

Dairy Green Ltd

Practical Engineering Solutions

Consents, Effluent, Stock water, Irrigation

Design through to Installation

Irrigation NZ Accredited Designer

Woldwide Runoff Limited

Farm Environmental Management Plan – Appendix N

Version 1.2

1 June 2019 – 31 May 2020

A **Phosphorus Mitigation Plan** prepared by Mr. Cain Duncan (CNMA), Tiaki, Farm Source Sustainable Dairying, forms part of this FEMP. The plan provides specific details regarding on-farm features, mandatory mitigation actions and target implementation dates.

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1 Property details

Entity Name:	Woldwide Runoff Limited (WRO)
Physical Address	Merrivale block - 20 Gill Road Merriburn block - 1711 Otautau Tuatapere Road
Description of landholding ownership	Woldwide Runoff Limited owns the Merrivale block. The Merriburn block is owned by J Flett and S Flett of Invercargill, who lease it to WRO.
Landholding owner's details	Merrivale block: A and JJ de Wolde, 104 Shaws Trees Road, Heddon Bush, RD3 Winton, 9783
Contact Person:	Abe de Wolde 021 227 2537 abe@woldwide.nz
Legal Description:	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
Land Area:	507 ha total, 321 ha effective – Merrivale 385 ha total, 338 ha effective – Merriburn
Location	NZTM 1201022, 4893762 – Merrivale NZTM 1200812, 4890495 – Merriburn
Resource Consents:	None

This document is designed to be a living document and should be updated at least yearly.

2 Maps

2.1 Accompanying notes to maps

- Woldwide Runoff (WRO) is located 20 km to the west of Otautau, on the western side of the Longwood Ranges.
- WRO is comprised of two separate blocks:
 - The Merrivale Block is owned by Woldwide Runoff Limited;
 - The Merriburn lease block is under a 5-year lease agreement to WRO, ending in October 2021. The lease has no right of renewal.
- Activities at WRO area:
 - Grazing of R1 and R2 heifers, grazing of carry over cows and grazing of mating bulls all year round (includes intensive winter grazing)
 - Production of baleage
 - 100 hectares of commercial pine plantation
 - 60 hectares of beech forest under sustainable management plan
 - A quarry is operated in partnership with DT Kings
- Topography is easy, rolling to steep.
- Steeper slopes are elevated and under forestry (commercial pine, beech forest).
- Critical source areas (CSAs) are found at the bottom of slopes and close to waterways. Please see the Phosphorus Mitigation Plan for map locations and descriptions.
- Infrastructure includes cattle yards, lanes and silage pads.

2.2 Boundaries



Figure 1. Boundary of WRO's Merriburn (left) and Merrivale (right) blocks.



Figure 2. General location of WRO

2.3 Farm maps

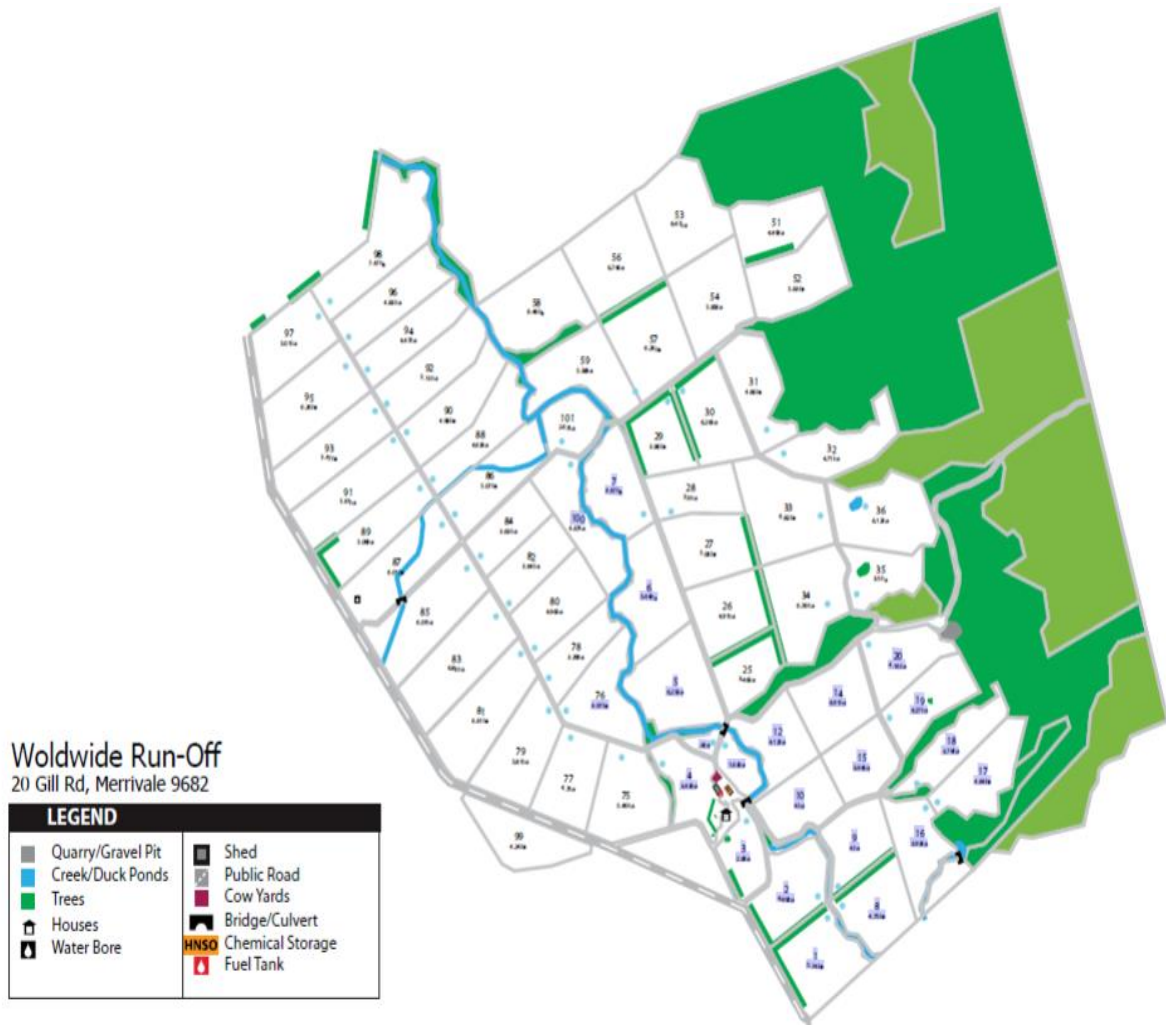


Figure 3. Farm map of Merrivale Block showing features.

