Woldwide Four Limited

Farm Environmental Management Plan

March 2019

FARM ENVIRONMENT MANAGEMENT PLAN

A: PROPERTY OVERVIEW

Contact Person(s)	Abe and Anita de Wolde	**Plan Prepared By**	Landpro Ltd
Contact Phone	02 227 2537	**Date**	23 August 2019
Email Address	abe@woldwide.nz	**Date of Next Review**	23 August 2020
Physical Address	104 Shaws Trees Road		
Consent Numbers and Expiry Dates	TBC		
Farm Area	394 ha Includes WW4 dairy platform, Gladfield support block and Woldwide Runoff	**Peak Milked Herd Size**	1000
Legal Descriptions	Lot 7 DP 152 Lot 11 DP 152 Lot 12 DP 152 Lot 26 BLK III DP 210 (Gladfield) Lot 7 DP 238 (new block from Cochran's) Merrivale Block: Part Section 7 Block XII Waiau SD Part Section 7 Block XII Waiau SD Part Section 7 Block XII Waiau SD Lot 1 DP 3537 Merriburn Lease Block: Lot 1 DP 302409 Sec 26 Merrivale Settlement No. 1 Sec 27 Merrivale Settlement No. 1		Lot 10 DP 152 Lot 11 A DP 152 Pt Lot 2 DP 4262

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

Objectives of this plan:

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

This will be achieved through;

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

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

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

B: SITE PLANS

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

KEY FEATURES	PLAN(S) WHERE KEY FEATURES ARE MAPPED
Site boundary	All site plans in this FEMP
Physiographic zones, variants and soil types	Figure 1 and 2: Physiographic Plan Figure 3 and 4: Soil map
Lakes, rivers, streams ponds, artificial watercourses, modified watercourses and natural wetlands	Appendix A: Existing Waterways and Critical Source Areas
Other critical source areas (gullies, swales etc)	Appendix A: Existing Waterways and Critical Source Areas
Land with a slope greater than 20 degrees	N/A
Existing and proposed riparian vegetation and fences (or other stock exclusion methods) adjacent to waterbodies	Appendix A: Waterway location, most have riparian planting
Places where stock access or cross water bodies (including bridges, culverts and fords)	Appendix A: crossings labelled
Known subsurface drainage system(s) and the location of drain outlets	Appendix B
All land that may be cultivated over the next 12 months	TBC – once consent granted
All land that may be intensively winter grazed over the next 12 months	TBC – once consent granted

C: PHYSIOGRAPHIC ZONES AND KEY CONTAMINANT PATHWAYS

This section of the FEMP documents the physiographic zones and key contaminant pathways present across the property.

The physiographic plans shows the spatial distribution of the physiographic zones on the entire property according to the Environment Southland Proposed Water and Land Plan 2018 (PSWLP) as mapped by Beacon Mapping Service. The mapping system also details the key contaminant pathways present for each physiographic zone and any variants for the location.

Figure 1: Physiographic Zones on the farm (showing dairy platform and Gladfield block)

Figure 2: Physiographic zones at Woldwide Runoff

D: SOIL TYPES

This section of the FEMP documents the soil types present across the property. The Soil Maps below shows the spatial distribution of the soil types across entire property according to the Environment Southland Beacon Mapping Service.

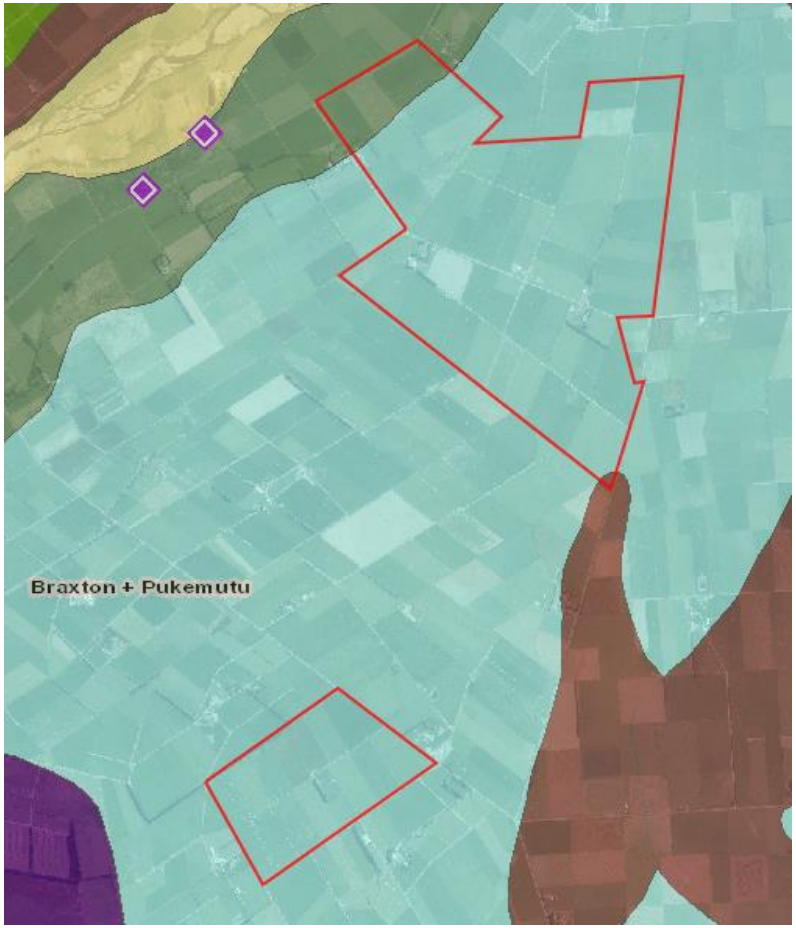


Figure 3: Soil types found on the farm (Blue = Braxton, Green= Tuatapere)

