Potential reductions in farm nutrient loads resulting from farmer practice change in the Waipā catchment:

SMP Final Call analysis

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Executive summary

The Waipā River is the largest tributary of the Waikato River, and the 306,569ha catchment faces significant water quality challenges, particularly in relation to erosion and sediment. Following the successful implementation of the Sustainable Milk Plan (SMP) project in the upper Waikato between 2012-2015 (WRA11-019), the project was extended to the Waipā catchment in 2015. In the SMP process, consultants work with farmers individually to assess the status of their farming system and to identify risks in key areas of environmental management. An action plan is developed, and follow-up support provided by a farming consultant. The primary aim of the project was to support on-farm changes that will enhance water quality and ecosystem health and demonstrate to policy-makers and the wider community the collective commitment of farmers to sustainable dairying in the catchment.

This report provides estimates of the potential reductions in nutrient losses for farms that completed the full Sustainable Milk Plan (SMP) process in the Waipā catchment, and for which Overseer data was available. Following the methodology developed to analyse potential reductions in farm nutrient loads resulting from the Upper Waikato catchment SMP project (Burger et al 2015), nitrogen (N) and phosphorus (P) reductions were calculated based on individual farm Overseer® Nutrient Budgets (hereafter referred to as *Overseer*) information and nutrient reduction efficacy rates assigned to each specific mitigation strategy.

Of the 285 farms that completed the full SMP process by the end of August 2018, overseer data was available for 217 farms for Nitrogen, and 198 farms for Phosphorus. Mean reductions in farm nutrient losses following the successful implementation of completed SMP actions were estimated to be 2% for N and 7% for P. These reduction estimates are expected to increase to 4% and 9% respectively, when all actions across all SMP farms are fully implemented.

Potential load reductions on individual farms for completed actions ranged from 0 to 14% for N and 0 to 59% for P, depending on the number and combination of actions implemented. This increased to 0-21% for N and 0-74% for P when all actions are fully implemented.

Action completion rates were lower than for the Upper Waikato project (40% compared to 70% for Upper Waikato). Several factors may have contributed to this, particularly the low milk payout during this period and resulting financial stress for farmers; as well as uncertainty around impending regional plan legislation.

As was observed in the Upper Waikato, the greatest N reductions were observed for farms implementing multiple strategies involving stock exclusion from streams and optimised effluent/fertiliser application. Riparian and critical source area management, stock exclusion and optimised effluent application were the most effective measures for reducing P losses to water. These estimates reflect the potential reduction in farm nutrient losses as calculated from *Overseer* nutrient budget outputs and other methods, and therefore do not reflect attenuation processes prior to discharge direct to surface waters. Not all farms recorded actions with a direct impact on nutrient losses, however, all action types recorded through the SMP process will ultimately lead to improvements in farm environmental performance over the long-term.

The SMP process has also raised awareness, broadened the perspective and increased the capability of farmers to complete plans and improve their environmental performance. The highest completion rates were observed for actions relating to farmers increased understanding of the farming system. For example, for nutrient management, 36% of farmers indicated they were going to utilise nutrient budget scenarios to understand nutrient loss drivers, of which 72% had completed these actions; and 55% of farmers indicated they were going to implement, update and review their nutrient management plans (54% complete). These actions are not quantified as part of this study but contribute significantly to building farmer's understanding of their systems, as well as preparing them for future farm planning which will likely be required under the Healthy Rivers/Wai Ora: Proposed Waikato Regional Plan Change 1.

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1 Introduction

1.1 Background and aims of the project

Following the successful implementation of the Sustainable Milk Plan (SMP) project in the upper Waikato between 2012-2015 (WRA11-019), the project was extended to the Waipā catchment in 2015. The primary aim of the SMP project was to support on-farm changes that will enhance water quality and ecosystem health and demonstrate to policy-makers and the wider community the collective commitment of farmers to sustainable dairying in the catchment.

The Waipā River is the largest tributary of the Waikato River. The catchment covers 306,569ha and is dominated by the Waipā River channel and associated tributaries. It faces significant water quality challenges from both historic land management decisions and current agricultural practices - in particular, erosion and resulting sediment issues in the river and its tributaries. As a result, the Waipā is a priority water quality catchment for the Waikato River Authority (WRA) and was identified by DairyNZ as an appropriate catchment in which to implement Sustainable Milk Plans. The 2012 Zone Plan for the Waipā (WRC 2011) noted a trend towards bringing steeper land into dairy production, and intensification of stocking rates on existing dairy farms.

The SMP process involves consultants working with farmers individually to assess the current status of their farming system and to identify risks in the key areas of nutrient, effluent, waterways and land management, and water use efficiency. An action plan is developed, and follow-up support provided by a farming consultant. A follow-up visit is carried out at the end of the process (approximately 10 months after the initial visit) to verify which of the intended actions have been completed and identify additional actions that have been completed. The SMP enables farmers to prioritise their existing and intended activities into one simple document. A key characteristic of the SMP is that it is voluntary and therefore contains the farmers' own agreed actions and a timeline for implementation.

All actions implemented through the SMP process were documented to enable potential changes in contaminant losses off-farm to be estimated after plan completion. The success of the project is measured by the collective actions of farmers demonstrably reducing dairy farm-sourced nutrients, sediment and faecal contaminants discharging to waterways, and an improvement in water use efficiency on farms.

The following success criteria were identified for the Waipā project:

- All farmers in the catchment identify the risks, options and appropriate actions for their farm in a Sustainable Milk Plan and are working to complete the voluntary actions recorded in their plan
- The collective actions of the 855 farmers[1] result in demonstrable reductions in dairy farm-sourced sediment, nutrient and faecal contaminant loads in the Waipā catchment and their subsequent effects on the Waipā and Waikato rivers
- The capability of farmers and advisors in the catchment has increased
- Farmers, as a result of participating in the project, are better prepared for the future.

1.2 SMP management target areas

The full SMP process is focused on five main environmental management target areas: nutrients, effluent, land and waterways management, and water use efficiency. These broadly reflect a wide range of management actions related to all aspects of the farming business, including farm planning, infrastructure, maintenance, monitoring, training and education. Four of the management areas are directly focused on nutrients (N and P), sediment and/or bacteria. While many actions categorised under effluent management

[1] As noted in the final report for the Waipā SMP project, this goal was later modified to 285 farms (Bramley et al. 2018).

are also directly related to nutrient management, as per the previous analysis, effluent was included as a separate target area due to the large emphasis being placed by farmers on this activity. In more recent SMP plans, waste management has also been included as an additional management target area (Table 1.1).

Table 1.1: Description of the SMP key management target areas and water quality parameters considered

Target area	Description of key included actions	Key parameter targeted			
		N&P	Bacteria	Sediment	Water use
Nutrients:	Actions related to all aspects of nutrient management except effluent, including nutrient budgeting, fertiliser application, stocking rates and feed management.	√			
Effluent:	Actions relating to the collection, containment and application of dairy effluent, including planning, infrastructure, operation, monitoring and training.	√	√		
Waterways:	Actions related directly to the management of runoff to waterways, including stock exclusion, riparian planting and wetlands.	√	√	√	
Land:	Practices related to land management practices, including cropping, pasture, erosion control and critical source areas (tracks, laneways and crossings).	√	√	√	
Water use:	Actions related to water use efficiency, including consents, monitoring and practices, or the implementation of new infrastructure to reduce water consumption.				√
Waste:	Containment and management of farm waste				

Targets for the Waipā Sustainable Milk Plan project were developed through robust debate at Steering Group meetings, acknowledging the learnings from the Upper Waikato Sustainable Milk project (see Burger et al, 2015). The targets form a critical element of the initial discussions between farmers and their project consultant.

Some initial plans were developed with WRC, based on a new SMP template that had been developed by DairyNZ to align more closely with regulatory requirements for farm plans in Canterbury and to have a nationally consistent template. This enabled adaptation of the objectives, plan targets and processes to suit the Waipā project and to train consultants in the new template before they began plan delivery.