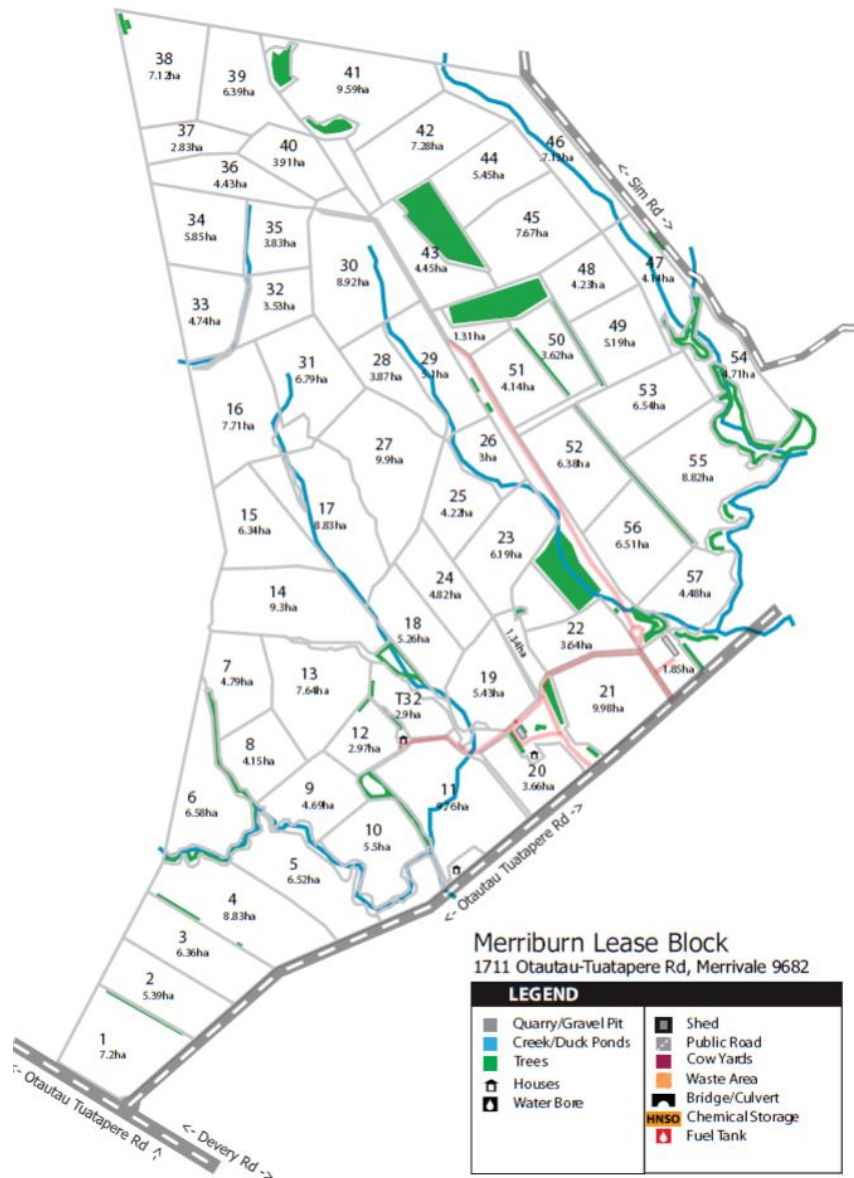


Figure 4. Farm map of Merriburn block showing features

2.4 Physiographic zones (PZs)

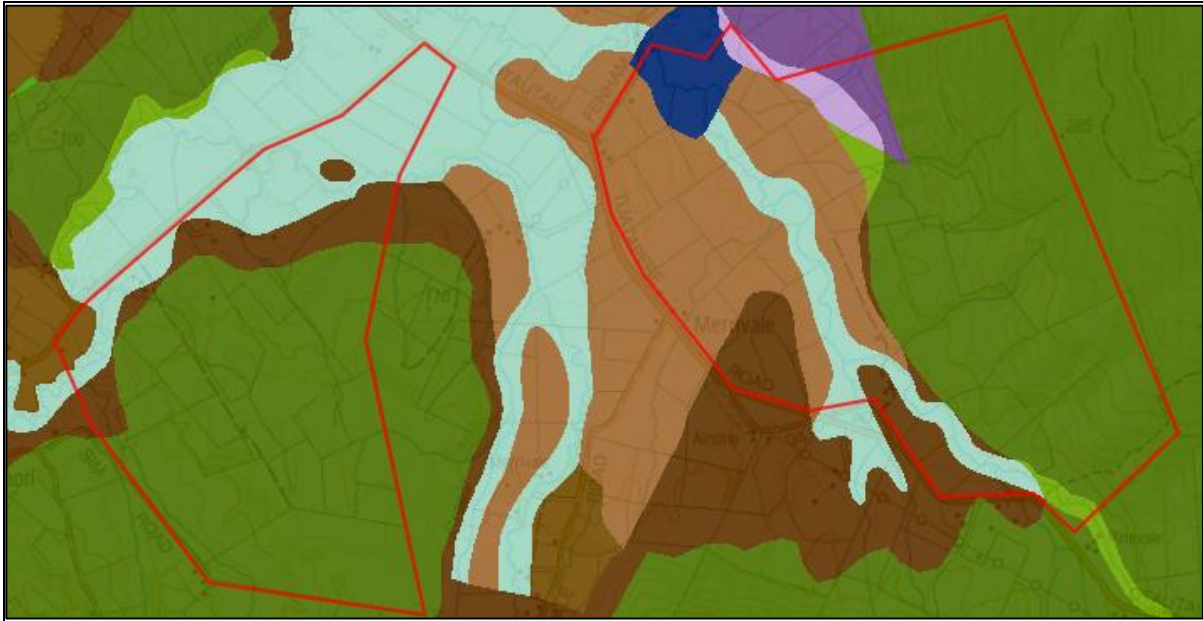


Figure 5. Physiographic zones at Merriburn block (left) and Merrivale block (right)

Physiographic Zones

	Alpine - No Variant		Lignite - Marine Terraces - Overland Flow
	Bedrock/Hill Country - Artificial Drainage		Old Mataura - No Variant
	Bedrock/Hill Country - No Variant		Oxidising - Artificial Drainage
	Bedrock/Hill Country - Overland Flow		Oxidising - No Variant
	Central Plains - No Variant		Oxidising - Overland Flow
	Gleyed - No Variant		Peat Wetlands - No Variant
	Gleyed - Overland Flow		Riverine - No Variant
	Lignite - Marine Terraces - Artificial Drainage		Riverine - Overland Flow
	Lignite - Marine Terraces - No Variant		Urban Area

2.5 Soils

The Merrivale block contains Malakoff, Waimatuku and Makarewa soils and the Merriburn lease block contains Aparima, Orawia and Makarewa soils. These soils are a mixture of heavier wetter soils and free draining soils.

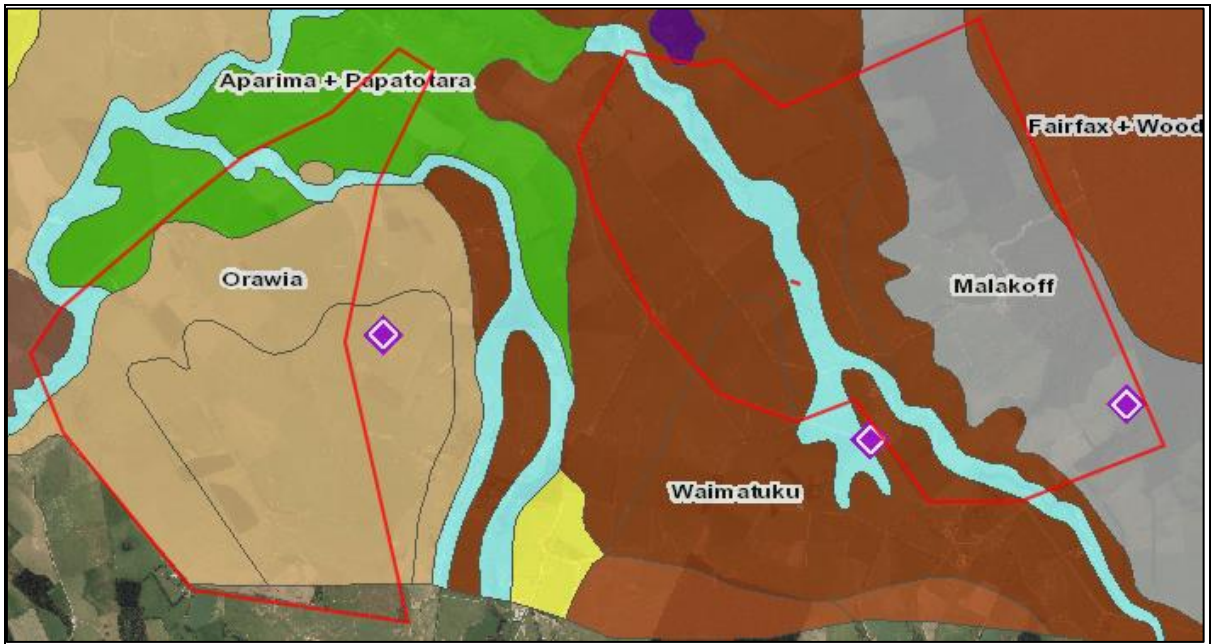


Figure 6. Soils at Merriburn Block (left) and Merrivale block (right)

2.6 Riparian vegetation and fencing

Streams and drains are fenced off to ensure stock cannot enter the waterways. Where permanent fencing is not yet in place, temporary fencing is erected to ensure stock cannot access waterways. Riparian buffers are wide and have good grass cover/mature vegetation.

2.7 Heritage

There are no known or recorded heritage sites.