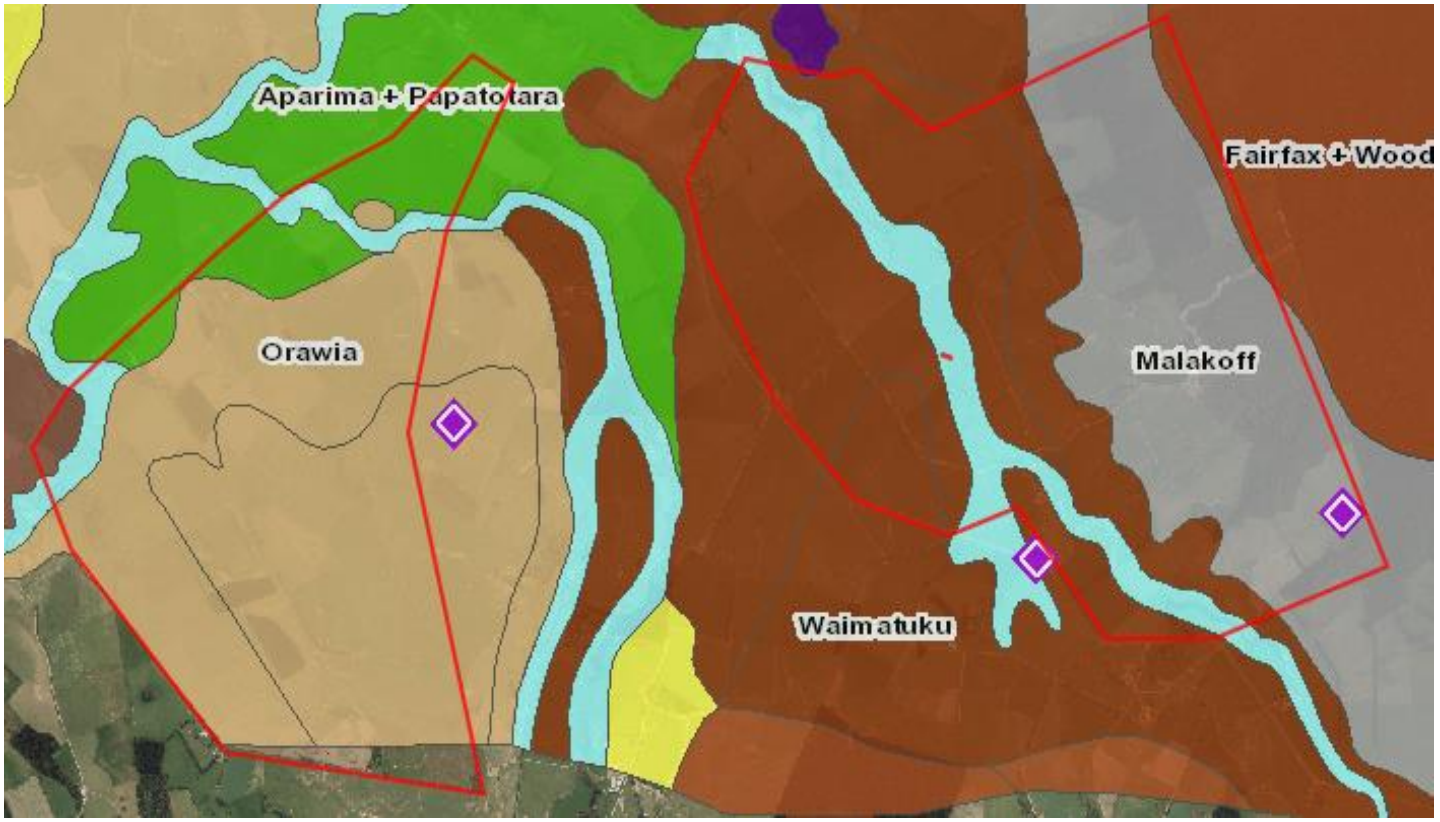


Figure 4: Soil types at Woldwide Runoff

E: GOOD MANAGEMENT PRACTICES - GENERAL

Mitigation	Good Management Practice	Review notes
Protect soil structure (will also help with P and N loss	Wintering the milking herd on fodder beet on the support block (Gladfield) until wintering barns completed. Also refer to Section G.	
	Re-sow bare soils as soon as possible	
	Use of selective grazing to avoid grazing very wet paddocks and open the breaks up to avoid pugging and treading damage.	
Manage Critical Source Areas (CSA)	Avoid working CSAs and their margins	
	Leave grassed areas (or native vegetation) around CSAs especially when grazing winter forage crop and/or graze as "last bite". Grazing direction must be down the slope or towards CSA.	
	All riparian margins must be fenced and left to establish with grasses to enable filtration of contaminants that may be transported via overland flow processes.	
	Create Riparian areas to mitigate overland flow into water ways Refer to Consent Nutrient Budget Adjustments'.	
Additional P loss reduction	Reduce use of P fertiliser where Olsen P values are above agronomic optimum. Maintain Olsen P levels at around 40.	
	Reduce the risk of run-off to laneways and other sources by ensuring crossings are adequately maintained and maintain gradients of laneways to direct runoff to pasture.	
Reduce accumulation of N in the soil	Use nutrient budgeting to manage nutrient inputs and outputs	
	Time N fertiliser application to meet crop and pasture demand using split applications and avoid high risk times of the year i.e. when soil temperature is low or during drought periods	

Avoid preferential flow of FDE through soil profile and artificial drains	Defer effluent application when soil conditions are unsuitable especially when applying effluent to high risk paddocks	
	Apply effluent at low rates and depths and utilize entire effluent discharge area	

F: RIPARIAN MANAGEMENT

The dairy farm and Gladfield are mapped to drain to Waimatuku Stream and Aparima River. Woldwide Runoff drains to the Orauea River.

All waterways are already fenced to exclude stock as required by the supplier on the dairy platform. Any other waterways on the support land are fenced. All riparian margins are left to establish with grasses and native vegetation in the first instance or as a minimum. Some waterways contain riparian planting.

Riparian buffer zones will be created with natives and hedge like trees to retain nutrients and stop over land flows, along the River edges and any further created water ways. Riparian planting areas are identified on the map in Attachment A.

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

Appendix A maps the waterways present on the property, any stock crossings and/or CSA's for riparian management, with additional identified areas required to enable the P loss reductions modelled for the consent.

Figure 5: Photos of artificial drainage channels on the farm with stock exclusion and riparian vegetation.

G: CRITICAL SOURCE AREAS

Critical Source Areas (CSA's) are areas that have high risk of channelling contaminants to waterways. CSA's for the property have been identified, as indicated in the Cultivation Map (Attachment A) The CSA's for the property include:

Good Management Practices that will be employed in the management of CSAs are summarised in the table above.

Areas where over land flows collect and pool, with ability to flow into water ways are CSAs. As in Woldwide 1&2, these areas will be fenced and planted with Natives and flaxes etc. Fence off CSAs to create a grass or grass shrub buffer zone to filter contaminants and prevent stock access. The faster the water is flowing across a buffer zone, the wider the buffer zone should be to provide time for effective filtering. Plants which will slow and filter the sediment and nutrient overflows from entering water ways. The areas have been identified in the attached map in Attachment A.

H: INTENSIVE WINTER GRAZING

Intensive winter grazing is defined in the PSWLP as the *"Grazing of stock between May and September (inclusive) on forage crops (including brassica, beet and root vegetable crops), excluding pasture and cereal crops."*

Appendix C includes a farm map of winter grazing paddocks for 2018/2019 and 2019/2020 seasons for the Gladfield block. Full cultivation is undertaken and crop type is fodder beet. Refer to Runoff block FEMP.

The table below outlines the good management practices which will be adopted on site for the intensive winter grazing activity.

Mitigation	Good Management Practice	Review notes
Protect soil structure and reduce N, P, sediment and faecal indicator organism loss from intensive winter grazing activities	Grazing direction must be top of slope to bottom of slope. Use break or block feeding and ensure a last bite of 5-20m is left from CSA's	
	Back fencing must be used to prevent stock from entering previously grazed areas	
	Portable water troughs must be used to prevent stock from entering previously grazed areas	

	Portable feed containers must be used for supplementary feed to avoid feed wastage	

I: NUTRIENT MANAGEMENT

Nutrient management is a key component to ensuring good on farm environmental practice. The farm utilizes nutrient budgeting through their supplier (Fonterra) as well as via their fertilizer representative (Ravensdown) and will append full nutrient budgets by May 2019 in accordance with the PSWLP. Any resulting nutrient budgets are reviewed and updated as required especially if farm system changes are proposed, but not less than on an annual basis. Any budget reviews are guided by a fertiliser representative and nutrient management advisor.

Regular soil tests will be undertaken to establish the nutrient status of the soils. Soils should be at nutrient levels which avoid any adverse effects on the environment but maintain good pasture production and animal health, by ensuring that the soils are suitable for optimal plant nutrient uptake.

Areas which are receiving FDE will be carefully managed to ensure nitrogen loadings are at acceptable levels and are compliant with conditions imposed by resource consents. The annual effluent nitrogen loading rate shall not exceed 150kg/N/ha. Effluent will be applied utilising low rate application. Effluent management is discussed in Section ~~H~~I of this FEMP.