As these are plans designed to move farmers towards Good Management Practice, an important consideration in the narrative was to capture any rules that were in place in the catchment when the project began. The catchment targets developed for the Waipā addressed existing regulations around effluent and water use under Variation 6. However, the ongoing development of the Healthy Rivers/Wai Ora: Proposed Waikato Regional Plan Change 1 meant there was considerable uncertainty in the catchment over future policy direction, particularly around the four priority contaminants: phosphorus, nitrogen, sediment and microbial pathogens.

The resulting compromise was to ensure farmers understood current contaminant losses, as well as water use, and were working to understand how they might reduce losses and improve efficiencies should that be required in future. They incorporated industry messages around improving efficiency.

The final targets agreed to by the Steering Group provided direction for consultants and helped farmers to consider actions that would be most effective in contributing to reductions in loads of contaminants, or directly improve resource use efficiency:

1.3 Waipā Sustainable Milk Plan targets

1.3.1 Water use

1. Identify and implement options to reduce water use and improve water use efficiency in the shed based on water use information;
2. View, understand and comply with Variation 6 consent and permitted activity conditions
3. Put practices in place to ensure rapid identification of water losses and fixing of leaks
4. Farmers to have a system in place to monitor, record and report water use (e.g. by installing water meters)

1.3.2 Effluent management

1. Investigate and decide on actions to ensure both infrastructure and its management is capable of being compliant 365 days/year and optimising water and nutrient use all year round.

1.3.3 Nutrient management

1. Ensure farmers have retrospective nutrient budgets based on input standards for the last full year. Discuss the N loss results with reference to your milk supply company ranges and averages.
2. Any identified risks for both P and N from questionnaire (and budget) should be discussed, appropriate actions defined and farmer agreed actions recorded. Future recommendations will likely be based on not yet agreed actions.
3. Identify any gaps between Overseer assumed good management practices and current practice and record actions around this. E.g. does the farm have a sealed pond?

1.3.4 Land management

1. Identify areas of soil loss risk properties and implement appropriate actions to reduce erosion and sediment run-off to waterways
2. Protect remnant wetlands, remnant natural areas and areas of cultural significance
3. Implement good management practices over the life cycle of a crop. This includes planning, paddock preparation, cultivation, harvest/grazing and regrassing.
4. Implement good soil management practices

1.3.5 Waterways

1. Minimise direct runoff from bridges, races and culverts into waterways through appropriate storm water diversion to pasture or other filters
2. Develop riparian management plans for 100% of dairy farms with waterways.
3. An appropriate assessment of waterway risks has been completed and used during the creation of the riparian management plan
4. Implement good management practices relating to the impact on peat lakes

1.3.6 Waste management and infrastructure

Improve identified weaknesses in the management of current and future infrastructure where it relates to waste.

2 Methodology

2.1 Data availability

Actions targeting identified risks in the key target areas of nutrient, effluent, waterways and land management and water use efficiency were recorded individually for each farm through the Initial SMP process. Completion of these actions were verified and recorded through the SMP final call.

In addition to the recorded actions, N and P losses to the root zone were documented for each farm at the start of the SMP process based on a farm-wide nutrient budget derived from *Overseer* (version 6). For this analysis, only complete and uncorrupted files were able to be used, reducing the total number of farms analysed to 254. Overseer loss estimates were available for 217 farms for N and 198 farms for P.

2.2 Approach

As outlined in Bramley et al. (2018), the first phase (Spring 2016) of the Waipā SMP project focused on providing plans to farmers in the initial three high priority subcatchments: Kaniwhaniwha, Mangapiko and Mangaotama streams. These catchments were identified as priorities particularly in relation to sediment, which was considered a key contaminant in the catchment by the Waikato Regional Council (WRC). As noted in the final report (Bramley et al. 2018), a close relationship with WRC was maintained during the project, which allowed the project team to ensure the consultant training was tailored to the specific requirements of the Waipā catchment, as outlined in the Waipā Catchment Plan (WRC 2014). This was achieved by spending time in the field with regional council staff and through regular meetings, both formal and informal.

It was originally anticipated that majority of these plans would be completed in the three priority subcatchments. However, of the 270 dairy farms in the subcatchments, only 143 farms (53%) signed up, despite a significant marketing campaign.

To increase numbers, the Puniu subcatchment was added in January 2016 (see Table 2.1). Of the 159 dairy farms in the Puniu, 50 signed up (31%). In May 2016, the remainder of Waipā Catchment Plan priority areas were added – Moakurarua, Mangawhero Stream A, Mangawhero Stream B and Ngahinapouri to Ngaruawahia Streams. Finally, in June 2016 the offer was extended to all farmers in the Waipā catchment.

Table 2.1: Phasing of SMP offers to farmers in subcatchments of the Waipā

Subcatchment(s)	Date
Kaniwhaniwha, Mangapiko and Mangaotama streams.	June 2015
Puniu subcatchment	January 2016
Moakurarua, Mangawhero Stream A, Mangawhero Stream B and Ngahinapouri to Ngaruawahia Streams	May 2016
Entire Waipā Catchment	June 2016

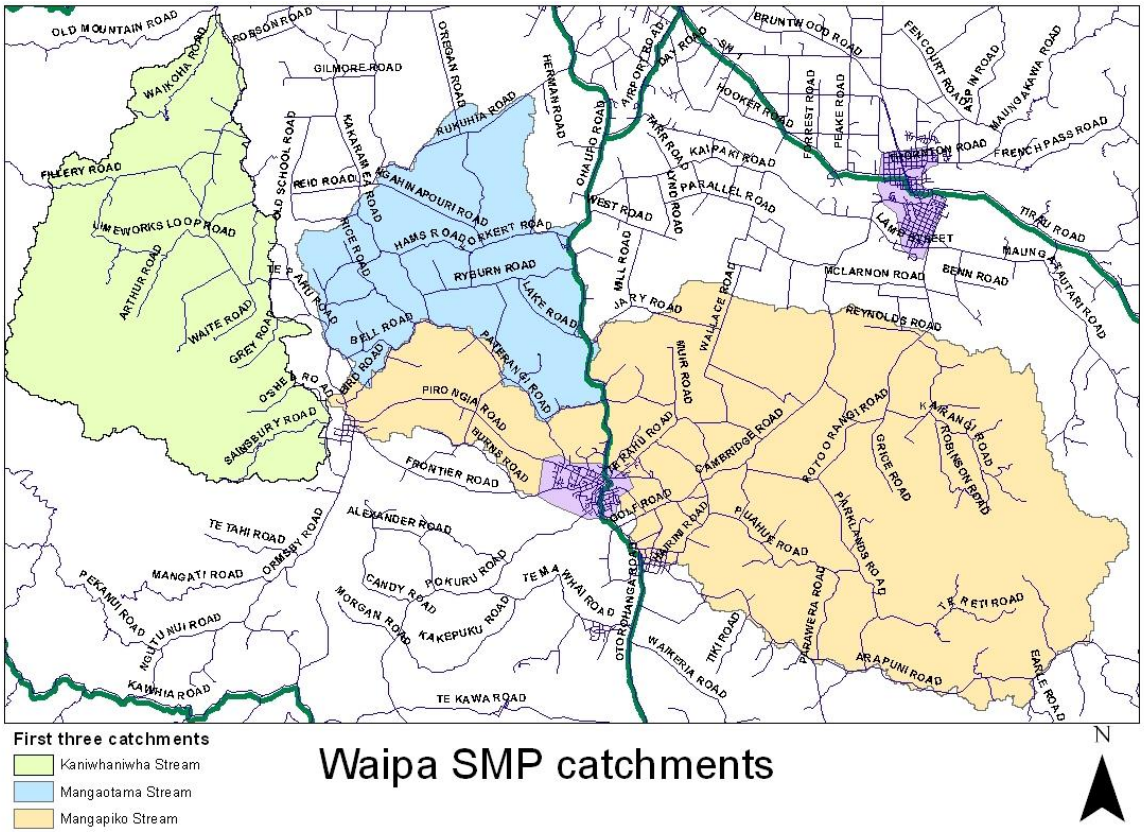


Figure 1: Road map of the initial three subcatchments.