2.8 Significant Indigenous Biodiversity

60 hectares of beech forest is under a sustainable management plan.

3 Nutrient Management

3.1 Environmental Management Actions

To mitigate the potential loss of nutrients the following actions will be adopted:

- i. Soil and herbage testing to monitor soil chemistry and inform decisions regarding fertiliser and lime application to maintain optimum soil fertility levels. Testing should be annually until an understanding and trends have been established;
- ii. Fertiliser and lime management plan prepared annually with guidance from Overseer output reports;
- iii. Exclude stock from streams;
- iv. Lanes constructed to divert run off away from potential waterway ingress. Water tables will be designed to shed water to pasture for riparian treatment.

3.3 Fertiliser Application Best Management Practices

The following practices will be followed.

- v. The spreaders used to apply fertiliser are 'Spread Mark' accredited ideally have Tracmap or a similar recording system to show proof of placement;
- vi. Buffer distances are maintained such that there is no application of fertiliser to waterways;
- vii. A minimum 10 m buffer between fertiliser placement and waterways is maintained when there is no riparian strip with a minimum 5- metre setback at all times;
- viii. Fertiliser is not applied to saturated soils;
- ix. Nitrogen-containing fertilisers are only applied to actively growing pastures;
- x. Fertiliser is not applied when or where air drift can occur beyond the farm boundaries;
- xi. The need for large fertiliser dressings will be achieved through split dressings rather than a single application; and
- xii. Observe 'The Code of Practice for Nutrient Management (With Emphasis of Fertiliser Use)' Fertiliser Association, 2013, ISBN 978-0-47328345-2'.

Note: The application of fertilisers is deemed a permitted activity by Environment Southland provided:

- Application must not occur within 30 m of a neighbouring residential unit without approval. Spray drift must also be minimised.
- There must be no direct discharge to water and no discharge when soil moisture exceeds field capacity. For permanently flowing waterbodies (including artificial drains), fertiliser in riparian plantings where stock is excluded can only be applied to establish the planting. If there is no riparian planting, a setback of 10 m is required.

3.3 Potential Nutrient Loss

Two nutrient budgets were prepared for the 2016/17 and 2017/18 seasons at WRO in OverseerFM Version 6.3.1 by Mr. Cain Duncan, Tiaki Fonterra, Certified Nutrient Management Advisor, in accordance with the latest version of the OVERSEERFM Guidance/Best Practice Data Input Standards.

One proposed nutrient budget was prepared by Mr. Duncan, to model the proposed farming system at WRO.

A nutrient budget analysis report has been prepared by Mr. Duncan and is available for review. Please refer to the report for an analysis of nutrient losses, including inputs and outputs. This information is not duplicated here.

Table 1: Overseer nutrient loss summary for WRO

	16/17	17/18	Average	Proposed	% Change
Total N Loss (kg)	26134	19931	23033	22603	-1.9
N Loss/ha (kg)	29	22	26	25	
Total P Loss (kg)	500	532	516	489 (454)*	-5.2 (-12)*
P Loss/ha (kg)	0.6	0.6	0.6	0.5	
Pasture Grown (kg/DM/ha/yr)	12639	11024	11832	13282	

*Additional P reductions calculated outside of Overseer (See Phosphorus Mitigation Plan)

3.6 Key mitigation measures

Using Overseer, nutrient budgets have been developed for WRO, comparing the nutrient losses of the 2016/17 and 2017/18 farm systems against the proposed farm system at WRO. Overseer has predicted that the nitrogen and phosphorus losses will decrease.

Key drivers for the 1.9% reduction in nitrogen losses are:

- i. Reduction in cows wintered compared to 16/17 season
- ii. Additional land planted in trees
- iii. More efficient use of nitrogen fertiliser

Key drivers for the 5.2% reduction in phosphorus are:

- i. Additional land planted in trees;
- ii. Reducing large applications of phosphorus fertiliser
- iii. Reduction in cows wintered compared to 16/17 season

Additional mitigation measures will target P, sediment and microbial losses. These are evaluated in a separate report (Phosphorus Mitigation Report) and increase the expected level of P mitigation to 12%.

4 Good Management Practices

4.1 Sustainable land management

Key strategies to achieve this objective:

- i. Fence off all waterways;
- ii. Maintain riparian vegetation and implement planting programme;
- iii. Maintain good pasture coverage;
- iv. Soil test regularly and operate a fertiliser management plan;
- v. Exclude stock from high risk critical collection source areas and swales when the soil is near or at field capacity;
- vi. Ensure adequate buffer zones from waterways during tillage;
- vii. Implement best management cultivation and IWG practices;
- viii. Maintain sustainable stocking rate; and
- ix. Manage stock to avoid soil compaction.

4.2 Review

General good management practices and those specific to the transport pathways to be implemented in the current year are contained in section 4.3. These good management practices will be reviewed annually as part of the overall review of the Farm Environmental Management Plan.

4.3 General good management practices

Contaminant Pathways – Overland Flow and Artificial drainage

Loss of nutrients via overland flow and artificial drainage presents the highest risk to the environment on the wetter, poorly drained soils on this property primarily in the Gleyed physiographic zone. These areas have high vulnerability to waterlogging, and in some areas require subsurface artificial drainage, which can become a mechanism for the rapid transfer of contaminants to the water bodies they drain to. GMPs adopted are:

- i. Ensuring critical source areas are left as buffer zones for cropping and fenced off to exclude stock;
- ii. Re-sowing bare soils as soon as possible;
- iii. Avoid grazing very wet soils by opening the breaks up to reduce tramping damage;
- iv. Using good management practice for winter grazing on either grass or forage crop – back fencing, CSA management, last bite grazing, portable troughs, minimum 5 m setback from waterways, etc.;
- v. Ensure waterways are fenced off to exclude stock and existing riparian vegetation is maintained;
- vi. Time fertiliser application to meet pasture demand and apply in a little and often manner;
- vii. Protecting steeper, erosion-prone land with trees.

Contaminant Pathways – Deep drainage

Loss of nutrients via deep drainage presents the highest risk to the environment on the free draining soils mainly within the Oxidizing physiographic zone. These areas have high vulnerability for nutrients, particularly N, leaching through the soil profile which has the potential to reach groundwater and surface water receiving environments. The operator will avoid and mitigate the risk of contaminant loss via deep drainage using the same measures as above, with the primary goal to avoid the accumulation of excess N in the soil profile prior to high drainage periods.

- i. Maintain stocking rates at sustainable levels using a rotational grazing plan;
- ii. Avoid the over-application of fertiliser by implementing best practice fertiliser application (section 3.2);
- iii. Utilise soil testing to guide fertiliser usage (section 3.1);
- iv. Minimise the time soils remain fallow following IWG, re-sowing them in grass in September or October depending of climatic conditions.

5 Riparian Management

5.1 Streams, Creeks and Drains

- i. All waterways are to be riparian fenced on both sides. All waterways at the Merrivale Block have been fully fenced off. The Phosphorous Mitigation Plan identifies waterways at the Merriburn Block that are yet to be permanently fenced off and outlines when this will be done by. In the meantime, stock will be excluded from waterways using temporary fencing and paddocks will only be grazed where stock are excluded from waterways at all times.
- ii. Regular riparian fencing checks will be carried out and any damaged sections or breakages/breaches repaired immediately;
- iii. Calves or other stock that are found in the riparian areas will be removed immediately;
- iv. Check all crossings are contoured to channel run-off onto pasture;
- v. Carry out weed control as required following best practice methods;
- vi. Remove drain cleanings and spread over paddocks to utilize the nutrients and to prevent material returning to the water way; and
- vii. Make sure fish have passage through all culverts and underneath bridges.

5.2 Weeds and Pests

Weeds (e.g. gorse, broom, blackberry, ragwort, thistles etc.) are controlled by manually removing them or by using sprays:

- i. When sprays are used to control weeds, care is taken to ensure all sprays are certified to be aquatic safe and that appropriate staff training is given to ensure good health and safety practices are fully implemented;
- ii. Spraying is best carried out when there is active growth (e.g. mid/late spring). The aim is to spray plants when they are small as less chemical is required;

6 Cultivation

6.1 Cultivation

For winter 2020, between 52 to 78 hectares have been sown in kale to be IWG by stock from May to August. Decisions will be made in September regarding what paddocks and total area to be cultivated.