The table below describes the good management practices which will be adopted in relation to nutrient management.

Mitigation	Good Management Practice	Review notes
Minimise nutrient losses from farming activities to ground and surface water	Whole farm nutrient modelling using OVERSEER budget (or equivalent model) prepared by a suitably qualified person	

by utilizing nutrient budgeting	Whole farm nutrient budget reviewed annually and updated in accordance with significant farm system changes	
	Minimise N losses by using soil testing to guide fertilizer recommendations and match fertilizer application with plant and animal requirements.	
	Use of a fertilizer representative to advise on fertilizer type, timing and application rates. Split applications where application rates exceed 100kg P/ha	
	Limit P application between June and August	
	Crop rotations adjusted to maximise the use of residual N in the soil	
	Stock wintering practices adjusted to minimise nutrient losses	

The following table sets out the evidence which needs to be collected for nutrient budgeting purposes:

Record	Nature of information/person	Collated (Y or N)
Production	Fonterra App, dockets	
Soil test results	Lab results, Ravensdown rep	
Fertiliser application records	MINDA land & feed, Ravensdown rep	
Proof of placement	MINDA land & feed	
Effluent application records	Dairy diary	
Crop rotation records	Farm map with total hectares	
Stock numbers	Culling timeframes Young stock grazed on farm Breeding bulls	
Record of supplements purchased	Invoices/Cash manager, MINDA	

Records of supplements made on farm	Invoices/Cash manager	
Farm map/effective hectares	Farm manager	

J: FARM DAIRY EFFLUENT

This section of this plan documents the methods that will be employed in the operation of the Farm Dairy Effluent (FDE) System to ensure that the discharge of effluent occurs in accordance with conditions of consent. Appendix D includes a full FDE Management Plan, monthly check sheets and staff training record.

Total effluent discharge area:	78 ha liquid effluent discharge area, 320 ha slurry discharge area
Available storage volume:	3,801m^3
Storage Type:	Effluent storage pond, concrete bunker, slurry effluent pond
Effluent application method:	Low rate pods Slurry tanker/muck spreader/umbillical Travelling irrigator
Maximum application rate and depth of application:	10mm/hr 25mm depth per application. 2.5mm depth for slurry/muck spreader/umbillical

Mitigation	Good Management Practice	Monitoring
Reduction in effluent generation	• Reduce water use in shed by reusing clean water where possible • Treat the herd gently to avoid upset	N/A
Effluent applied only when soil conditions are appropriate	• Sufficient storage provided so that when soils are at or above field capacity and/or during adverse weather conditions, effluent can be stored in the effluent storage pond until conditions are suitable for application • Monitoring of soil moisture using the ES website. • Paddocks will be inspected before effluent application to check that soil water deficit exists.	N/A

	• Low rate application will be preferentially used during higher risk periods of the year with the travelling irrigator used mainly in summer when a greater soil moisture deficit occurs	
Avoidance of direct effluent disposal or runoff to sensitive areas	• Effluent discharge will observe a range of buffers from sensitive receiving environments as shown on the Appendix I plan attached to the discharge permit • Low rate effluent discharge will avoid ponding and/or runoff • Effluent will not be discharged onto any land areas that have been grazed within the previous 5 days • Effluent discharge will be to the entire effluent discharge area	Record irrigation dates, times and areas in the DAIRY DIARY
Avoidance of effluent contamination in tile drains	• Low rate effluent discharge to reduce the risk of through-drainage and associated risk of effluent entering water • Mapping of tile drains	N/A
Efficient and effective collection, storage and delivery of effluent from infrastructure at all times	• Monthly/frequent system checks will be undertaken using the Monthly Effluent Check Sheet attached • All parts of the effluent system will be checked and maintained regularly • Leaks will be repaired immediately • Fail safe systems will be kept in place and kept in good working order i.e. automatic alarm and shut off system	Record all repairs and maintenance (invoices, cash manager) Monthly Effluent Check Sheets filled out and signed
Staff appropriately trained in operation and understand the effluent system	• All staff involved in the management of the effluent system are fully trained in its use • All staff are familiar with and understand the conditions of consent • All new staff will be taken through the "Staff Training Guide" (attached) • Staff to take immediate action if incident or breakdowns occur including; - Rectifying the problem - Cleaning up if possible	Keep signed training record in the back off this FEMP Ensure both farm manager and employee sign to confirm training
Application that is not offensive to neighbours	• Wind conditions will be checked to ensure the effluent can be discharged without resulting in spray drift and odour beyond the property boundary • Observation of buffers to dwellings not located on the property (200 m) and property boundaries (20 m)	Complaints received by Environment Southland

K: COMPLIANCE AND REPORTING

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

Record	Kept	Date of most recent version
Nutrient budget		
Fertilizer application records		
Soil sampling results		
Water meter certification		
Water abstraction records		
Effluent system training record		
Effluent system monthly maintenance checks		
Effluent proof of placement		
Effluent application depth test results		