An initial SMP visit was conducted for each farm at the start of the process to develop and document farmer-agreed actions within the six SMP target areas (Table 1.1). A final SMP visit was carried out approximately 10 months later to review these actions and verify and document completion. Follow-up support and advice were provided for the period between the two SMP visits.

As of August 2018, 285 farms across the Waipā had completed the full SMP process. All actions documented through the Initial and Final calls were collated for all farms and coded into specific categories to provide a comprehensive analysis of the individual actions within each management target area. A total of 42 action categories and 147 sub-categories were defined. Categories were chosen to broadly reflect various stages of farm planning and development, infrastructure investment, implementation, operational management and training and education (see Table 3.1). Consideration was also given to separating actions associated with investigating or considering a change versus actually implementing the change. A small number of actions not directly associated with the six SMP target areas were dealt with separately. All individual actions recorded through the Initial Calls were reviewed at the end of the study and documented as either complete or incomplete.

2.3 Analysis of data

This study follows the same methodology developed to estimate potential reductions in nutrient losses in the Upper Waikato SMP project. A full description of the methodology is provided in the report: *Potential reductions in farm nutrient loads resulting from farmer practice change in the Upper Waikato catchment: SMP Final Call analysis (*Burger et al. 2015).

As described in Burger et al. (2015), potential reductions in farm nitrogen and phosphorus resulting from all recorded on-farm actions undertaken as part of the Waipā SMP process were calculated based on individual farm *Overseer* loading information and nutrient reduction efficacy rates assigned to each specific mitigation strategy (Table 2.2).

Table 2.2: Summary of initial (WRC, 2013) and revised efficacy rates applied to individual on-farm action strategies within each management target area. Rank represents the order in which the strategy was included in the quantification process used to determine overall % reductions in contaminant loss.

Target area	Mitigation strategy	Efficacy WRC[1]		Revised efficacy values applied				Analysis method[3]	Rank
		N	P	N	N min[2]	N max[2]	P		
Nutrients	Review optimal effluent block and management	5%	10%	3%	0%	8%	2%	O	2
	Improve fertiliser application methods*	5%	20%						
	N fertiliser management	10%	n/a	7%	0%	32%	0%	O	3
	P fertiliser management	n/a	20%	0%	0%	0%	0%	O	4
	Improve feed management	10%	n/a	12%	0%	28%	2%	O	17
Effluent	Improve effluent capture	5%	10%	10%			22%	L	5
	Improve containment of feed stores, feed pads			4%			2%	L	6
	Improve pond infrastructure and storage	5%	20%	3%			8%	L	7
	Upgrade effluent infrastructure			0.01%			0.02%	L	8
	Effluent solids management*	10%	10%						
	Low rate effluent irrigation*	5%	20%						
Waterways	Stock exclusion	5%	20%	4%	3%	7%	21%	O	1
	Riparian planting	5%	20%	3%	n/a	n/a	47%	BMP	14
	Wetlands management	5%	10%	2%	0%	8%	0%	O	18
Land	Improve crop cultivation practices	5%	50%	0%	0%	2%	0%	O	11
	Reduce crop runoff	5%	20%	3%	n/a	n/a	8%	BMP	10
	Improve crop grazing practices*	5%	20%						
	Time N fertiliser to crop demand	25%	n/a	0.4%	0%	3%	0%	O	9
	Critical source areas laneways	5%	20%	0.1%	n/a	n/a	1%	BMP	12
	Critical source areas gates & troughs	5%	20%	0.1%			0.4%	L	13
	Sediment management	5%	20%	0%			0%	L	16
	Manage stock crossings	5%	20%	0.4%			1.3%	L	15
	Implement wintering strategies	25%	50%	21%	7%	29%	0%	O	19
	Apply controlled grazing regimes*	5%	20%						
	Cut and carry pasture management*	25%	50%						

[1] Represents the minimum of the estimated efficacy range for each action. For some strategies where the reported minimum was zero, the mean between the minimum and maximum was applied.
[2] The minimum and maximum for N represents the range of % reductions or the 12 case study farms modelled though Overseer. As most P reduction measures could not be modelled on Overseer, minimum and maximum values for P could not be estimated.
[3] O is *Overseer* modelling, L literature and/or expert judgement and BMP is from AgResearch BMPToolbox modelling.
* Action not present in data set or not applied due to uncertainties

In brief, the effectiveness of each mitigation strategy for N and P was estimated based on a combination of *Overseer* modelling, Best Management Practice (BMP)-Toolbox modelling, expert judgement and existing literature values (see Burger et al. 2015). *Overseer* modelling was carried out on 12 representative farms from the Upper Waikato catchment to determine efficacy values for N and P for eight mitigation strategies (see Burger et al. 2015). Individual mitigation strategies were modelled for each farm using the assumptions and protocols summarised in Burger et al. (2015). The effectiveness of each strategy for reducing N and P was assumed to be the % difference between the initial and final loads for each model simulation. The mean of all 12 case study farms was used to derive the final % effectiveness values.

As *Overseer* assumes best practice is always occurring, not all actions could be modelled through the *Overseer* model framework. Therefore, as described in Burger et al. (2015) a combination of BMP-Toolbox modelling and expert judgement was applied to define efficacy rates for the 11 strategies that could not be simulated through the *Overseer* model.

2.4 Quantification approach

Mean reductions in farm N and P loss achieved through the completion of documented actions were then quantified for farms that had completed the Final SMP process by August 2018. While all actions recorded through the SMP process will ultimately lead to an improvement in environmental practices on farm, not all have a direct and quantifiable impact on farm nutrient losses. For example, actions related to the reviewing of information, farm planning and environmental education will not lead to a direct reduction in farm contaminant losses. As this analysis was focused on quantifying reductions in farm nutrient losses, only those actions with a direct impact on contaminant loading were assessed.

Of the 147 individual action sub-categories defined through the SMP process, 19 mitigation strategies representing a total of 44 individual actions (Table 3.3) were assumed to have a direct impact on contaminant loading. These strategies mostly reflect actions related to improved effluent, nutrient, cropping, feed and wintering practices, as well as improved waterways management and the management of critical source areas. All strategies target either phosphorus, nitrogen or both nutrients, although many also have potential to influence sediment and bacterial loadings (Table 3.3).

A number of additional mitigation strategies with a direct impact on farm contaminant loss were excluded from the quantification framework due to the absence of site-specific information which would be required to make an accurate assessment. For example, the impact of land retirement and planting for sediment control is highly dependent on areal extent, slope and existing erosion present. This information is not recorded through the existing SMP process.

Controlled grazing regimes and cut and carry pasture management were also excluded from the analysis framework as these actions were not recorded for any of the current SMP farms. Load reductions were estimated based on individual farm *Overseer* information, the actions successfully completed on each farm and the efficacy values assigned to each mitigation strategy. In addition, mean reductions in farm nutrient loss, should all intended actions be completed in future, were also estimated. The following methodology was applied to determine these estimates.

For each farm:

1. Total annual farm N and P losses were derived from baseline *Overseer* output collected through the SMP process.
2. As *Overseer* cannot be applied to test scenarios related to good practice (as the model framework already assumes this is being followed), an additional load to reflect poor practice was estimated based on a combination of *Overseer* modelling, expert judgment and standalone simulations with the BMP toolbox. If the farm documented specific actions focused on achieving good practice, this additional load was added to the *Overseer* “base” loss/load to obtain a better estimate of total load

prior to the implementation of these strategies. The additional load was calculated (see Burger et al. 2015) to be:

   a. 4% of the total *Overseer* load for N and 21% for P to reflect actions related to restricting stock access to waterways.
   b. Up to 10% of the total *Overseer* load for N and up to 8% for P for each poor effluent management practice action described for the farm.