52 hectares of grazed crop paddocks will be re-grassed in September and October 2019.

Re-grassing

An extensive re-grassing policy is underway, with a portion of the property having been re-grassed at the time of writing. Where grass to grass re-grassing occurs, paddocks are sprayed off and direct drilled with grass seed or undergo full cultivation.

Forage brassica crop

- Paddocks are sprayed off in October/November;
- Paddocks are direct drilled or fully cultivated into fodder crop (kale) from mid-October to mid-November;
- Fodder crop is IWG in over winter by dry stock, mainly R1s and R2s;
- Paddocks are subsequently re-grassed in September/October;

Surplus grass is harvested as baleage and silage. Specialist machinery is used to avoid the risk of soil compaction when harvesting grass if required.

Grass production, soil structure and fertility are the primary factors in paddock selection, with poorly performing pastures targeted for renewal. Soil moisture content is also a factor in the choice of paddock selection and timing of cultivation.

6.2 Cultivation Good Management Practices

- i. Where drainage depressions in crop paddocks are likely to channel sediments and nutrients to drainage, these are left uncultivated to act as sediment traps;
- ii. Direct drilling is used where full cultivation is deemed to be unnecessary;
- iii. Choose paddocks away from waterways to plant winter feed crops;
- iv. Plough lines are kept 5 metres back from the top of drain banks. This ensures at least a 5 m buffer along waterways;
- v. A buffer of at least 10 metres is implemented where the topography is sloping down toward a waterway; and
- vi. Steeper slopes are avoided when cultivating.

7 Intensive Winter Grazing

7.1 Stock Grazing Management

The Environment Southland Intensive Winter Grazing Rule covers the period from 1 May until 30 September.

7.2 IWG

Paddock selection

Judicious paddock selection based on the soil moisture content is a key tool. This is important not only to avoid overland flow, pugging etc. but to ensure that the pasture and soils are not damaged to any extent that would inhibit spring pasture growth. The range in soil types gives some flexibility of being able to move away from waterways to better draining soils during wet weather.

Back fencing

The eating of the excess feed will not (for spring growth reasons) result in the paddocks being eaten down hard, or pugged.

- Breaks once eaten off, will be back fenced;
- Breaks will be sequenced to ensure grazing is towards the watercourse, leaving a “last bite”;
- If the area to be grazed is located on sloping ground, stock will be progressively grazed from the top of the slope to the bottom, with a 20 metre ‘last-bite’ strip is left at the base of the slope. This is unlikely to be necessary due to the very flat topography;
- If baleage is used, place baleage in the paddock before soil becomes too wet thereby preventing heavy vehicles from damaging the ground;
- Portable feeders will be used to feed baleage/hay/straw to stock.

Mob sizes

Mob sizes will be no more than 120 cattle.

Water

Where breaks do not encompass a trough, a portable trough will be used to avoid pug lanes between the water troughs and the feed breaks.

Buffer zones

There will be fenced buffer zones (minimum 5-metres) along all water ways, and higher risk areas over tiles, drainage depressions (swales) or cracked soils will be temporarily fenced off.

Wet weather

In wet weather, where there is risk of pasture and soil damage, care must be taking to minimise grazing and avoid supplement feeding and pugging within 10 metres of a waterway or drain.

8 Other Environmental Issues

8.1 Lanes and Races

Run-off from races can in some situations constitute an illegal discharge to land. These can be mitigated by:

- i. Ensuring that lanes and races are not used as feed pads, yards, or herd holding areas;
- ii. Ensuring that riparian vegetation is adequate to treat storm water;
- iii. Checking after heavy rain the lane/track edge cut-outs, to ensure they are not blocked and there is no risk of large single point discharges;
- iv. Gateways – to avoid compaction around the gateways and reduce lane edge wear, where possible bring stock out of the paddock at a different gate to which they were let in; and
- v. Ensure that swales away from culverts are kept clear, and discharge is directed away from the waterway.

Annual maintenance to races can often result in the “run back” shaping over culverts and lane edge discharge divot/cutouts not being restored. All lane edges and culverts will be checked after lane maintenance.

8.2 Silage pad

Silage pads are constructed on dry sites to store surplus feed. Rain landing on silage covers does not mix with leachate and is diverted to the farm drainage.

Silage pads are managed to ensure that no leachate flows off the pad at any time and any leachate is contained at the pad.

Only wilted silage is stored and stacks remain covered to minimise leachate

8.3 Cut and Carry

Grass harvesting is carried out according to best practice management. Harvesting is not carried out if the risk of soil compaction cannot be avoided.

Health and safety protocols are adhered to when operating machinery.

8.4 Animal Pests

- i. Rabbits, hares, possums – regular culls using night shooting, poisoning etc.
- ii. Magpies – trap, shoot;
- iii. Rodents – poison according to appropriate health and safety requirements

9 Emergency Response

9.1 Emergency Contacts

Abe de Wolde - 021 227 2537

Environment Southland – 0800 768 845 or 03 2115115

Dairy Green Limited – 03 215 4381

10 Review

Review whole effluent management plan and update by 1 June each year – and complete the version control below.

- i. Development targets for coming season/plan.
- ii. Nutrient Management
 - Overseer Inputs
 - New Overseer report if applicable
- iii. Good Management Practices
- iv. Implementation of key mitigation measures
- v. Cultivation Areas
- vi. Intensive Winter Grazing
- vii. Emergency Contacts

Version	Date	Reviewed	Distribution List
1.0	22 August 2017	Nessa Legg, Dairy Green Ltd	A & JJ de Wolde
1.1	21/8/19	Nessa Legg (Dairy Green Ltd), Mike Freeman (Land Pro)	A & JJ de Wolde
1.2	5/9/19	Nessa Legg (Dairy Green Ltd), Mike Freeman (Land Pro)	A & JJ de Wolde



PHOSPHORUS MITIGATION PLAN

Version 2 - 05/09/19



ABOUT YOUR PLAN

This Phosphorus Mitigation Plan document is the result of a tailored farm environment planning service provided to you through Tiaki Sustainable Dairying. It's part of the advantage you get through Farm Source as a member of the Fonterra Co-Operative. The purpose of this plan is to describe the environmental conditions present on your farm and the management of these conditions. From this, mitigations to potential impacts to water quality are documented and additional mitigations maybe planned, with sensible timeframes. Underpinning this plan, are the agreed national Good Farming Practices that are supported by the agricultural and horticultural sectors. Industry bodies along with Regional Councils and Central Government have developed the Good Farming Practice: Action Plan for Water Quality 2018 in a commitment to swimmable rivers and improving the ecological health of our waterways. The Dairy Industry Strategy (Dairy Tomorrow), as well as the Good Farming Practice: Action Plan for Water Quality 2018, both align with the goal for all dairy farms to have a Farm Environment Plan by 2025. Now that this plan has been created it's the plan owner's responsibility to ensure it is put into action and kept up to date as actions are completed or conditions on farm change. Tiaki Sustainable Dairying is here to help with that implementation and ongoing management through our team of Sustainable Dairying Advisors who can be contacted via the details below.