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

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

L: ANNUAL REVIEW AND AUDIT OF FEMP

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

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

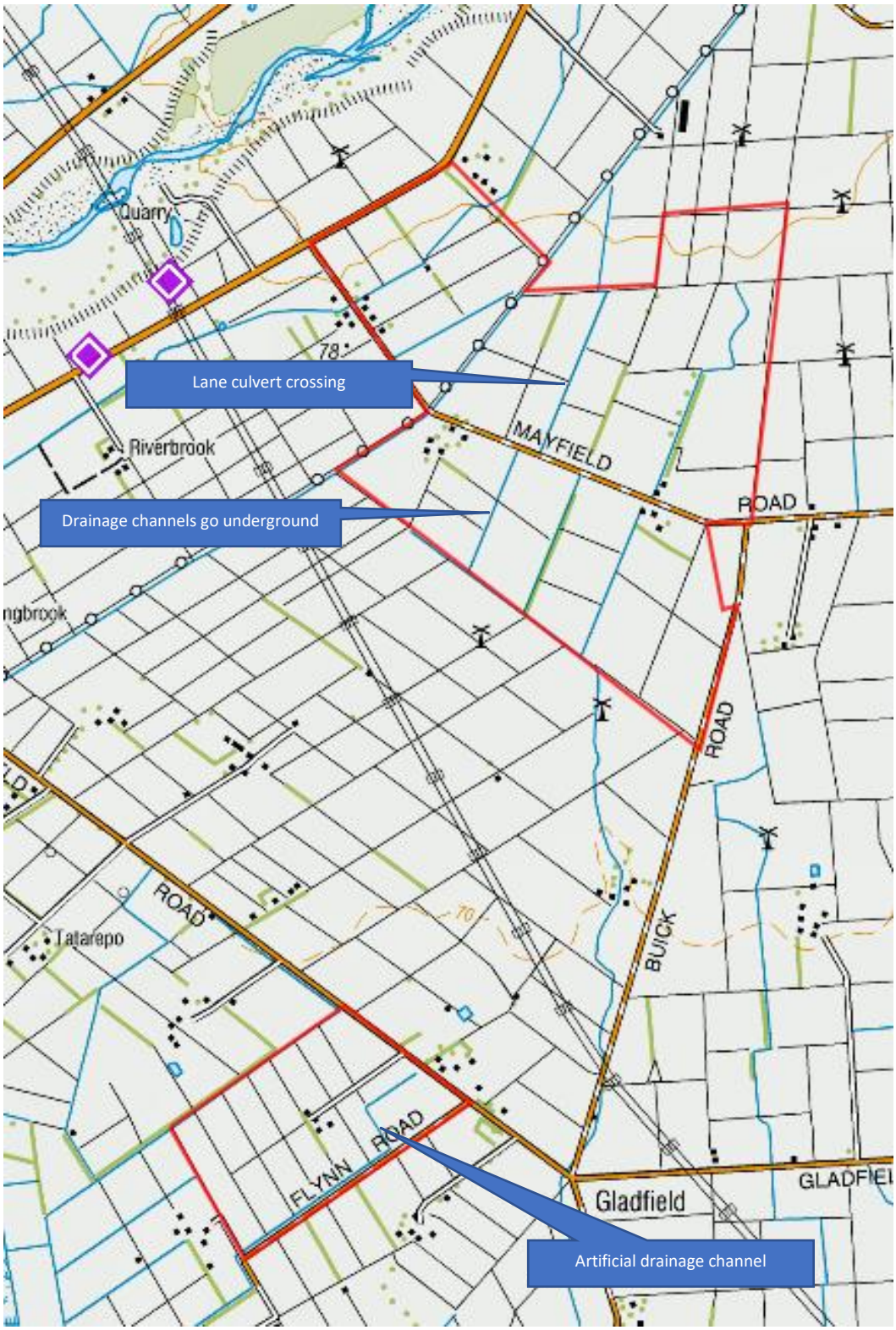
M: INDUSTRY GUIDELINES

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

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

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

Attachment A – Waterways, CSA



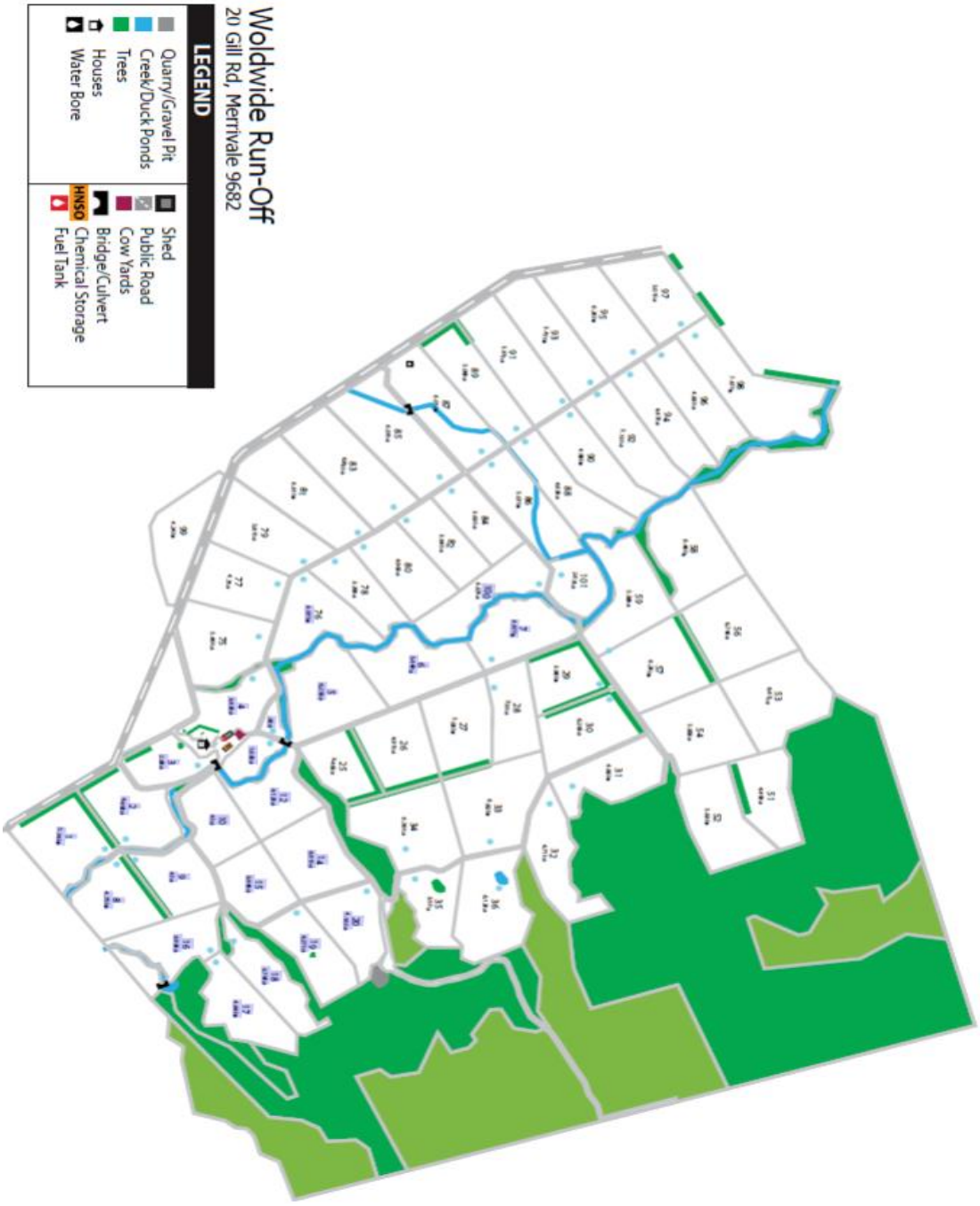
WW 4 P loss Mitigations

Features of P Mitigation WW4	GPS point	Area
Critical Source Area 1	-46.098770; 168.1162341	0.09
Critical Source Area 2	-46.098691; 168.114946	0.02
Critical Source Area 3	-46.098745; 168.117293	0.02
Critical Source Area 4	-46.102338 168.103812	0.05
Total		0.2 ha effects 14.2 ha (3.6 % modelled 2.5 %)
Laneway 1	-46.094740 168.113817	0.4 km
Laneway 2	-46.088775 168.116765	0.3 km
Lane way 3	-46.099268 168.105640	0.6 km
Total		1.3 km (modelled 1.1 km)