3. The revised *Overseer* N and P loss estimates were then sequentially reduced by the efficacy values documented in Table 3.3 for each mitigation strategy undertaken on the farm.
4. The final reductions in total farm N and P losses were calculated as the difference between the revised base load and final load after implementation of actions.

The sequence in which each mitigation strategy was implemented in the load reduction calculation was based on how change on farm would most likely be implemented (see Burger et al. 2015). Actions which are becoming mandatory, for example through the Sustainable Dairying: Water Accord (SDWA, 2013), or have little cost or provide cost savings were implemented first (i.e. stock exclusion, optimisation of effluent block size, N fertiliser management). This was followed by actions associated with farm dairy effluent management (infrastructure, containment, infrastructure, management practices), and actions that were relatively cost-effective (i.e. critical source area management). Actions which influence the farm system, or require time or capital to undertake were implemented last (i.e. the implementation of wintering strategies, feed management, wetland management).

A number of action categories were excluded from the analysis due to the substantial uncertainty or variability associated with quantifying the likely effectiveness of these strategies (Burger et al. 2015).

2.5 Estimate of effectiveness for sediment and bacteria

The effectiveness of individual mitigation strategies for sediment and bacteria (*E. coli*) reduction were also reviewed as part of the Upper Waikato study (Burger et al. 2015). Due to the uncertainties associated with quantifying the effects of different mitigation strategies on sediment and bacteria loading, likely efficacy was categorised as low, medium or very high, in line with the ranges applied by WRC (2013). However, in the absence of individual farm bacterial and sediment loss estimates, the benefits of SMP implementation for reducing these contaminants could not be reliably estimated.

3 Results

3.1 Key results - all recorded actions

A total of 1471 individual new actions were recorded as complete for the 254 farms analysed in this study across the six management target areas (effluent, waterways, nutrients, land, water use and waste). This reflects an average of 5.8 actions per farm. Actions not directly associated with these target areas represented less than 1% of the total number of actions.

Figure 2 shows the total number of on-farm actions, including 5229 achieved before the start of the project, 1471 completed before the final call, and a further 2214 planned actions that were incomplete at the time of the final call.

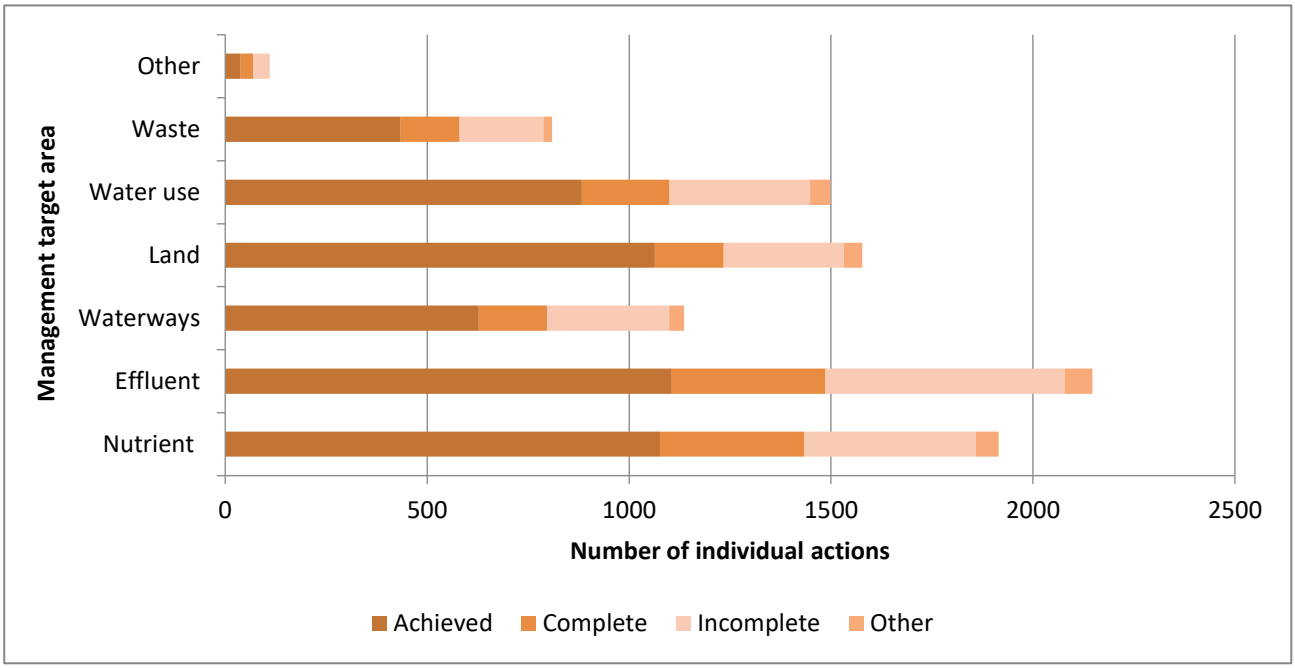


Figure 2: Total number of on-farm actions within each management target area for the 254 farms with completed SMPs analysed for this report.

Table 3.1 (below) provides an overview of actions for each sub-category within the six management target areas, including the percentage of new actions completed at the time of the final call (duplicate actions have been removed). Most actions were focused on effluent (27%) and nutrient management (22%) followed by water use (16%), waterways (13%) land (13%) and waste management (10%) (Table 3.1). Waterways management actions are only applicable to farms with surface waters present, either within or adjacent to the farm boundary.

Of the 3,619 actions planned as part of the SMP process, 41% have been successfully completed. The highest rates of completion (46%) were observed for actions related to nutrient management (Table 3.1). Completion rates within all other target areas ranged between 35-43%. Overall, 59% of all actions documented through the initial call were not complete at the time of the final call.

The distribution of actions within each management and category area are summarised in Table 3.1. In addition, the top five individual actions within each management area expressed as a percentage of the total number of farms are listed in Table 3.2. Actions categories which are more difficult to implement over the short time scale of the SMP process (for example, actions related to the implementation of effluent infrastructure, expansion of effluent block size, fencing and land retirement) generally had lower rates of completion (Tables 3.1 & 3.2).

Table 3.1: Overview of actions for each sub-category within the six target management areas for the 254 farms analysed.

Management Area	Category	% of actions within each management target area	% actions completed
Nutrient	Nutrient budgets and understanding	41%	52%
(783 actions)	Review and manage nutrient use	6%	43%
	Stocking rate	0%	0%
	Effluent nutrient management	8%	34%
	Fertiliser application practices	19%	42%
	Feed management	1%	44%
Effluent	Effluent planning	30%	44%
(972 actions)	Infrastructure/inflow volume reduction	3%	39%
	Infrastructure/inflow capture	4%	31%
	Infrastructure/feed storage, wintering/feed pads	4%	33%
	Infrastructure/storage	5%	30%
	Infrastructure/application	5%	31%
	Infrastructure/health and safety	6%	33%
	Operation	7%	48%
	Monitoring	33%	36%
	Training and education	3%	57%
Waterways	Waterways planning	6%	38%
(471 actions)	Training and education	4%	43%
	Fencing and riparian	60%	35%
	Wetlands	6%	31%
	Significant natural areas	3%	17%
	In-stream	15%	41%
	Monitoring	1%	29%
	Other	6%	38%
Land	Cropping	20%	39%
(468 actions)	Pasture	2%	36%
	Tracks, races, stream crossings, critical source areas	47%	39%
	Off pasture (wintering, pugging, steep areas)	8%	38%
	Erosion control	4%	29%
	Planting for aesthetics, bees	2%	0%
	Drainage	9%	25%
	Farm waste	2%	56%
	Other	7%	35%
Water use	Consents	8%	36%
(565 actions)	Water meters	41%	32%
	Investigate water use efficiency options	23%	51%
	Improve efficiency dairy	5%	26%
	Improve efficiency farm reticulation	18%	40%
	Other	5%	42%
Waste	Storage and Management	61%	45%
(354 actions)	Other	39%	35%
Other (6 actions)	Other	100%	43%

Table 3.2: Summary of the top five actions within each management target area expressed as a percentage of the total number of farms.