PHONE: 0800 65 65 68

EMAIL: sustainable.dairying@fonterra.com

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FARM DETAILS

FARM NAME

Woldwide Runoff

SUPPLIER NUMBER

Merrivale & Merriburn

PLAN OWNER

Albert De Wolde

+64 27 2272537
dewolde@farmside.co.nz

FARM ADDRESS

**20 Gill Road & 1711 Otautau-
Tuatapere Road**

LOCATION



REGIONAL COUNCIL

Southland

PLAN LAST EDITED DATE

02 August 2019

POINTS OF NOTE

MERRIBURN FARM OVERVIEW MAP

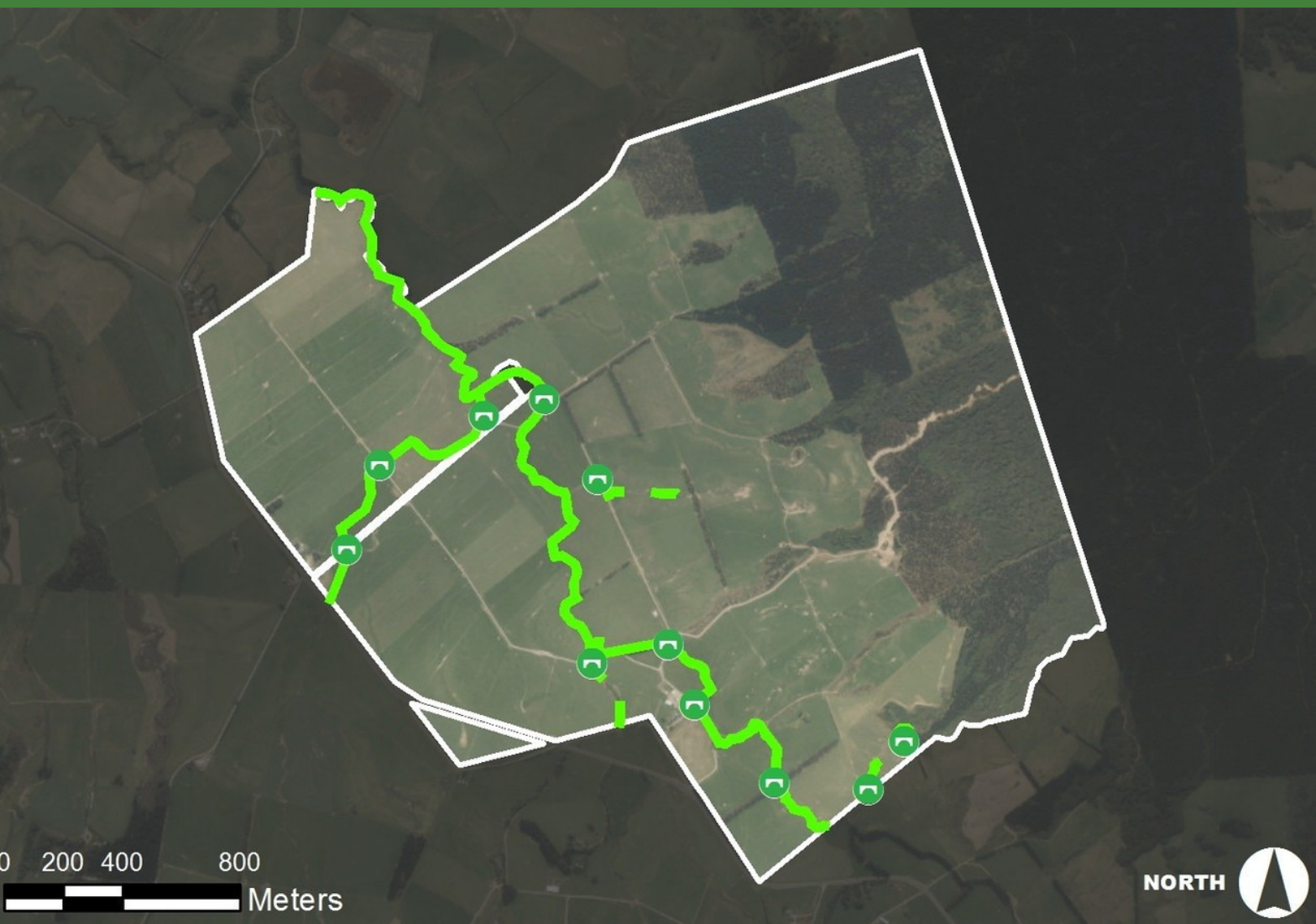
The map below presents the land on which the farming operations covered in this document occur and identifies some key points of interest. More detailed maps looking at specific environmental management topics are contained throughout the document.












- | | | | |
|--|--|--|------------------------------------|
| | Accord Defined Stock Excluded Waterway | | Compliant Crossing |
| | Accord Defined Stock Not Excluded Waterway | | Non-Compliant Crossing |
| | Non-Accord Defined Stock Excluded Waterway | | Non-Compliant Non-Regular Crossing |
| | Non-Accord Defined Stock Not Excluded Waterway | | Dispensation Crossing |
| | Farm Boundary | | Dairy Shed |

MERRIVALE FARM OVERVIEW MAP

The map below presents the land on which the farming operations covered in this document occur and identifies some key points of interest. More detailed maps looking at specific environmental management topics are contained throughout the document.



-  Accord Defined Stock Excluded Waterway
-  Accord Defined Stock Not Excluded Waterway
-  Non-Accord Defined Stock Excluded Waterway
-  Non-Accord Defined Stock Not Excluded Waterway
-  Farm Boundary

-  Compliant Crossing
-  Non-Compliant Crossing
-  Non-Compliant Non-Regular Crossing
-  Dispensation Crossing
-  Dairy Shed






MERRIVALE SUMMARY OF OPEN ACTIONS

This table includes all open or ongoing actions that have been agreed as part of this Phosphorus Mitigation Plan. They are organized by their target due date. **Where a target date is underlined it is a mandatory action that contributes to the calculated P loss reduction.**

CATEGORY	FEATURE TYPE & NAME	ACTION REQUIRED	TARGET DATE
 L5	Culvert Management - Culvert(Paddock 101)	Unblock Culvert - Paddock 101	Completed
 L1	Critical Source Area - Fenham Creek Tributary (Northern Section)	Extend Riparian Margin (Fenham Creek North)	<u>1 Aug 21</u>
 L2	Critical Source Area - Critical Source Areas - Overland Flow	Extend Riparian Buffers - CriticalSource Areas	<u>1 Aug 21</u>
 L6	Erosion Control - Gully Paddock27	Exclude Stock from Hill Face (Paddock 27)	1 Aug 22
 L7	Critical Source Area - Crossing - Paddocks 6& 7	Extend Riparian Margin (Drain Paddock 6& 7)	1 Aug 22
 L4	Critical Source Area - Gully Paddocks 10 & 15	Exclude Stock from Erosion Areas (Pad 10 & 15)	1 Aug 25
 L8	Sediment Trap - Sediment Trap (Paddock 58)	Sediment Trap Installation(Paddock 58)	1 Aug 25
 L3	Critical Source Area - Gully Paddock9	Re-fence Gully - Paddock 10	1 Aug 21

MERRIBURN SUMMARY OF OPEN ACTIONS

This table includes all open or ongoing actions that have been agreed as part of this Phosphorus Mitigation Plan. They are organized by their target due date. **Where a target date is underlined it is a mandatory action that contributes to the calculated P loss reduction.**

CATEGORY	FEATURE TYPE & NAME	ACTION REQUIRED	TARGET DATE
 W1	Waterway Fencing - Foats Stream - Fencing	Fence Foats Stream - 2m Buffer	<u>1 Aug 20</u>
 W2	Waterway Fencing - Fenham Creek Tributary Fencing	Fence off Fenham Creek (Central Section)	<u>1 Aug 21</u>
 W3	Waterway Fencing - Buckton Creek Tributary Fencing	Fence off Buckton Creek Tributary	<u>1 Aug 21</u>



Phosphorus Overview (Merriburn & Merrivale)

DESCRIPTION:

Woldwide Runoff (WRO) is comprised of two farm in close proximity to each other. The Merrivale block is owned by WRO and the Merriburn block is leased. The properties have numerous waterways flowing through them and the topography is generally rolling with some area of flat land and some areas of steeper hill country. Due to the topography of the farms there are many critical source areas and these are likely to be the conduit for the majority of the farms phosphorus losses.

Overseer is not spatially explicit and is unable to take into account landscape features. It assumes a hydrological connection exists to second order streams and that there is a transport mechanism to get phosphorus to those streams (Gray, 2016).

The initiation and transport of phosphorus from the landscape requires conditions conducive to either overland or subsurface flow. In many situations, P loss to the stream is dominated by overland flow since soil will sorb most phosphorus from subsurface flow, unless, as with mole-pipe drainage, there is a direct conduit to the stream (McDowell et al. 2001). In general, more P is lost from soils with increasing slope, largely as particulate phosphorus.

Critical source areas are included in the model in general terms as the model was calibrated against catchment studies where losses from critical source areas would have occurred (Gray, 2016). On this basis, protecting critical source areas is a mitigation that needs to be applied outside of Overseer and will reduce phosphorus losses further from those modelled.