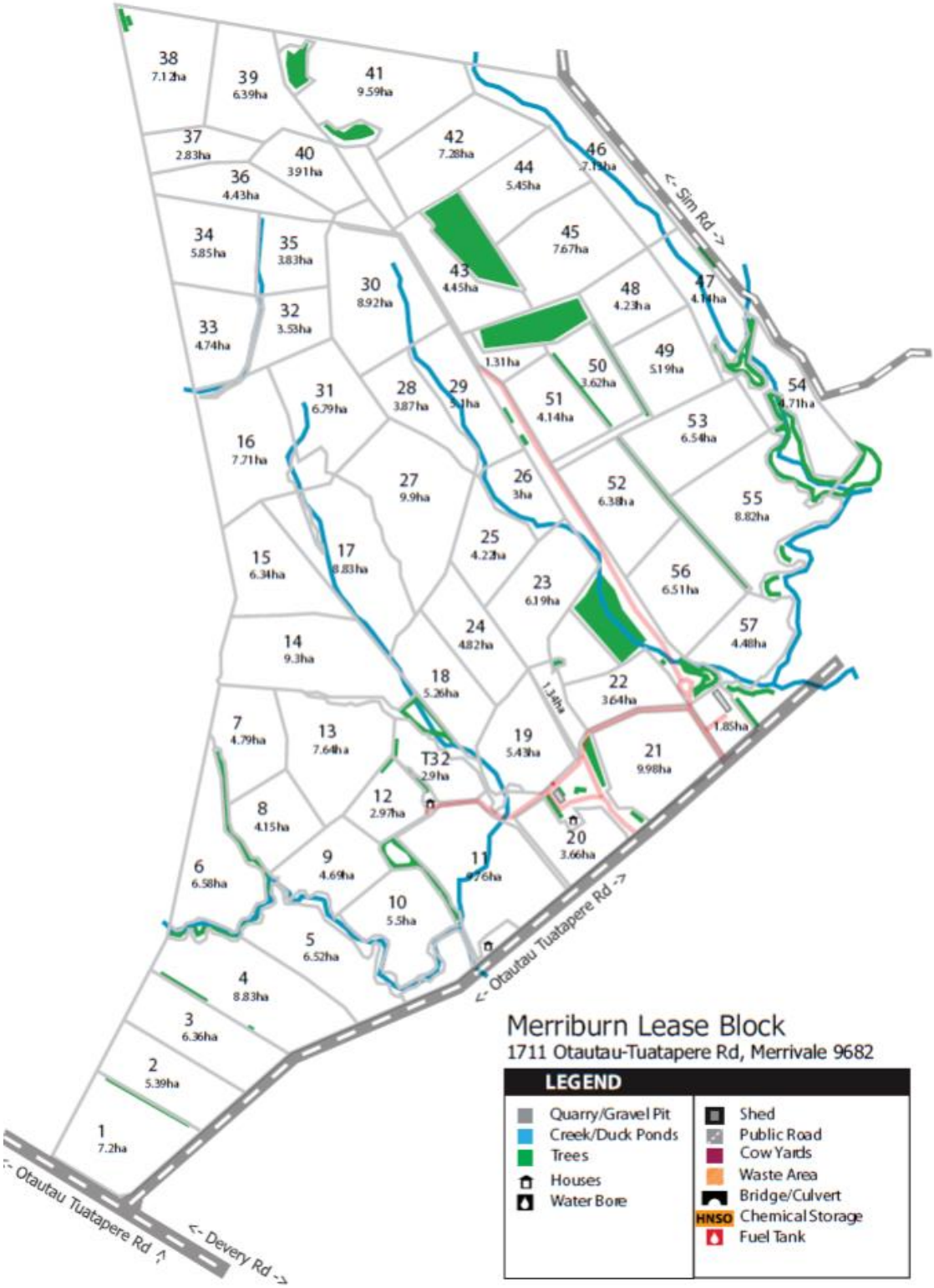
Lane way 1

Critical Source Areas 1-3

Culvert 2 and Laneway 3



Farm map for Woldwide Runoff original block (Merrivale Block)

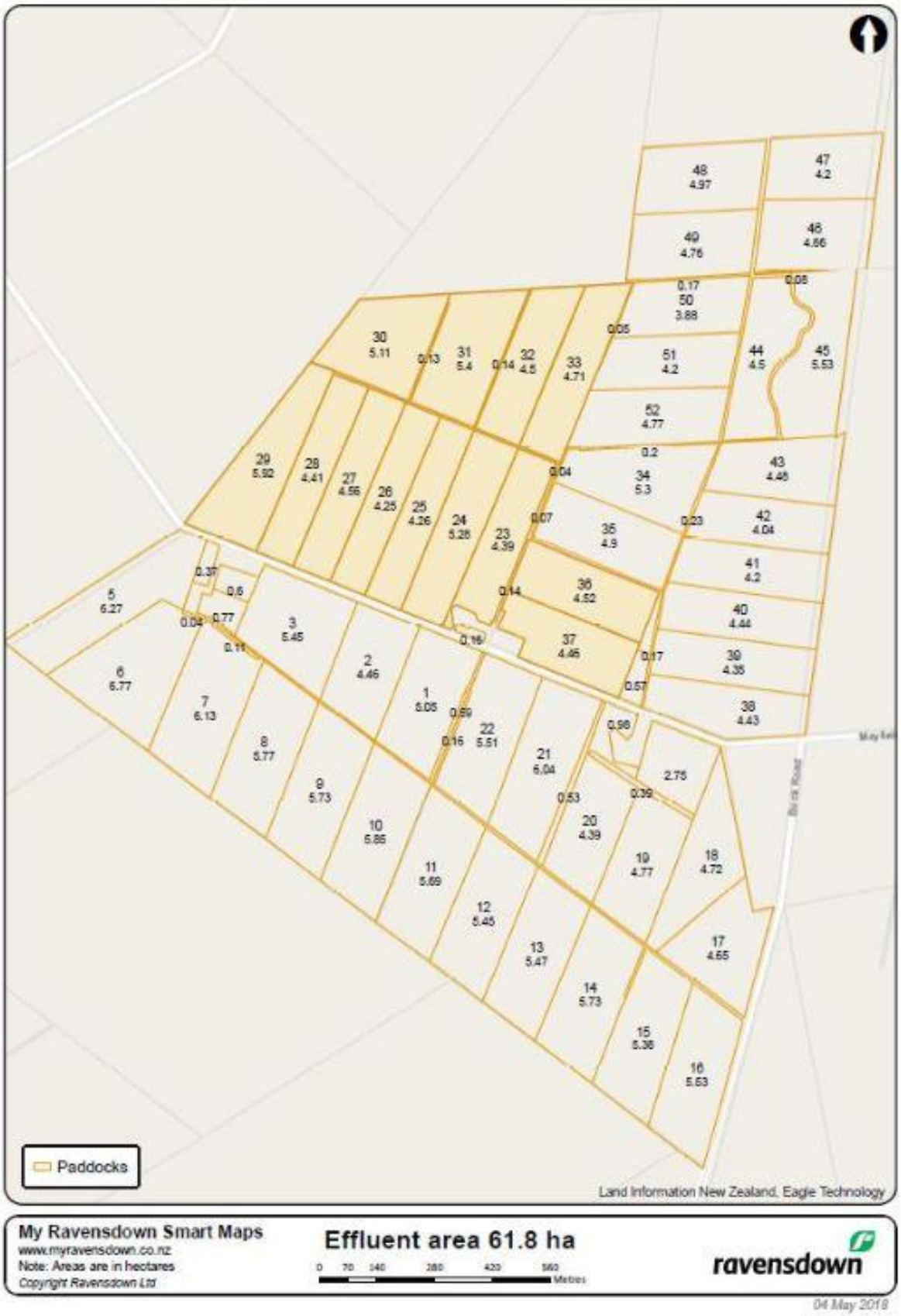


Farm map for Woldwide Runoff lease block (Merriburn)

Appendix B – Tile drain map (Dairy platform)

Appendix C – Crop paddocks (Gladfield block)

Appendix D: Effluent Management



My Ravensdown Smart Maps
www.myravensdown.co.nz
Note: Areas are in hectares

Effluent area 61.8 ha

0 70 140 280 420 560 Metres

ravensdown

04 May 2018

Effluent Orientation and Training Record

Season___/___

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

Trainer signature			
Employee signature			
Date			

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

DairyNZ

Irrigator run sheet

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

Date	Paddock	Run	Name	Comments

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

DairyNZ

Smart Water Use in the Farm Dairy

This guide looks at water use in and around the farm dairy, and whether there's potential for greater efficiency. Use it to evaluate your options for improvement.



Efficient use of water can help:

- control power use and costs
- manage effluent in a cost-effective manner
- get the most out of staff time
- reduce water costs if you pay for it by volume
- meet regulatory obligations that may apply in your region.

smartwateruse® on dairy farms

DairyNZ

Profitability. Sustainability. Competitiveness.