Management area	Agreed actions	No of actions	% actions completed	% of farms
Nutrient	Implement, update, review nutrient management plan	139	54%	55%
	Update whole-farm nutrient budget to latest Overseer	113	44%	44%
	Improve records of fertiliser, effluent and/or supplementary feed applications	109	50%	43%
	Utilise nutrient budget and scenarios to understand nutrient loss drivers	92	72%	36%
	Improve/update soil nutrient and health monitoring	63	48%	25%
Effluent	Monitor application depth	135	46%	53%
	Effluent management policy	106	46%	42%
	Improve health and safety around pond	62	35%	24%
	Monitor nutrient concentration	61	23%	24%
	Review/investigate / effluent infrastructure upgrade	51	31%	20%
Waterways	Develop riparian planting plan	161	38%	63%
	Maintain stock exclusion	43	44%	17%
	Control erosion	42	50%	17%
	Carry out/re-establish Riparian planting	37	27%	15%
	Fence off waterways according to accord	28	46%	11%
Land	Manage runoff from tracks and races	114	45%	45%
	Implement/maintain sediment traps, settling ponds, detainment bunds, grass filters	57	33%	22%
	Manage stock crossings	53	42%	21%
	Improve crop cultivation practices	42	43%	17%
	Reduce crop runoff	42	33%	17%
Water use	Monitor water use	125	32%	49%
	Investigate efficiency options	97	60%	38%
	Improve water flow/loss	73	45%	29%
	Install water meter	69	25%	27%
	Investigate and water meter	51	41%	20%
Waste	Waste	153	52%	60%
	Create a contingency plan for spills	146	35%	57%
	Consumables	84	46%	33%
	CSA Management	24	67%	9%
Other	Farm mapping	19	63%	7%

Table 3.3: Summary of selected SMP mitigation strategies with a direct impact on nitrogen (N), phosphorus (P), sediment (S) and bacteria (B) loads. Percentage of farms carrying out each strategy is calculated from the 254 farms which have completed the full SMP process and were analysed for this study.

Management area	Mitigation strategy	Corresponding individual actions	N	P	S	B	Complete	Intended
Nutrients	**Review optimal effluent block and management**	-Review optimal effluent block size, location and/or application rate -Increase effluent area -Apply effluent to forage crops/crop effluent block/sidelings -Export effluent solids to cropping or runoff blocks -Reduce effluent application rate	√	√		√	10%	25%
	N fertiliser management	-Manage fertiliser application based on nutrient budget -Reduce N application (rates, timing, no winter application) -Improve N efficiency (N application with Progibb, LessN or sulphur, use of Ammo instead of urea, gibberellic acid, EcoN options, slow release products (Sustain) monitoring of soil temperature during application)	√				13%	24%
	P fertiliser management	-Manage/target P application to optimal Olsen P levels (apply P only for maintenance) -Reduce P application; use less soluble P fertiliser products where necessary		√			2%	7%
	Improve feed management to reduce N inputs	-Lower quantities of higher quality feed, improve feed efficiency, reduce imported protein feeds, feeding infrastructure, reduce wastage, import maize silage rather than using pastoral, silage, build a better bin	√				1%	2%
Effluent	**Improve effluent capture**	-Improve shed effluent capture and diversion to pond (extend nibbed area around shed, drain diverters) -Improve solids capture and management (install and upgrade sand and stone traps, regular cleaning and spreading of trapped material, install solids separator, improve storage of removed solids, install dung buster, improve wash down, adjust flow rates, sand trap overflow to pond) -Improve storm water runoff diversion -Improve rain water capture and recycling -Improve sludge management	√	√	√	√	9%	21%
	Improve containment of feed stores, feed pads	-Improve containment of feed stores -Improve effluent containment from feed pads, herd homes, -Improve storage of solids from feed pad	√	√		√	1%	2%
	Improve pond infrastructure and storage	-Install new (lined) pond, -Upgrade storage capacity - Improve pond lining -Improve pond agitation/stirring	√	√		√	2%	12%

Management area	Mitigation strategy	Corresponding individual actions	N	P	S	B	Complete	Intended
	Upgrade effluent infrastructure	- Upgrade effluent infrastructure (additional travellers, increase sprinklers, irrigator line, hydrants, pipeline leaks, filtration systems, solids separator, underground network, increased pump capacity, K-Line pods on slopes). -Install safety/alert systems -Improve effluent system application and performance	√	√		√	9%	21%
Waterways	**Stock exclusion**	-Fence off waterways according to Accord requirements -Fence off waterways additional to Accord requirements (seeps, springs, ponds, wet areas, drains)	√	√	√	√	7%	16%
	Riparian planting	-Carry out/re-establish Riparian planting	√	√	√	√	4%	12%
	Wetlands management	-Fence off/retire existing swamp and wetland areas -Plant existing swamp/ wetland areas - Restore natural or implement constructed wetlands; protect wetland through covenant -Maintain wetland water levels	√	√	√	√	3%	9%
Land	**Improve crop cultivation practices**	-Use minimum tillage forage crops, immediately re-sow crop paddocks to pasture after harvesting, spray and direct drill re-grassing procedures to minimise soil disturbance, chicory on winter crop paddocks, reduce crops near waterways, lengthen crop rotation, reduce crop area, thicken swards, cultivate along contours, no crops on slopes - Reduce cropping on steeper slopes	√	√	√		6%	16%
	Reduce crop runoff	- Reduce crop runoff through buffer strips -Improve crop grazing practices	√	√	√	√	6%	19%
	Time N fertiliser to crop demand	- Time N fertiliser application to meet crop demand	√				0%	0%
	Critical source areas laneways	- Manage runoff from tracks and races	√	√	√	√	16%	37%
	Critical source areas gates & troughs	-Manage runoff around gates and troughs	√	√	√	√	1%	2%
	Sediment management	-Implement/maintain sediment traps, settling ponds, detainment bunds, grass filters	√	√	√	√	7%	20%
	Manage stock crossings	-Put in/manage culverts, bridges	√	√	√	√	8%	19%
	Implement wintering strategies	-Build infrastructure shelters, loafing pads, stand-off/winter pads - Apply controlled grazing regimes	√	√	√	√	1%	2%

3.2 Mean reductions in farm nutrient losses

Mean potential reductions in farm nutrient losses following the successful completion of 40% of all intended SMP actions across all farms are estimated to be 2% for N (based on 217 farms) and 7% for P (198 farms). These reduction estimates are expected to increase to 4% for N and 9% for P when all actions across all SMP farms are fully implemented.

Potential reductions in N loss on individual farms ranged from 0 to 14% where actions targeting N were successfully completed (Fig. 3A). Nearly 70% of farms did not record a reduction in nitrogen losses as a result of SMP actions, as not all actions specifically targeted N reduction. There is a 2% difference in estimated N loss reduction between completed and intended actions. Many of the actions not yet complete relate to strategies targeting farm dairy effluent, for example effluent storage and infrastructure. These strategies were undertaken on many of the study farms and in turn have potentially large impacts on farm N loss compared to many of the other strategies applied. Actions that were easier to implement had higher completion rates. For example, monitoring effluent application depth (46% completion on 53% farms).