The estimated reductions in P referenced in this report are derived from the following calculations and research:

Phosphorus Loss – Culverts & Small Riparian Margin Increases

There will be a reduction in phosphorus loss from mitigations applied around culverts but there is no robust research information to base an estimate on, however experience indicates these areas can result in significant losses of sediment (and associated P) to water. On this basis estimated reductions in phosphorus have been referenced as >0 Kg/P. In addition to this, small increases in riparian margins to include areas of erosion or unproductive land have also been referenced as >0 Kg/P and are not included in the overall phosphorus reduction figure.

Phosphorus Loss – Critical Source Areas & Waterway Fencing

Overseer predicts 425kg of phosphorus will be lost to water from paddocks (effective area of 647ha). Assuming phosphorus loss occurs evenly over the effective area of the farm, then the critical source areas and unfenced waterways and their associated catchments identified in this report would account for 24% of the phosphorus loss from blocks on the property. This equated to 102kg of phosphorus.

Assuming a 30-40% reduction in phosphorus loss occurs through waterway fencing and the implementation of wider, vegetated riparian buffers (at locations where critical source areas enter waterways) and better management of critical source areas, then a further reduction of 34.7kg of phosphorus is estimated to occur beyond that modelled in Overseer (with all mitigations implemented). See Table 1 and 2 below.

Site and Fencing Length (m)	Catchment Area (% of Catchment)	P Loss (kg)	Mitigations (% Reduction)	Reduction in P Loss (kg)
W1 (L2) – 1900	78 (12)	51	30*	15.3
W2 – 800	10.5 (1.6)	6.9	30*	2.1
W3 – 420	4.5 (0.7)	2.9	30*	0.9
L1 – 1000 (Merrivale)	7 (1.1)	4.6	30**	1.4
				19.7

Table 1 – Phosphorus Loss – Unfenced Waterways (*30% as no expansion of riparian margins where critical source areas enter waterways is proposed on the lease block; **30% as already small riparian margin in place)

Site and Catchment Area	% of Total Catchment	P Loss (kg)	Mitigations (% Reduction)	Reduction in P Loss (kg)
L2 – 57ha (Merrivale)	8.8	37.4	40	15
				15

Table 2 – Phosphorus Loss – Critical Source Areas

The 40% reduction is based on research that shows management of critical source areas and vegetated buffers can reduce phosphorus loss by 38-59% (Figure 1). A lower range reduction figure of 40% has been used to try and ensure the impact of the proposed mitigations is not over estimated.

It is acknowledged by McDowell et al, 2005 in the original design of the Overseer sub-model that, in some areas, 90% of phosphorus loss may come from only 10% of the catchment area (Sharpley et al, 1999). McDowell states that defining and isolating critical source areas, combined with adaptive management over the farm is the best approach to decreasing phosphorus loss. For the purposes of this analysis, it has been assumed that phosphorus loss occurs evenly over the farm as there is insufficient data to quantify phosphorus losses to a critical source area level. This means mitigations centered on critical source areas are likely to have more of an impact than stated in this report and as such result in a larger reduction in phosphorus losses to those outlined above.

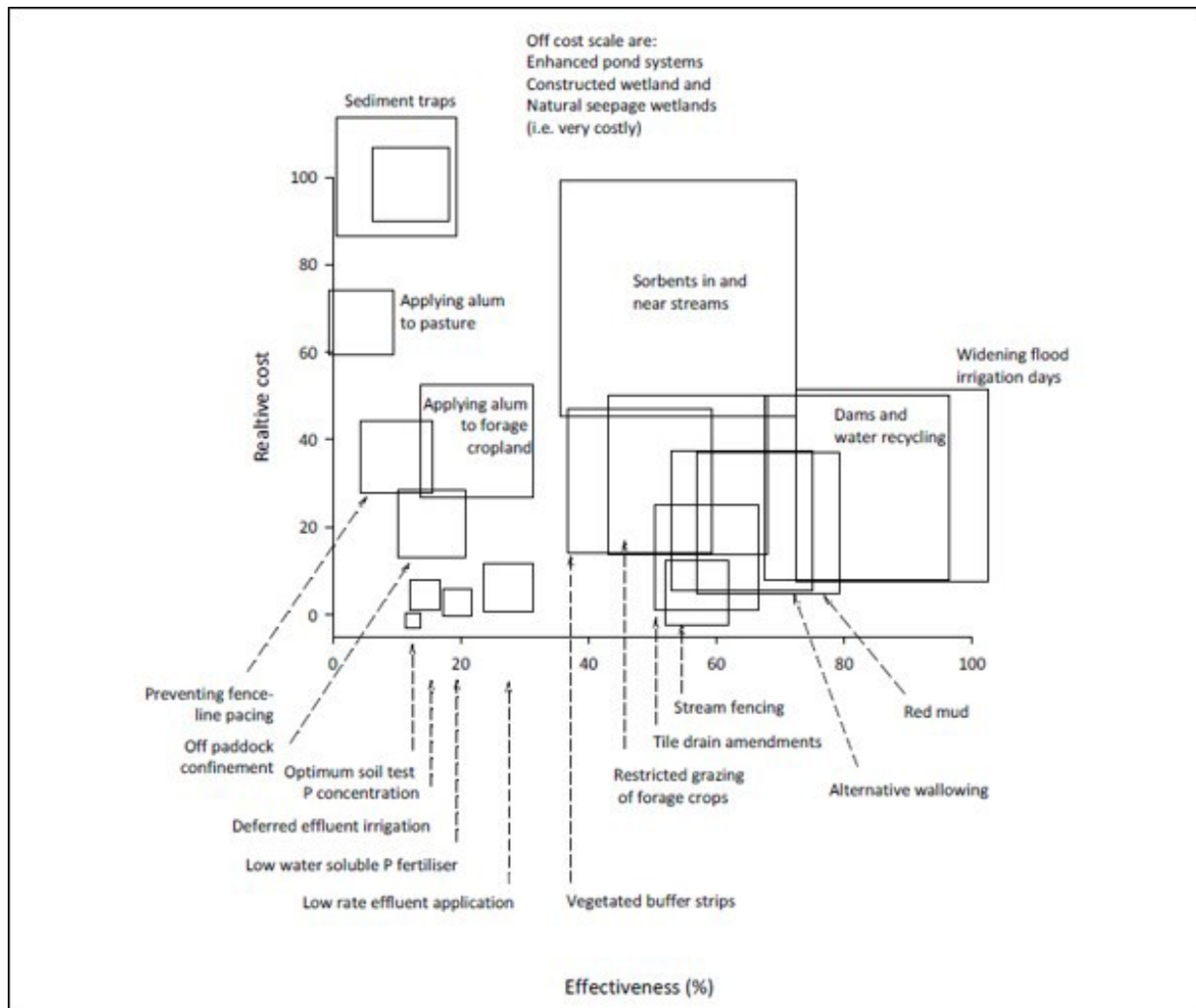


Figure 1 - Cost and effectiveness of strategies to mitigate phosphorus losses (McDowell et al, 2013)

References:

- Fertiliser and Lime Research Centre. (2014). *Sustainable Nutrient Management Introductory Notes and Mastery Test*. Massey University.
- Gray, C.W., Wheeler, D.M. and McDowell, R. (2016). *Review of the phosphorus loss submodel in OVERSEER®*. Report prepared for OVERSEER® owners under AgResearch core funding contract A21231(A). AgResearch. Report RE500/2015/050.
- McDowell, R; Monaghan, R and Wheeler, D. (2005). *Modelling phosphorus losses from pastoral farming systems in New Zealand*, New Zealand Journal of Agricultural Research, 48:1, 131-141.
- McDowell, RW; Sharpley, AN; Beegle, D and Weld J. (2001). *Comparing phosphorus management strategies at the watershed scale*. Journal of Soil and Water Conservation 56: 306-315.
- McDowell, R; Wilcock, B and Hamilton, D. (2013). *Assessment of Strategies to Mitigate the Impact or Loss of Contaminants from Agricultural Land to Fresh Waters*. Report prepared for MfE. AgResearch. Report RE500/2013/066.
- Sharpley, AN; Gburek, WJ; Folmar G and Pionke, HB. (1999). *Sources of phosphorus exported from an agricultural watershed in Pennsylvania*. Agricultural Water Management 41: 77-89.