Smart Water Use in the Farm Dairy

Milk cooling

Use source water from Tank 1.

Aim for the recommended ratio of 2½ water: 1 milk

For example,

2.5 litres (water) x peak daily litres (milk) ÷ 1,000 = m³/day water use

To measure milk cooling efficiency

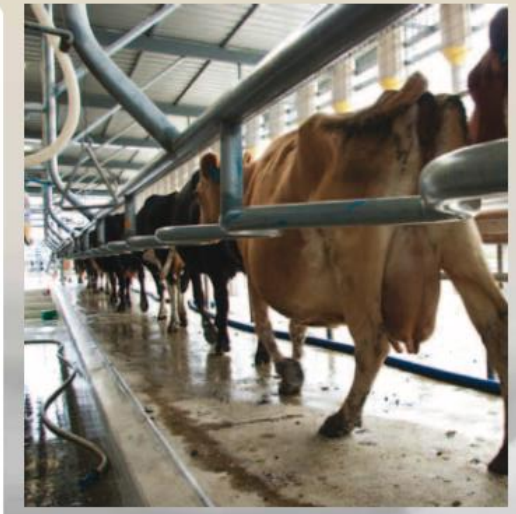
Measure exit flow into a 200 litre drum during milking.
Flow rate in litres/min x total daily milking time (clock this) ÷ 1,000 = m³/day water use

Alternatively, install a meter on the line delivering water to the plate cooler

Efficiency options

Things to consider if improved cooling efficiency is warranted:

- use of correct flow rates
- optimal plate spacing to increase flow
- pre-cool water source
- ice banks/heat exchangers (can be costly).



Return milk cooling water to Tank 2 for use in yard wash down.

Ensure adequate storage space remains to take all milk cooling water (use float ball or probes).

Capture roof water for reuse or at least exclude it from the yard to prevent increasing effluent volumes.

As a measure of efficiency, yard wash water use should not exceed milk cooling water.

Yard wash down

To measure yard wash down water use

Follow the steps and calculations in the accompanying *Worksheet* to estimate water use.

Efficiency options

For manual yard washing, here are some ways to improve water-use efficiency.

- Pre-wet the yard on warm, sunny days with a yard hose or sprinkler.
- Use a scraper or a chain (inside an old yard hose) on the backing gate to break up dung before hosing.
- Wash the yard after each milking.
- Work actively and close to the effluent.
- Hose the yard with high water volume under low pressure.
- Include a timer setting on the yard wash down pump (set a time standard for wash down and train staff to achieve it).
- Consider capturing excess cooler water (that would otherwise go to waste) in tipper drums for yard wash.
- Flood wash with water recycled from the effluent pond (refer to conditions of use from your milk processor).

Plant/vat wash

Use water from Tank 1.

To track plant/vat water use

Wash tubs and hot water cylinders use set amounts of water. Refer to washing routine instructions supplied by the detergent companies.

Efficiency options

Here are some steps you can take to reduce plant/vat wash water use:

- Seek advice from your detergent rep on litres required for hot/cold wash options.
- Refill tanks/cylinder with automatic shut-off (to avoid overflows). Use a toilet cistern and trough floats as proven refill/shut-off options.
- Consider heat exchange or pre-heating to improve energy efficiency.

Milking routines

Procedures and practices during milking affect water-use efficiency. Below are some ways to cut water use.

- Pre wet bail and yard.
- Minimise sprinkler/spray washing.
- Hose little and often (as required) in pit area.
- Put cups on dry, clean udders (see DairyNZ's SmartSAMM – www.smartsamm.co.nz).
- Implement a calm, consistent routine to reduce stress in animals and, in turn, effluent in the dairy (see DairyNZ's Milksmart – www.milksmart.co.nz).
- Maintain the dairy (paint/surfaces) to minimise the need for continual wetting.
- For rotaries, use air jet or other methods instead of water to back cows off.

Efficiency options

Here are a few more tips for efficient water use and to reduce water loss.

- Ensure high standard of water quality (if treatment is required).
- Do regular checks for pump pressure, line restrictions and possible leaks.
- Reduce the number of hand-held hoses in use throughout the dairy.

ravensdown

Consent Nutrient Budget Adjustments

Further Clarifications and P Mitigation Requests of Scenario Reports

Prepared by Mark Crawford
Senior Farm Environmental Advisor
CNMA
Certified Nutrient Management Adviser

60877676 and 60876935
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2/08/2019

optimiser™
Environmental analysis and planning

Executive Summary

Landpro Senior Scientist/Planner Mike Freeman on behalf of Woldwide Four Limited and Woldwide Five Limited have requested additional nutrient loss mitigation to completed OVERSEER FM® Nutrient Budgets to model the farm systems and assess the nutrient loss changes in support of the current consent being sought.

The 349.3 ha and 262.6 ha farms are located at 805 Mayfield Road and 800 Bayswater Road, Heddon Bush, with Woldwide 4 including the 78.8 ha support block located at 477 Gladfield Rd, 19 km west north west from Winton Township, 40 km nor-north west from Invercargill city and 36 km from the south west coast (Orepuki). Both properties are dryland dairy farms, milking approximately 810 cows (consented numbers 850) and 680 cows (consented numbers 800 respectively; with Woldwide 5 modelled at 680 from current 540 average with the additional cows modelled allowed for the 44.3 ha of consented land yet converted.

Point 1 – Adjusted Barn Autumn Numbers and Supplementary feed plus re adjusted fertiliser with additional barn slurry.

For Woldwide Five: Average Nitrogen lost from the root zone from the farm system modelled using OVERSEER FM® Nutrient Budgets 6.3.1/2.6.2.0 is changed from **15,804 kg N/year** or **47 kg N/ha/year** to **14,873 kg N/year (5.9% decrease)** or **43 kg N/ha/year.**

For Woldwide Four: Average Nitrogen lost from the root zone from the farm system modelled using OVERSEER FM® Nutrient Budgets 6.3.1/2.6.2.0 is changed from **11,276 kg N/year** or **27 kg N/ha/year** to **9,550 kg N/year (15% decrease)** or **23 kg N/ha/year.**

For Woldwide Five: Average Phosphorus lost from the root zone from the farm system modelled using OVERSEER FM® Nutrient Budgets 6.3.1/2.6.2.0 is changed from **247 kg P/year** or **0.7 kg P/ha/year** to **244 kg N/year (1% reduction)** or **0.7 kg N/ha/year.**

For Woldwide Four: Average Phosphorus lost from the root zone from the farm system modelled using OVERSEER FM® Nutrient Budgets 6.3.1/2.6.2.0 is changed from **371 kg P/year** or **0.7 kg P/ha/year** to **366 kg N/year (1% reduction)** or **0.7 kg N/ha/year.**

Average Nitrogen loss reductions by and large reflect the additional wintering of cattle in doors, whilst the Phosphate losses reflect the adjustments made to fertiliser and barn slurry distribution.

Point 2 – P Loss Mitigation from Other Sources

For Woldwide Five, the average Phosphorus mitigated and therefore not lost from the root zone from the farm system modelled using OVERSEER FM® Nutrient Budgets 6.3.1/2.6.2.0 is calculated to be **12.7 kg P/year** and so the final P loss is recalculated to **231 kg/year** (6% reduction) or **0.7 kg P/ha/year**

*This was not reported in the Overseer report***.**

For Woldwide Four, the average Phosphorus mitigated and therefore not lost from the root zone from the farm system modelled using OVERSEER FM® Nutrient Budgets 6.3.1/2.6.2.0 is calculated to be **28.8 kg P/year** and so the final P loss is recalculated to **337 kg/year** (6% reduction) or **0.8 kg P/ha/year.**

This was not reported in the Overseer report.