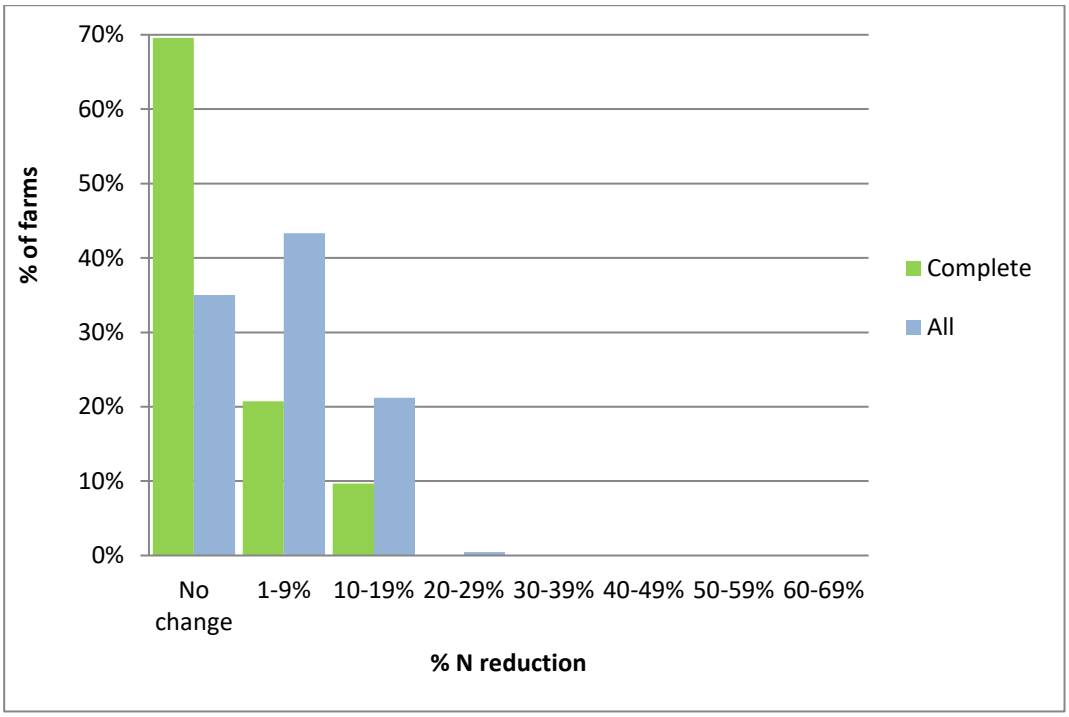
Estimated reductions in farm P loss ranged from 0 to 59% across individual farms for completed actions focusing on P (Fig.4b), increasing to 0 to 74% should all intended actions be completed. The largest reductions (>45% P reduction) occurred on farms where a combination of riparian management, management of critical source areas, and dairy effluent nutrient application was collectively carried out (Fig. 4b). Riparian planting was documented on 15% of farms analysed (Table 3.2) although 63% of farms were developing riparian planting plans (38% complete). Reductions in P losses were not observed for 50% of farms. This number is expected to decrease to 15% should all actions be competed (Fig. 3b).

Most incomplete actions for P were related to riparian planting, stock exclusion and farm dairy effluent. Collectively these strategies have large benefits for reducing farm P loss but may take much longer to implement than the project duration and are less able to be implemented in times of income stress. Mean reduction in farm P loss is estimated to more than double to 16% should all actions be completed in future.

The highest completion rates were observed for action relating to further understanding the farming system. For example, in the area of nutrient management, 36% of farms indicated they were going to utilise nutrient budgets and scenarios to understand nutrient loss drivers, of which 72% had completed these actions, and 55% of farms indicated they were going to implement, update and review their nutrient management plans (54% complete). These actions are not quantified as part of this study but will likely lead to more concrete action and have significant long-term effects on nutrient management efficiency.

Higher completion rates were also indicated for a range of other actions for which the impacts are unquantified in this report. For example, 38% of farms indicated they were going to investigate water use efficiency options, and this was 60% complete. 60% of farms indicated they would address waster management (52% complete) and 57% intended to create a contingency plan for spills (35% complete).

A



B

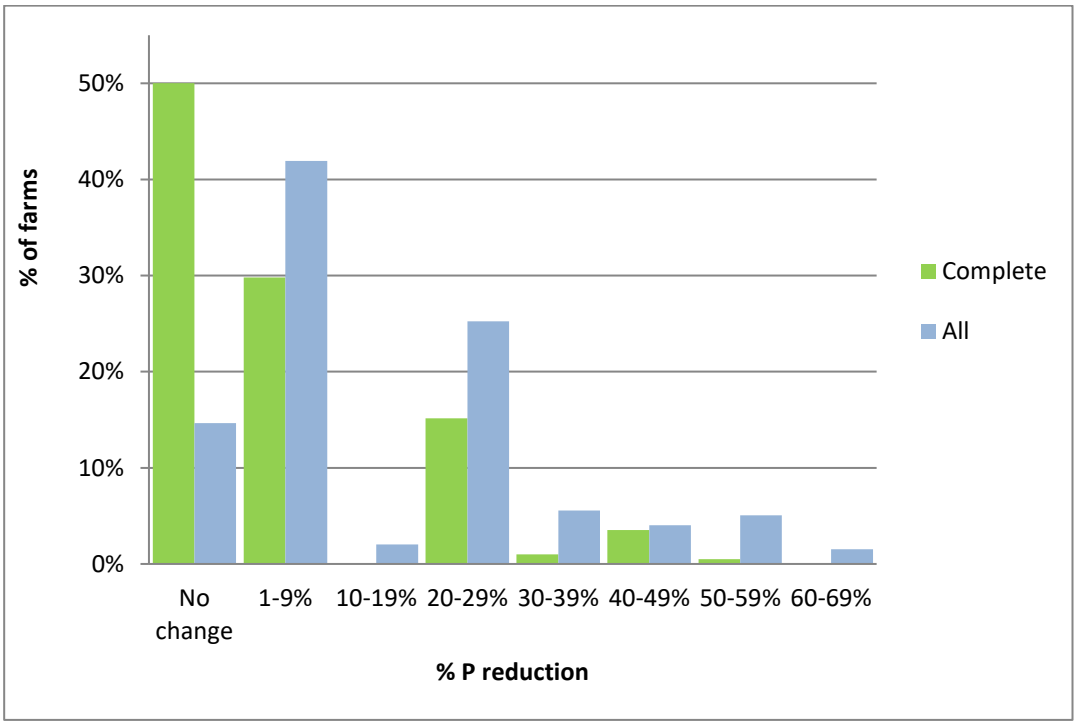
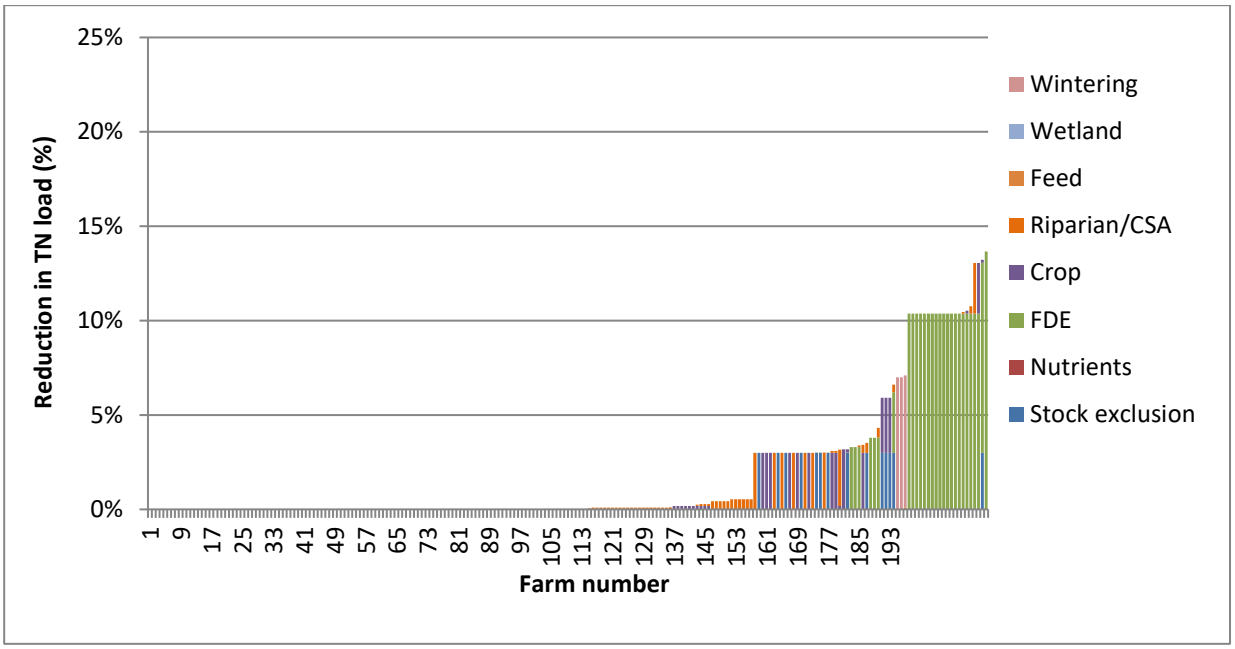


Figure 3: Distribution of farm (A) nitrogen (N) and (B) phosphorus (P) percentage reductions across individual farms for all actions and competed actions only (217 farms for N and 198 farms for P). No change reflects farms where recorded actions are not likely to impact on N and/or P loading directly, although all actions will ultimately lead to improved environmental performance and load reductions over the long term.