MERRIBURN RISK RATING

The map below shows the location of the risk areas identified on your farm. The Risk Rating presented here is a combined measure of the impact and likelihood of contamination occurring from each risk area.

- LOW
- MEDIUM
- HIGH
- SEVERE



- W1 Waterway Fencing - Foats Stream - Fencing
- W2 Waterway Fencing - Fenham Creek Tributary Fencing

- W3 Waterway Fencing - Buckton Creek Tributary Fencing

W1 Waterway Fencing
Foats Stream - Fencing

IMPACT OF CONTAMINATION



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LIKELIHOOD OF CONTAMINATION

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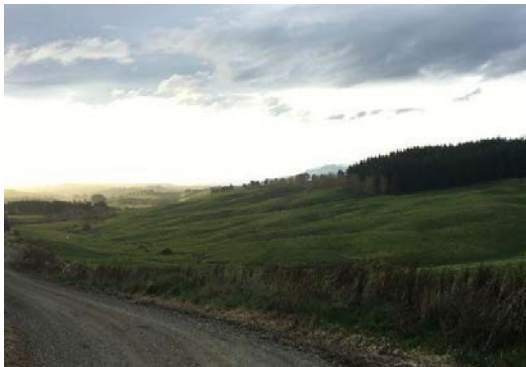
HIGH RISK RATING

DESCRIPTION:

A tributary of Foats Stream flows along the western side of the Merriburn Lease Block adjacent to Sim Road. Run-off from the steeper hill country to the east all flows down into the stream via a multitude of critical source areas. The stream is currently not fenced to exclude stock and there is no vegetated riparian margin. Fencing of the waterway will reduce phosphorus losses from the farm by preventing direct deposition into the stream by stock and filtering run-off from surrounding paddocks. Foats Stream Tributary has a catchment of approximately 78ha (located on the farm).

Estimated Reduction in Phosphorus: 15.3 Kg/P

IMAGES:



**OPEN ACTIONS:****▶ Fence Foats Stream - 2m Buffer (MANDATORY ACTION)**

Fence off the Foats Stream tributary running along the western side of the farm. A minimum 2m rank grass riparian buffer will be established on both sides of the creek.

TARGET DATE: 1 Aug 2020



Waterway Fencing

Fenham Creek Tributary Fencing

IMPACT OF
CONTAMINATION



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LIKELIHOOD OF
CONTAMINATION

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MEDIUM RISK RATING

DESCRIPTION:

A tributary of Fenham Creek flows down from the higher elevations of the farm out to Otautau-Tuatapere Road. The upper and lower reaches of the Creek are permanently fenced to exclude stock (although the riparian buffers will be extended when adjacent paddocks are being winter grazed). In the middle section a small forestry block has recently been removed and the creek flows down through a gully to the bottom of the farm. Run-off from surrounding paddocks flows down into the stream via the general topography of the land and critical source areas.

Fencing of the central section of the waterway will reduce phosphorus losses from the farm by preventing direct deposition into the stream by stock and filtering run-off from surrounding paddocks.

The unfenced section of the Fenham Creek Tributary has a catchment of approximately 10.5ha.

Estimated Reduction in Phosphorus: 2.1 Kg/P

IMAGES:





OPEN ACTIONS:

Fence off Fenham Creek (Central Section) (MANDATORY ACTION)

Fence off the central section of the waterway. A minimum 2m rank grass riparian buffer will be established on both sides of the creek.

TARGET DATE: 1 Aug 2021

W3

Waterway Fencing

Buckton Creek Tributary Fencing

IMPACT OF CONTAMINATION



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LIKELIHOOD OF CONTAMINATION

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MEDIUM RISK RATING

DESCRIPTION:

Small ephemeral waterway that runs between paddocks 6, 7 and 8. The waterway is not currently permanently fenced, however there is a variable riparian margin due to the slope of the bank and the fact the stream flows through a gully. Fencing will prevent stock access and allow rank grass to better establish within the riparian margin, assisting with filtering of run-off. A permanent fence will be installed at the top of the bank/gully.

The catchment area draining into the unfenced section of the Buckton Creek Tributary is approximately 4.5ha.

Estimated Reduction in Phosphorus: 0.9 Kg/P

IMAGES:



OPEN ACTIONS:**Fence off Buckton Creek Tributary (MANDATORY ACTION)**

Permanently fence off the waterway that runs between paddocks 6, 7 and 8. There is a natural riparian buffer due to the topography of the land of approximately 2-4m. The fence line will follow this natural contour.

TARGET DATE: 1 Aug 2021

MERRIVALE RISK RATING

The map below shows the location of the risk areas identified on your farm. The Risk Rating presented here is a combined measure of the impact and likelihood of contamination occurring from each risk area.

● LOW
 ● MEDIUM
 ● HIGH
 ● SEVERE



- L1 Critical Source Area - Fenham Creek Tributary (Northern Section)
- L2 Critical Source Area - Critical Source Areas - Overland Flow
- L3 Critical Source Area - Gully Paddock 9
- L8 Sediment Trap - Sediment Trap (Paddock 58)

- L4 Critical Source Area - Gully Paddocks 10 & 15
- L5 Culvert Management - Culvert (Paddock 101)
- L6 Erosion Control - Gully Paddock 27
- L7 Critical Source Area - Crossing - Paddocks 6 & 7

L1

Critical Source Area

Fenham Creek Tributary (Northern Section)

IMPACT OF
CONTAMINATION



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LIKELIHOOD OF
CONTAMINATION

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MEDIUM RISK RATING

DESCRIPTION:

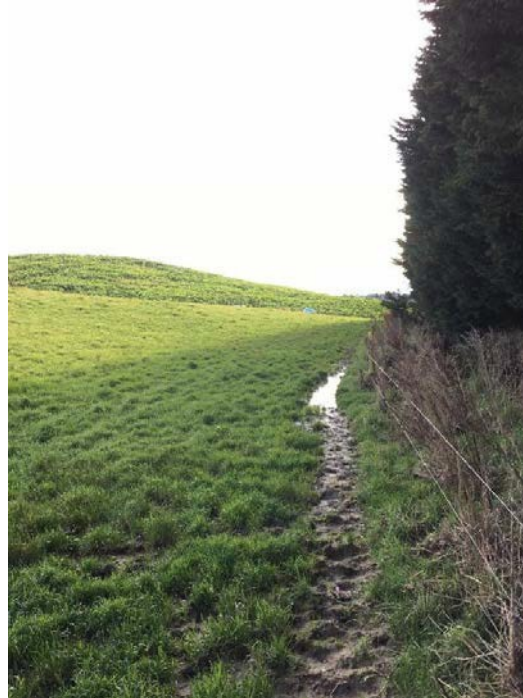
Northern end of the Fenham Creek Tributary flowing along the bottom of paddocks 88, 90, 92, 94, 96 and 98. The riparian buffer on the western side is approximately 1-1.5m yet there is a significant slope from the adjoining paddocks down to the creek. A 3m grass buffer will be fenced off to allow for filtering of overland flow and associated contaminants off the surrounding paddocks. This is especially important when adjacent paddocks are being winter grazed (buffer will be temporarily extended to at least 5m).

The catchment flowing into the riparian buffer is approximately 7 ha over a length of approximately 1km.

Estimated Reduction in Phosphorus: 1.4 Kg/P

IMAGES:





OPEN ACTIONS:

Extend Riparian Margin (Fenham Creek North) (MANDATORY ACTION)

The riparian margin of the Fenham Creek Tributary flowing below paddocks 88, 90, 92, 94, 96 and 98 will be extended to 3m and maintained in rank grass.