Actual data was used in compiling the Nutrient budgets, with adjustments made where sensibly required to align modelled outputs.

The key reductions are in line with amounts shown for Woldwide 1&2.

The barn calculations have been sent to OVERSEER FM for an explanation of why other source P loss appears not to be consistent with cows spending less time on the laneways.

The farms are entities, modelled as production units with their systems using actual averaged data for the inputs and this data is then extrapolated for the scenario budgets.

Overseer nutrient budgets Version 6.3.1/2.6.2.0 have been used to create the nutrient budgets presented in this report.

Contents

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Mark Crawford

Senior Farm Environmental Consultant

Dated: 4th August 2019

Point 1 – Adjusted Barn Autumn Numbers and Supplementary feed plus re adjusted fertiliser with additional barn slurry.

Description of farm system scenario; Woldwide Four and Five:

The properties will be operated as a dryland dairy farms, calving 1032 and 960 cows and peak milking 1000 and 930 (540 & 500 kg LW) Friesian cows respectively. Milk production aimed for is at 535,000 and 570,000 kg MS/year (575 and 570 kg MS/cow peak). Cow numbers are shown in the table below.

Key changes to the original farm proposed farm systems are;

- Additional cows and R 2 Heifers are milked and wintered indoors. Numbers are highlighted in the table below;

Stock Number details and Barn Information (Woldwide Five): Table 1

	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	LW (kg)
Dairy cows		265	715	705	695	695	675	665	655	645	600	260	540
First calving heifers	30	220	247	240	235	235	235	225	225	225	195		500
Dairy grazers (milking cows)	715	450									0	455	540
Dairy grazers (Repl. In calf hfrs)	***218***	***27***									***122* (248)***	***248***	480 & 500
Bulls						20	20						700
Number in Barns	960	960								***435***	918	960	

* Overseer FM shows 248, however would have calculated the weighted average from 15th May, and so have also shown 122 as a weighted average

Stock Number details and Barn Information (Woldwide Four): Table 1(a)

	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	LW (kg)
Dairy cows		300	769	760	750	750	730	720	710	700	655	295	540
First calving heifers	30	235	260	255	250	250	250	240	240	230	210		500
Dairy grazers (milking cows)	769	469									0	474	540
Dairy grazers (repl. In calf heifers)	***233***	***27***									***131* (263)***	***263***	500
Bulls						20	20						700
Number in Barns	1032	1031								***465***	995	1032	

* Overseer FM shows 263, however would have calculated the weighted average from 15th May, and so have also shown 131 as a weighted average

- With added cows and more time in barns, supplements were adjusted, and pastoral productivity aligned more in line with the current farm systems productivity, with associated reductions in fertiliser N and P as well. This fertiliser reduction was not significant and merely aligned P and N inputs with the added effluent and barn slurry P and N inputs

Pasture and Supplementary Feed Comparison

The predominant pasture species on the dairy farms is ryegrass/white clover. Annual pasture production has been weighted by relative productivity as 1 between dairy blocks, and 0.8 for the lesser producing grazing blocks on the platform respectively:

Woldwide Four

Block	Relative productivity	Current System T DM/ha/year	Proposed Barn System T DM/ha/year	Final Proposed Barn System T DM/ha/year
Dairy pastoral areas	1.0	15.1	16.0	15.6
Brax_4a.1 Non Eff Other Grazing	0.8	12.1	12.8	12.5
Cut & carry block Gladfield RO	n/a	12.2	16.3	16.3
Increased supplement amount				+100 T DM grain cows +115 T DM silage to heifers
Whole Farm N and P		195 and 26	216 and 26 249 and 34 slurry incl.	205 and 25 244 and 35 slurry incl.

Woldwide Five

Block	Relative productivity	Current System T DM/ha/year	Proposed Barn System T DM/ha/year	Final Proposed Barn System T DM/ha/year
Dairy pastoral areas	1.0	15.3	15.7	15.7
Upukeroroa soils	0.8	12.2	12.5	12.5
Increased supplement amount				+105 T DM silage to heifers
Whole Farm N and P fertiliser including slurry		158 and 47	156 and 12 193 and 26 slurry incl.	161 and 6 219 and 26 slurry incl

It should be noted that this estimated pasture production is based on default South Island pasture ME values and may be different to actual ME values and utilisation values on this farm which in turn would influence estimated pasture production.

All other factors have remained the same.

Results

For Woldwide Five: Average Nitrogen lost from the root zone from the farm system modelled using OVERSEER FM® Nutrient Budgets 6.3.1/2.6.2.0 is changed from **15,804 kg N/year** or **47 kg N/ha/year** to **14,873 kg N/year** or **43 kg N/ha/year.**

There is an overall decrease in the amount of N lost on a per hectare basis. This has been reported in the Overseer Report

For Woldwide Four: Average Nitrogen lost from the root zone from the farm system modelled using OVERSEER FM® Nutrient Budgets 6.3.1/2.6.2.0 is changed from **11,276 kg N/year** or **27 kg N/ha/year** to **9,550 kg N/year** or **23 kg N/ha/year.**

There is an overall decrease in the amount of N lost on a per hectare basis.

For Woldwide Five: Average Phosphorus lost from the root zone from the farm system modelled using OVERSEER FM® Nutrient Budgets 6.3.1/2.6.2.0 is changed from **247 kg P/year** or **0.7 kg P/ha/year** to **244 kg N/year** or **0.7 kg N/ha/year.**

There is an overall decrease in the amount of P lost on a per hectare basis.

For Woldwide Four: Average Phosphorus lost from the root zone from the farm system modelled using OVERSEER FM® Nutrient Budgets 6.3.1/2.6.2.0 is changed from **371 kg P/year** or **0.7 kg P/ha/year** to **366 kg N/year** or **0.7 kg N/ha/year.**

There is an overall decrease in the amount of P lost on a per hectare basis.

Point 2 Mitigate P losses from Other Sources

Description of farm system scenario

The request is to clarify from the provided Nutrient budgets for the Winter Barn final proposals, that further mitigations are able to reduce overall P losses. This was not an initial request of the modeller but is so now. The approach taken is in line with the approach from the Woldwide 1&2 proposals, the key difference here being that the farms are not already in winter barns.

Key assumptions to the farm system results reported from the model are stated below.

Management details and Information: Proposed modelled P loss reductions Other Sources Woldwide Four: Table 2

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

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

All farm systems: Vegetated buffer strips For SS and P; Effectiveness is Moderate (34 to 66%) and cost is Moderate (108-200) to High (332-1393) see Smith 1989, Redding et al. 2008

Laneways	**WW4**		
Cow Numbers	1000	P loss	(1000*(299/7)) *0.4*0.66
Kg P eaten per week	0.4		=11,276.6*0.04*0.3=135.3
% excreted	66	P loss lanes	1.1 km
Lactation length	299	Total lanes	5.2 km
% time on lanes	4%	% of Total lanes	0.21
% P loss to water	30%	% effectiveness	34 to 66%
		P loss mitigated	135.3*0.21*0.5
			=14.2 kg P
Critical Source Areas (CSA)			
Number	4	P loss of Pastoral blocks	146
Area	2.5%	% effectiveness	34 to 66%
		P loss mitigated	146*0.025*0.5
			=1.825 kg P

A major component of P losses are losses from other sources which is from lanes, yards and stock camp areas.