A



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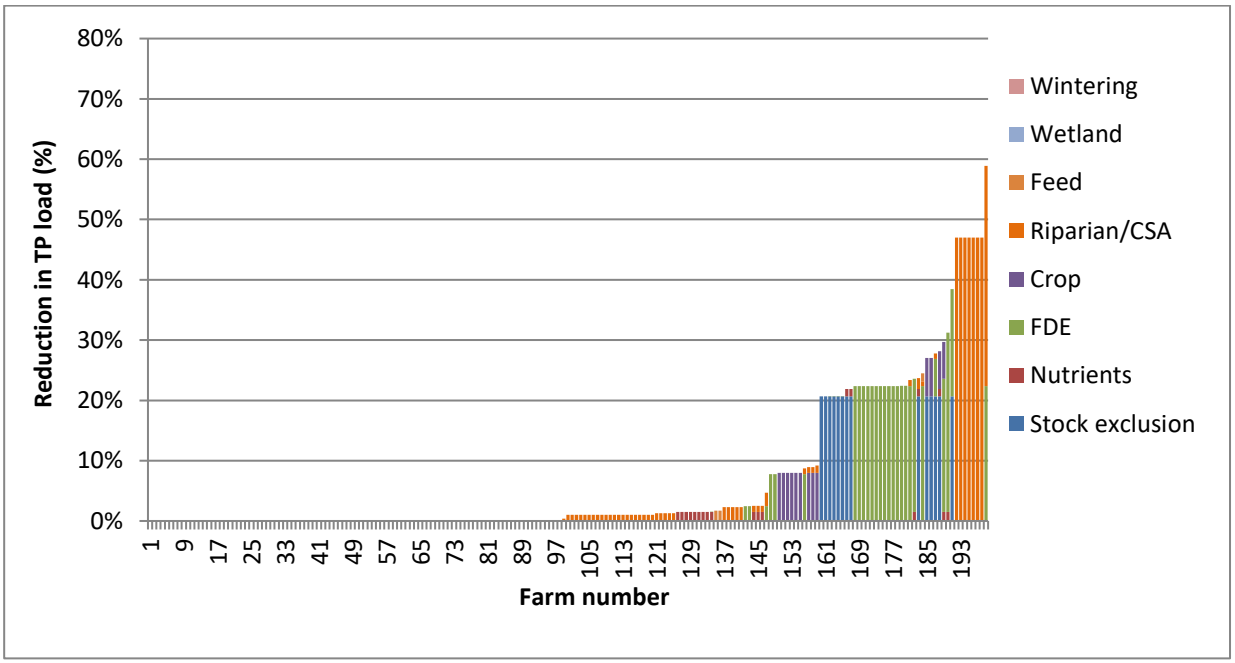
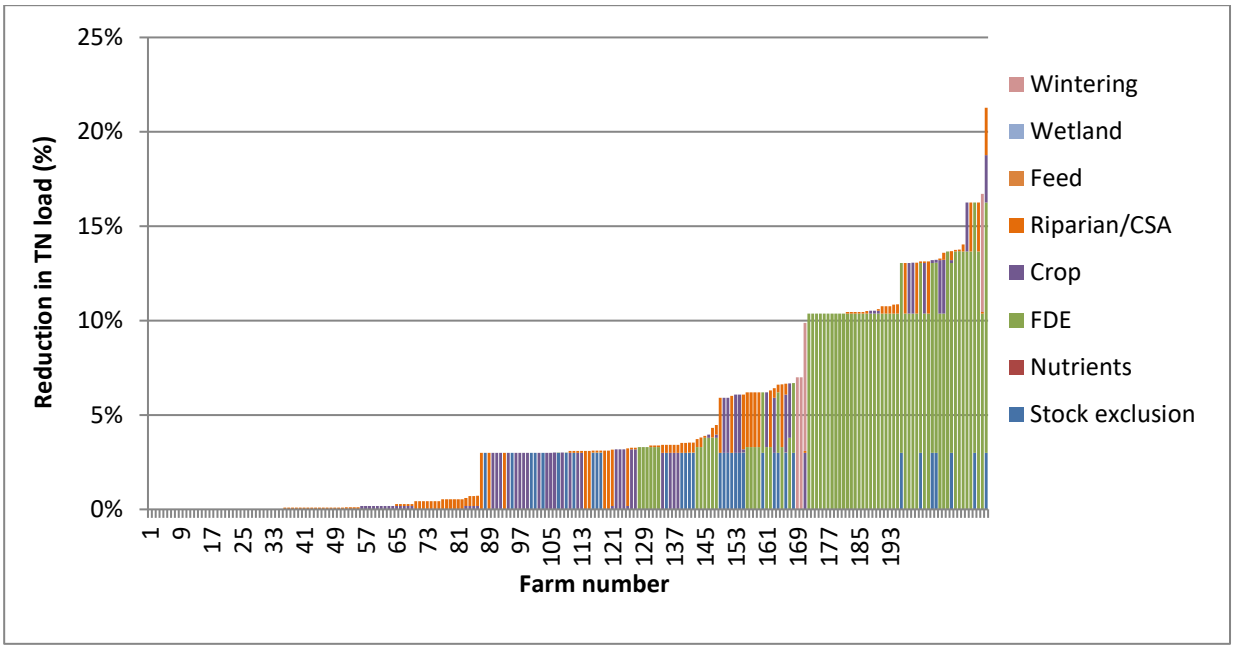


Figure 4: Estimated potential % reduction in farm (A) nitrogen (N) and (B) phosphorus (P) losses attributed to specific action categories following the successful completion of 41% of all SMP actions across individual farms. The mitigation actions represented in each category are summarised in table 3.3. Farms are ranked according to percentage N or P reduction, and farm nutrients are therefore different for N and P.

