Appendix 1

OVERSEER Nutrient Budget software

OVERSEER Nutrient Budget software

Background

OVERSEER is a long term equilibrium model that models nutrient flows in a farming situation providing a full picture of a farm's nutrient movements, including producing both nutrient and greenhouse gas reports. OVERSEER makes use of long term average climatic data, soil information, and season specific input information from the farmer, assisting farmer decision making to achieve the best use of farm nutrients.

OVERSEER is able to model a large range of farm types and systems, including dairy, sheep, beef and deer farming.

OVERSEER is owned by MPI, AgResearch, and the New Zealand Fertiliser Association through the OVERSEER Limited parent company. OVERSEER Limited is operated as a not-for-profit corporate entity with an annual budget of 2.25 million. The value of the benefits OVERSEER brings to the agricultural sector and New Zealand have been estimated at $271 million per year, through improvements to farm fertiliser application, farm nutrient management on-farm and agricultural research.

OVERSEER was originally developed in 1982 as a tool to support farmer decision making in relation to nutrient use and has evolved over time to the model it is today. In recent times, regional councils have begun to use OVERSEER as a regulatory tool (from 2007 under the Waikato Regional Plan Variation 5 – Lake Taupo Catchment).

Access to OVERSEER and expert users

OVERSEER is presently available free of charge. Any farmer or any other member of the public can access the OVERSEER software and use this software to conduct farm assessments or analysis. Using OVERSEER to generate a reliable farm assessment however requires strong knowledge of farm systems and an understanding of OVERSEER specific data input requirements.

The Fertiliser Association of New Zealand has established the 'Nutrient Management Adviser Certification Programme' to build and uphold a transparent set of industry standards for nutrient management advisers to meet, so that they provide nationally consistent farm nutrient budgets and advice using the OVERSEER software. For this training to have real value it is also highly desirable that expert users also have strong knowledge of farm systems.

Nutrient Management Advisor Certification Programme Limited presently list 162 currently practicing certified nutrient management advisors.[1] Of these, 117 are listed as working for Ravensdown (fertiliser provider, 58), Balance Agri-Nutrients (40), DairyNZ (3), Fonterra (14) or a regional council (2), leaving 45 certified nutrient management providers who may be working as consultants.

Regional councils require farmers to engage a certified nutrient management advisor to report nitrogen under nitrogen limiting regulations. OVERSEER reports not produced by certified advisors are generally not accepted.

Present use

[1] See http://www.nmacertification.org.nz/Site/Nutrient_Management/Certified_Advisers/default.aspx , retrieved September 2017.

Data entry will adopt a differing degree of precision depending on the purpose the OVERSEER file will be used for.

When a certified nutrient management advisor is preparing an OVERSEER report for regulatory purposes, the advisor is required to sight farm records to ensure the highest degree of data accuracy. A minority of farmers will have undertaken such an assessment using OVERSEER.

Close to 100% of dairy farmers will have a current OVERSEER file generated for the purposes of estimating farm fertiliser needs. These assessments are likely to be based on a mix of written records and information provided by a farmer.

Farmers are also supplying information to dairy processors under the dairy industry's nitrogen reporting programme. Farmers are able to supply information through an online portal, through a mail form or by supplying an existing OVERSEER file.

Uncertainty in model estimates

There are two sources of uncertainty in OVERSEER estimates.

The first arises from inconsistent data input practices and the ability of farmers to accurately measure farm parameters. For example, the weight of animals may be approximated, time stock spent off pasture is unlikely to be measured by a farmer and / or the volume of supplementary feed that is spilt and not consumed by stock will be estimated. We are not aware of any published report that measures this uncertainty.

The second avenue of uncertainty relates to the normal uncertainty within biophysical relationships.

