). The impacts of animal wintering on water and soil quality. Report prepared for Environment Southland.

[4] Smith & Monaghan (2013). Comparing Overseer estimates of N leaching from winter grazed forage crops with results from Southland trial sites. Report prepared for Environment Southland.

feed and water to minimise stress. Based on these factors with support from Overseer predictions, effects on groundwater and receiving surfacewaters due to an adapted system with additional cows would be expected to be similar or less than under the prior farming system and certainly be no greater than what is already in place.

Specific effects from the whole activity, which includes additional cows, are described and considered in the context of soil processes, drainage, attenuation, hydrology and receiving waters in the previous section. To avoid repetition, please see the previous section for details.

Cumulative effects from farming on the receiving environment

Introduction

S 3 of the RMA defines cumulative effects as effects that arise over time or in combination with other effects. This assessment aims to identify and consider effects on the receiving environment that arise over time, accounting for other land use activities in the catchment and other influences such as hydrology, drainage properties and nutrient attenuation.

Mataura catchment and Toetoes Estuary catchment

The dairy farm lies in the Waikaka River/Mataura River catchment. Sitting at the base of the catchment, Toetoes (Fortrose) Estuary has been impacted over time by land use activities in the wider catchment. It is a medium-sized (~500 ha) "tidal lagoon" type estuary that discharges to Toetoes Beach at the mouth of the Mataura River and Titiroa Stream[5]. It drains a large and primarily high productivity agricultural catchment and has a large freshwater influence because the estuary is small in relation to the freshwater input. Existing land use activities and increasing agricultural intensification are key contributors to the degradation of water quality in the Mataura catchment. Most of the catchment has been developed for agriculture, which is particularly intensive in the middle and lower reaches. Significant abstractive pressures for pasture irrigation exist in the middle reaches near Riversdale.

According to LAWA[6] the Mataura River has a catchment area of 560,018 hectares comprising 63% exotic grassland, 17% tussock grassland, 8% indigenous forest, 4% exotic forest and 1% cropping. The balance comprises shrubland, urban and waterways. The Garden Gully Road dairy farm accounts for 0.04% of the total catchment area.

Agricultural land use in the Toetoes catchment is made up of sheep & beef, dairy farming and forestry. As reported in a 2014 study prepared for Environment Southland by Aqualinc, there are 237 dairy farms, 784 sheep & beef farms and 314 forestry blocks[7]. This may have changed slightly since 2014 but would be expected to be broadly similar. Sheep & beef farming remains the dominant land use although there is crossover since some sheep & beef enterprises carry out dairy support activities such as IWG. The Aqualinc study concluded that "sheep & beef remains the dominant land use by area in the Southland region, but losses from dairy farms are greater per hectare. Overall, the contributions

[5] Stevens & Robertson. 2016. Fortrose (Toetoes) Estuary 2016. Broadscale substrate, macroalgal and seagrass mapping. Report prepared by Wriggle Coastal Management for Environment Southland.
[6] https://www.lawa.org.nz/explore-data/land-cover/

[7] Assessment of Farm Mitigation Options and Land Use Change on Catchment Nutrient Contaminant Loads in the Southland Region. Aqualinc Report C13055/04, 2014 Prepared for Environment Southland.

from both land uses are significant. However, given the higher per hectare losses, it follows that mitigation on dairy farms provides a greater per hectare benefit for water quality."

The wider Toetoes Estuary catchment is characterised by the major Mataura River and other significant tributaries, which provide for potential dilution of contaminants. Within the wider catchment, there are several groundwater zones (e.g. Edendale, Lower Mataura, Knapdale, Chatton, Riversdale, Waimea Plain, Wendon, Wendonside) as well as unmapped groundwater zones, reflecting different aquifer profiles. The denitrification potential rating for GW zones generally range from very low to low, with greater denitrification potential found at the base of the catchment[8].

N LOAD – TOETOES ESTUARY

A 2014 Aqualinc [9]report prepared for Environment Southland assessed farm mitigation options and land use change on catchment nutrient contaminant loads in Southland[10]. Nutrient loss estimates were based on the Overseer farm nutrient budgeting model, which was also used to estimate how loss rates would change under three levels of on-farm mitigation measures. Information from the report has been used to estimate the contribution to the total N and P loads of the Toetoes catchment from the farming activity at the Garden Gully Road dairy farm. The report estimates that dairy farming contributes 30% of the agricultural N source load in Toetoes catchment, with sheep and beef contributing the balance (70%). Dairy farming contributes 40% of the agricultural source load of P, with sheep and beef contributing 60%. Significantly, wintering-off dairy cows within the catchment is a component of the sheep & beef activity.

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)

Figure 6. Estimated loads of N and P in the eight study catchments[11]

Approximately 9,839 kg N/year may be lost from 205.7 hectares of land at the Garden Gully Road dairy farm according to Overseer nutrient budget analysis (see proposed Block Nitrogen report). Assuming an attenuation rate of 34% from the above table, approximately 6,494 kg N/year could over time end up in receiving waters. This amounts to 0.15% of the estimated realised N load for Toetoes Estuary catchment.

[8] Rissman (2011). Regional Mapping of Groundwater Denitrification Potential and Aquifer Sensitivity. Technical Report.

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

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

A similar calculation can be carried out to estimate the P load from the farm to Toetoes Estuary catchment without using an attenuation rate. 199 kg of P may be lost annually from 205.7 hectares (see proposed Block Phosphorous report from Overseer). This amounts to 0.14% of the current catchment agricultural source P load in Toetoes Estuary catchment.

Both estimates show that the farming activity at Garden Gully Road contributes a very small proportion of the nutrient (N and P) loading to Toetoes Estuary catchment and represents a very small proportion of total nutrient load in that catchment. It follows that cumulative effects from the activity will be minimal. Certainty that nutrient losses will not increase is provided to the Consent Authority through the capping of N loss per hectare through a consent condition. Given that Overseer is not spatially explicit down to the level of individual farms, a consent condition specifying a P limit based on Overseer is not proposed. While the limit-setting process will primarily address the challenge of improving water quality in the coming years, this proposal is expected to allow water quality in Toetoes Estuary catchment to be maintained if not improved in the meantime. Accounting for effects from all other land uses in the catchment, cumulative effects on Toetoes Estuary from the proposed activity at the Garden Gully Road dairy farm are expected to be minimal.