TARGET DATE: 1 Aug 2021



Critical Source Area

Critical Source Areas - Overland Flow

IMPACT OF
CONTAMINATION



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LIKELIHOOD OF
CONTAMINATION

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MEDIUM RISK RATING

DESCRIPTION:

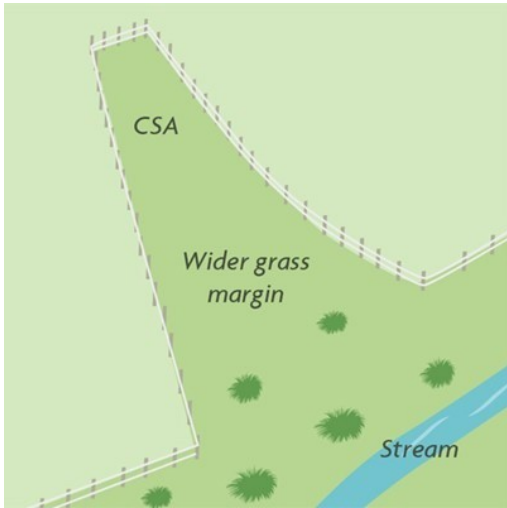
There are a number of critical source areas (overland flow paths) on the farm as identified on the map at the start of this section. Those shown are not an exhaustive list but form a guide to the areas that should be investigated further. The critical source areas across the farm are areas where water and contaminants off surrounding paddocks are concentrated and transported over the land surface to nearby waterways. Where these areas enter waterways a larger riparian buffer will be provided to filter sediment and associated contaminants (such as phosphorus). Buffers will be appropriately sized for the catchment area of the critical source area (5m minimum).

The approximate catchment area of the critical source areas identified (not including specific areas identified elsewhere in this plan) is 57ha.

Estimated Reduction in Phosphorus: 15 Kg/P

IMAGES:





**OPEN ACTIONS:****Extend Riparian Buffers - Critical Source Areas (MANDATORY ACTION)**

Extend the riparian buffers where critical source areas such as gullies and swales enter waterways. Buffers will be a minimum of 5m or larger depending on the size of the critical source area catchment. Buffer areas will be left in rank grass or planted in native grasses such as carex secta, red tussock and toetoe.

TARGET DATE: 1 Aug 2021

L3

Critical Source Area

Gully Paddock 9

IMPACT OF
CONTAMINATION



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LIKELIHOOD OF
CONTAMINATION

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MEDIUM RISK RATING

DESCRIPTION:

The gully through paddock 9 has previously been fenced off (posts in place). This will be re-fenced to exclude stock. The area is of low production potential and having stock in this area is likely to cause pugging and sediment (and associated phosphorus) loss to the nearby waterway.

Estimated Reduction in Phosphorus: None - Area was previously fenced (will prevent an increase)

GPS Co-ordinates: 1203678, 4884309

IMAGES:



OPEN ACTIONS:

Re-fence Gully - Paddock 10

Reinstate the fence around the gully in Paddock 10.

TARGET DATE: Ongoing

L4 Critical Source Area
Gully Paddocks 10 & 15

IMPACT OF CONTAMINATION



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LIKELIHOOD OF CONTAMINATION

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MEDIUM RISK RATING

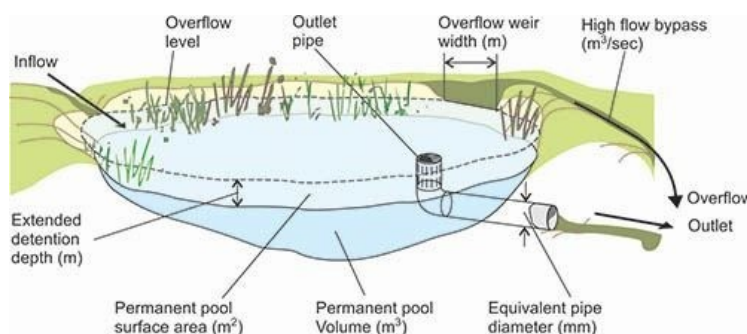
DESCRIPTION:

Gully through the center of paddocks 10 and 15. In some places erosion is occurring. These areas will be fenced off to avoid further damage (consider planting with natives to stabilise). In addition to this, the gully is a conduit for overland flow down to the waterway at the bottom. Due to the location of the lane there is minimal opportunity to extend the riparian margin, however long term there is an opportunity to install a sediment trap at the bottom of the gully with an overflow into the creek.

Estimated Reduction in Phosphorus: None Attributed - Long Term Project

GPS Co-ordinates: 1203657, 4884403

IMAGES:



OPEN ACTIONS:

Exclude Stock from Erosion Areas (Pad 10 & 15)

Fence off areas of the gully that are eroding. Long term consider the installation of a sediment trap at the bottom of the gully to remove sediment and associated phosphorus from overland flow off the adjacent paddocks.

TARGET DATE: 1 Aug 2025

Culvert Management

L5 Culvert (Paddock 101)

IMPACT OF
CONTAMINATION



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LIKELIHOOD OF
CONTAMINATION

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HIGH RISK RATING

DESCRIPTION:

The culvert joining paddocks 101 and 86 is blocked resulting in the build-up of water in the surrounding paddocks. This will result in contaminants including phosphorus and sediment being washed off the adjacent paddocks in the flood waters. Unblock the culvert and ensure it is adequately sized.

Estimated Reduction in Phosphorus: >0 Kg/P

GPS Co-ordinates: 1202642, 4885331

IMAGES:



OPEN ACTIONS:

Unblock Culvert - Paddock 101

Unblock the culvert and ensure it is adequately sized.

TARGET DATE: 1 Aug 2019

L6

Erosion Control Gully Paddock 27

IMPACT OF
CONTAMINATION



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LIKELIHOOD OF
CONTAMINATION

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LOW RISK RATING

DESCRIPTION:

Fencing of the gully/ephemeral waterway through paddock 27 has taken place. There is a section of hill above the fence line that is steep and suffers from erosion. This area has minimal productive value and will be fenced out to reduce sediment and subsequent phosphorus loss. Planting of the area in low natives such as red tussock and toetoe would help prevent erosion and filter run-off from the adjacent paddock.

Estimated Reduction in Phosphorus: >0 Kg/P

GPS Co-ordinates: 1203246, 4885068

IMAGES:



OPEN ACTIONS:**Exclude Stock from Hill Face (Paddock 27)**

Extend the fence around the waterway flowing through Paddock 27 so it excludes stock out of the steep gully face that is beginning to erode. This area could be planted in red tussock and toetoe to help with stabilisation and for aesthetic reasons.

TARGET DATE: 1 Aug 2022



Critical Source Area

Crossing - Paddocks 6 & 7

IMPACT OF
CONTAMINATION



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LIKELIHOOD OF
CONTAMINATION

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LOW RISK RATING

DESCRIPTION:

Crossing and low point in paddock between paddocks 6 and 7. Water and contaminants can flow of this area into the adjacent drain. The riparian buffer will be moved out at the top of the drain to allow for filtration of overland flow. Maintain this area in rankgrass.

Estimated Reduction in Phosphorus: >0 Kg/P

GPS Co-ordinates: 1203014, 4885107

IMAGES:



OPEN ACTIONS:

Extend Riparian Margin (Drain Paddock 6 & 7)

Extend the riparian margin of the drain, below the crossing from Paddocks 6 & 7. Keep the riparian margin in rank grass to filter run-off from the adjacent crossing and paddocks.

TARGET DATE: 1 Aug 2022



Sediment Trap

Sediment Trap (Paddock 58)

DESCRIPTION:

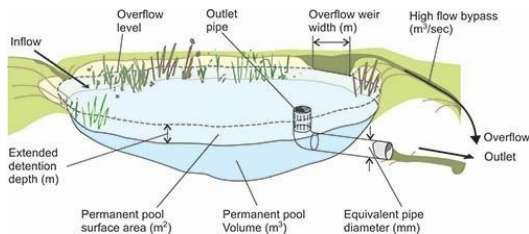
A number of critical source areas enter into a small waterway running down the side of the pine trees on the boundary of paddock 58. There is the potential to construct a sediment trap in the upper section of this area following the harvesting of the pine trees. This will assist in trapping sediment and any sediment bound phosphorus, preventing it reaching the main surface waterways on the farm. This is an aspirational, long term project and has not been factored into current phosphorus reduction figures.

Estimated Reduction in Phosphorus: Not Calculated - Long Term Project

GPS Co-ordinates: 1202743, 4885650

IMAGES:





OPEN ACTIONS:

Sediment Trap Installation (Paddock 58)

There is potential to construct a sediment trap in the upper section of the pine plantation on the boundary of paddock 58, following the harvesting of the trees. This will assist in trapping sediment and any sediment bound phosphorus, preventing it reaching the main surface waterways on the farm. Long term, aspirational project.

TARGET DATE: 1 Aug 2025