The same information contained in the Phosphate Mitigation report by Cain Duncan the modeller for Woldwide 1 & 2 is used here;

An estimated 135 kg P/year is lost to lanes on Woldwide 4; the length of the laneway whereby trees are felled, and the lane way adjusted, and riparian planting and buffer zone installed is 1.1 km of the laneway system. This adds to 28 kg P/year lost to water and thus at a 50 % effectiveness for the mitigation as outlined in the table above, there is a reduction of 14.2 kg P/year.

In addition, it is been identified that there are 4 areas of Critical Source Areas (CSA) which would benefit from suggested riparian planting. Using the same figure of 2.5% of area as for Woldwide 1&2 and the P losses from Woldwide 4 of 73 kg P/year (of pastoral blocks totalled) a further reduction of 1.8 kg P/year can be made.

Management details and Information: Proposed modelled P loss reductions Other Sources Woldwide Five: Table 3

Waterway and riparian area	WW5		
Cow Numbers	930	P loss	(930*(299/7)) *0.4*0.66
Kg P eaten per week	0.4		=10487.2*0.04*0.3=136.3
% excreted	66		**=1.46 kg P/year**
Lactation length	299	P loss for riparian buffer	10+5 =15
% time in paddocks	4%	% spent grazing on block	42.8*8/(268.5*10+42.8*8)
Area of platform block	268.5		=0.1131
Paddock area with water way	39.2	P loss mitigated	15*0.1131=
Paddock area with buffer zone	42.8		**=1.7 kg P**
		% effectiveness	67 to 100% (midpoint 85%)
			(1.7+1.5) *0.85=2.7 kg P/year
Critical Source Areas (CSA)			
Number	4	P loss of Pastoral blocks	73
Area	2.5%	% effectiveness	34 to 66%
		P loss mitigated	73*0.025*0.5
			=0.91 kg P

Overseer is not able to account for the difference in P loss from Other sources when there is a winter barn used as a scenario option. It assumes the additional cows being milked and cattle wintered are still on the lanes and yards and the losses in these areas and subsequently the portion lost to waterways is not reduced. This was evidenced by the modelling of the same parameters with the final barn option and deleting the structures thus all animals grazed the pastoral blocks, with all supplements now fed on pasture, whilst all other inputs remained the same.

The N losses rose dramatically, thus showing that the Nitrogen sub model was accounting for the barn as a mitigation, however the P losses were very similar, with a very small increase, likely due to the grazing of all the dry stock on pasture.

The two results of this modelling are shown in the Table below;

Management details and Information: Modelled changes in P loss reductions No Barns or Winter Barns Woldwide Four & Five: Table 4

Losses	WW 4 N loss kg N	WW4 P loss kg P	WW5 N Loss kg.N	WW5 P loss kg P.
Barn	9550/year or 23/ha/yr.	366/yr. or 0.9/ha/yr.	14378/yr. or 43/ha/yr.	244/yr. or 0.7/ha/yr.
No Barn	13572/yr. or 33/ha/yr.	371/yr. or 0.9/ha/yr.	22070/yr. or 66/ha/yr.	245/yr. or .07/ha/yr.

Management details and Information: Proposed modelled P loss reductions Winter Barns Woldwide Four & Five: Table 5

Barn Calculation WW 5			
Cow Numbers	930	P loss	(930*(299/7)) *0.4*0.66
Kg P eaten per week	0.4		=10487.2*0.04*0.3=125.8
% excreted	66	Total Grazing days	930*299=278,070
Lactation length	299	Grazing days April May& Aug	92*930=85560
% time in laneways	4%	% spent grazing in barn	(85560/278070) *14/24
% loss to waterways	30%		=0.18
P loss for month April	125.9/12=10.49	P loss mitigated	(31.47*0.18) +7.9
P loss for month May	10.49		**=13.51 kg P**
P loss for month August	10.49	% effectiveness	34 to 66% (high effect 60%)
P loss for month June/July	10.49*2/*(3/8)		**(13.51) *0.6=8.1 kg P/year**
	=7.9		
Total P mitigation			
CSA	0.9	Barn	8.1
Waterway and		Dry Cattle	1.0
Buffer Riparian area	2.7	Total P mitigated	**=12.7 kg P/year**

Barn Calculation WW 4			
Cow Numbers	1000	P loss	(930*(299/7)) *0.4*0.66
Kg P eaten per week	0.4		=11276.6*0.04*0.3=135.3
% excreted	66	Total Grazing days	1000*299=299,000
Lactation length	299	Grazing days April May& Aug	92*1000=92000
% time in laneways	4%	% spent grazing in barn	(92000/299000) *14/24
% loss to waterways	30%		=0.18
P loss for month April	135.3/12=11.28	P loss mitigated	(33.84*0.18) +8.5
P loss for month May	11.28		**=14.6 kg P**
P loss for month August	11.28	% effectiveness	34 to 66% (high effect 60%)
P loss for month June/July	11.28*2/*(3/8)		**(14.6) *0.6=8.8 kg P/year**
	=8.5		
Total P mitigation			
CSA	1.8	Barn	8.8
		Dry Cattle	4
Laneways	14.2	Total P mitigated	**=28.8 kg P/year**

Explanation of calculations

The amount of P deposited on laneways and assumed to be lost to water is as before.

The amount deposited in a month from this figure is a function of number of grazing days, with the assumption that the grazing days are similar between months. Thus the % of time on lanes over April and May and August is 31% and given 14 hours of the 24 hours is in the barn then the amount deposited on lanes is 18% of the monthly P loss which is the total (135.3 kg P/year for WW4) divided by 12 months. For June and July, there is 3 weeks which they are milking, the rest of the time they are dry cattle, so the figure for June and July is twice the monthly figure but 3/8ths of that figure is not lost to laneways.

The effectiveness of barns is between 34 to 66 % and it was decided that these barns are highly effective and the figure of 60 % is used.

Finally, the difference between the P loss between the barn and no barn examples seemingly showed the effect of the dry cattle grazing on pastoral blocks when effectively they do not see the pastoral blocks until calved. For Woldwide Four this figure was 4 kg difference and for Woldwide Five the figure was only 1, due to lower numbers. It is assumed that this is a probable amount that is not lost to water as well, given the model still assumes that the dry cattle are somehow required to be assigned to pastoral blocks when in fact they are in barns for the full 24 hours.

Results

For Woldwide Four, the average Phosphorus mitigated and therefore not lost from the root zone from the farm system modelled using OVERSEER FM® Nutrient Budgets 6.3.1/2.6.2.0 is calculated to be **28.8 kg P/year** and so the final P loss is recalculated to **337 kg/year** or **0.8 kg P/ha/year.**

This was not reported in the Overseer report.

For Woldwide Five, the average Phosphorus mitigated and therefore not lost from the root zone from the farm system modelled using OVERSEER FM® Nutrient Budgets 6.3.1/2.6.2.0 is calculated to be **12.7 kg P/year** and so the final P loss is recalculated to **231 kg/year** or **0.7 kg P/ha/year**

Average Phosphorus lost from the root zone from the farm system modelled using OVERSEER® Nutrient Budgets 6.3.0 is calculated to be **237 kg P/year** or **0.7 kg P/ha/year.**

This was not reported in the Overseer report.