A



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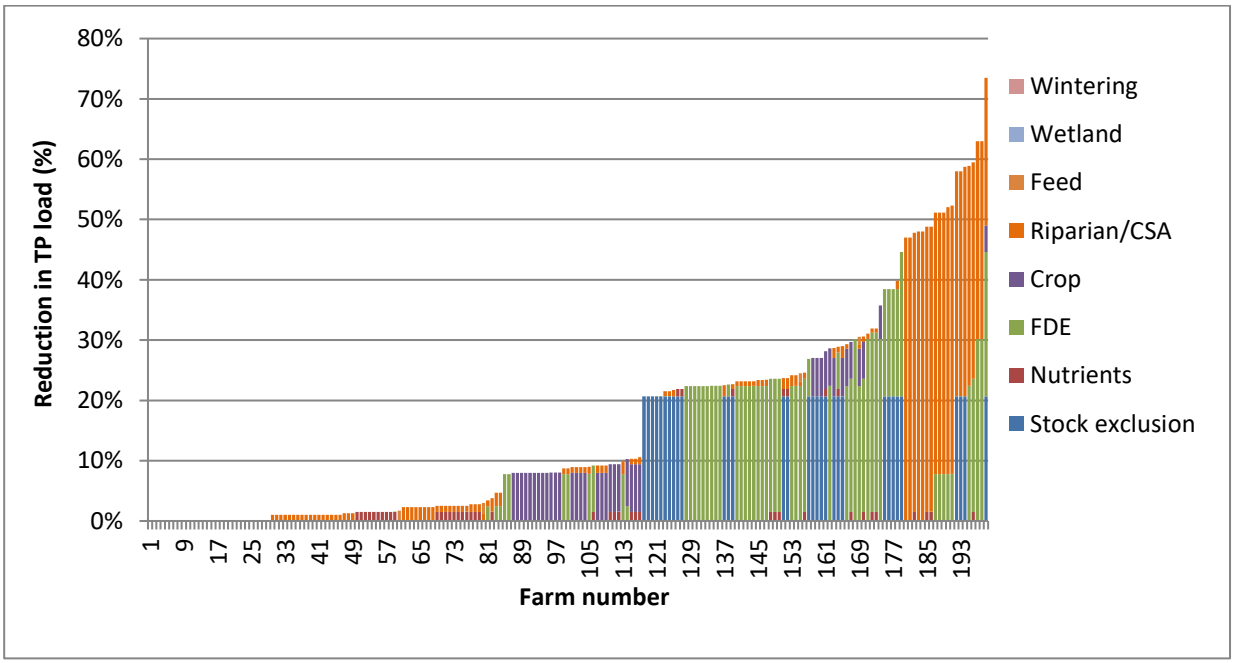

Figure 5: Estimated potential percentage reduction in farm (A) nitrogen (N) and (B) phosphorus (P) losses attributed to specific action categories following the successful completion of all SMP actions (complete plus intended) across individual farms. The mitigation actions represented in each category are summarised in table 5. Farms are ranked according to percentage N or P reduction, and farm nutrients are therefore different for N and P.

4 Summary and conclusions

The following success criteria were identified for the Waipā project:

1. All farmers in the catchment identify the risks, options and appropriate actions for their farm in a Sustainable Milk Plan and are working to complete the voluntary actions recorded in their plan
2. The collective actions of the 855 (revised to 285) farmers result in demonstrable reductions in dairy farm-sourced sediment, nutrient and faecal contaminant loads in the Waipā catchment and their subsequent effects on the Waipā and Waikato rivers
3. The capability of farmers and advisors in the catchment has increased
4. Farmers, as a result of participating in the project, are better prepared for the future.

4.1 Development of Sustainable Milk Plans

As described in the final report (Bramley et al. 2018), the Waipā project faced significant challenges in farmer engagement, resulting in the revision of the initial project goals. A number of factors contributed to these challenges: The very low dairy payout in the 2015-16 season and subsequent years meant that farm incomes were very low during the most crucial part of this voluntary project. The resulting financial stress for farmers may have affected their ability to complete planned actions on farm. In particular, more costly actions required longer timeframes to be carried out.

There was also a high level of uncertainty around impending changes to regional plan legislation: The Healthy Rivers/Wai Ora: Proposed Waikato Regional Plan Change 1 was notified on the 22nd of October 2016 for submissions. This set out proposed new rules for farmers in the catchment. One key rule was that farmers will need to do a Farm Environment Plan by set dates. Uncertainty around the final requirements under the new rules affected farmers willingness to take up Sustainable Milk Plans.

Another contributing factor was Fonterra's decision to develop Farm Environment Plans for all their farmers nationwide. At the end of 2017 they started to deliver these plans including in the Waipā. The project team had dialogue with Fonterra about the potential cross over with Sustainable Milk Plans. Some farmers opted out of the SMP's to do the Fonterra plans. However, the SMP's provided a foundation for these plans by initiating a planning process with farmers and getting them thinking and acting on risk areas on their farms.

4.2 Demonstrable reductions in contaminant loads

Despite the challenges outlined above, for the 285 farms that had completed the full SMP process by the end of August 2018 (of which 254 were analysed), small but demonstrable improvements were made in farm environmental performance, based on the modelling approach taken. The results of this analysis suggest that mean reductions in farm nutrient losses associated with all completed SMP actions are estimated to be 2% for N and 7% for P. These reduction estimates are expected to increase to 4% for N and 9% for P when all actions across all SMP farms are fully implemented.

Potential load reductions on individual farms for completed actions ranged from 0 to 14% for N and 0 to 59% for P, depending on the number and combination of actions being implemented. As observed in the Upper Waikato, the greatest reductions were observed for farms implementing multiple strategies around stock exclusion, optimised effluent/fertiliser applications for N, and riparian management plus critical source area protection, stock exclusion and dairy effluent nutrient applications for P.

As noted in the report on potential reductions in farm nutrient loads in the Upper Waikato (Burger et al. 2015), not all farms recorded actions with a direct impact on nutrient loading and this analysis represents the direct impacts of only a sub-set of actions undertaken through the SMP process. However, all actions

will ultimately lead to improvements in farm environmental performance over the long term and overall reductions in N and P loading are likely to be greater than calculated here.

The uncertainties and assumptions made in the process of developing the methodology used in this report are more fully described in Burger et al. (2015). However, it should be noted that the impacts associated with some action categories were excluded from the analysis due to the high level of uncertainty associated with their analysis. For example, retiring land as a strategy to prevent erosion is difficult to address as the area and slope of the land being retired needs to be known in order to estimate net benefits. These variables were not documented though the SMP process.

As outlined in the previous report, there is significant uncertainty and variability associated with quantifying efficacy rates attributable to different mitigation strategies. This analysis is limited in several ways. In particular, it is restricted to those actions where direct contaminant loss reductions could be attributed based on expert knowledge and/or published estimates. Many other actions are likely to have indirect or long-term benefits. In addition, the analysis provides estimates on potential N and P load reduction only. The impact of actions on sediment were not quantified in this report, although sediment was a primary focus of the project, identified as a priority for the Waipā by the Waikato Regional Council (WRC) and emphasised in the consultant training.

4.3 Capability of farmers and advisors

The SMP process raised awareness, broadened the perspective and increased the capability of farmers to complete plans and improve their environmental performance (Bramley et al. 2018). As noted in previous sections, the highest completion rates were observed for action relating to further understanding the farming system. For example, in the area of nutrient management, 36% of farms indicated they were going to utilise nutrient budget and scenarios to understand nutrient loss drivers, of which 72% had completed these actions, and 55% of farms indicated they were going to implement, update and review their nutrient management plans (54% complete). These actions are not quantified as part of this study but contribute significantly to building farmer's understanding of their systems, as well as preparing them for future farm planning which will likely be required under the Healthy Rivers/Wai Ora: Proposed Waikato Regional Plan Change 1.

While the project has not directly reached all dairy farmers in the project area, the importance of farmer-to-farmer communication in the process of on-farm practice change is widely acknowledged and it is likely that the flow-on effects of capacity building conducted during the SMP process will continue to catalyse change long after the project itself ends.

As described in the final report (Bramley et al. 2018) a key focus of the project has been developing the capability of consultants for the delivery of farm environmental plans through training, the provision of resources, ongoing mentoring and direct review and feedback on the plans produced. Relationships with the consultants has been an important factor throughout and the training process and materials developed have also been subject to ongoing feedback and improvement.

4.4 Farmers better prepared for the future.

As noted in the final report (Bramley et al. 2018), the main underlying goal of the SMP process has always been to prepare farmers for the future. Farm environmental plans are now being implemented into many regional policy processes nationwide and signalled from within the industries themselves (as per the Dairy Tomorrow Strategy and Good Farming Practice Action Plan). With the increased interest in farm environmental planning around the country, the value of the SMP process as a forerunner of other farm environment planning processes is becoming more and more evident in the range of direct and indirect ways the experience gained through this project is being fed into other processes.

5 References

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