An assessment by Ledgard and Waller in 2001 is the only current published report that has compared measured drainage nitrate nitrogen with modelled farm block drainage nitrate nitrogen estimates.[2]

Ledgard and Waller stated "An indication of the imprecision in the long-term estimate of average nitrate leaching for pastoral systems is about ±20%. ... Consequently, an estimate of nitrate-N concentration in drainage will have a greater uncertainty than the estimate of the amount of nitrate-N leached, at approximately ±25-30%."

While these conclusions relate to a previous version of OVERSEER, OVERSEER Limited state the range is considered to be very good for a complex biophysical model such as the present version of OVERSEER.

OVERSEER Limited state that, "A figure of ±30% uncertainty would be useful only as a conceptual starting point for any discussion about whole farm nitrogen drainage loss estimates modelled with Overseer version 6 [the current version]. This level of uncertainty is considered to be very good for a complex biophysical model. It is important that it is understood that this level of uncertainty is normal in any biophysical modelling, not just Overseer. No biophysical model will ever be 100% accurate."

Estimate of biological emissions

[2] Ledgard, S. F., & Waller J. E. (2001). *Precision of estimates of nitrate leaching in OVERSEER*. Client report to FertResearch.

A recent assessment by de Klein et al (2017) noted some errors in OVERSEER's current estimate of biological emissions.[3] These related to calculations for stock dry matter intake and the calculation of farm specific nitrous oxide emissions factors.

An estimation of farm biological emissions first requires an estimation of farm dry matter intake. OVERSEER uses a different method to estimate dry matter intake to that used in the New Zealand Agricultural Greenhouse Gas Inventory (the Inventory). Nevertheless, if the error identified is corrected, OVERSEER's calculation produces very similar results to the calculations used in the Inventory (average 2% variation).

OVERSEER includes flexibility to allow users to define the emissions factors used in calculating biological emissions. Options to use Inventory emissions factors are available and generally applied as default settings.

OVERSEER also allows users to calculate nitrous oxide emissions using a farm specific emissions factor, based on farm specific soil conditions. This calculation is also experiencing error at present.

De Klein et al recommended that, for the purposes of calculating farm greenhouse gas emissions, all default emissions factors within OVERSEER be the same as those in the Inventory (i.e. no longer use farm specific nitrous oxide emissions factors as a default setting), and that farm specific nitrous oxide emissions factors be disabled until the methods underpinning these are carefully reviewed.

While OVERSEER currently requires some amendments to accurately calculate biological emissions, OVERSEER is capable of producing a robust estimate of biological emissions with minimal update. For the purposes of our assessment, it is appropriate to view OVERSEER as a suitable option to calculate biological emissions.

If OVERSEER was used to estimate biological emissions in any of the scenarios described in our assessment, data protocols used by certified nutrient management advisors would need to be updated to include direction on biological emissions relevant OVERSEER settings (such as emissions factors) and potentially minor improvements to some methods of data capture. Training courses for certified nutrient management advisors would need to be updated and existing certified nutrient management advisors would need to undertake an update course.

[3] De Klein, C., van der Weerden, T., Kelliher, F., Wheeler, D. & Rollo, M. (2017). *Initial review of the suitability of OVERSEER Nutrient Budgets Model for farm scale greenhouse gas reporting (DRAFT).* AgResearch.

Appendix 2

Cost estimate methodology report

Methodology report

Contents

1 Method

We have designed a method that provides a second-order approximation of the administration costs associated with each scenario identified. This approximation provides a meaningful estimate of the comparative costs of different options and allows BERG members to understand the approximate total cost of any individual scenario.

We have engaged with stakeholders to understand potential barriers associated with each scenario. We have analysed key mitigations for selected barriers.

Our assessment of costs has been somewhat limited by the uncertainties involved with each scenario. Uncertainties relate to both how each scenario may be implemented in practice and the burden various scenarios would place on regulators. In many cases stakeholders were unsure exactly what level of resource would be required to service a scenario and / or were unable to disclose information due to commercial sensitivity.

1.1 Key Steps in Analysis

Beca began our analysis by conducting a project initiation workshop with a sub-committee of BERG. At this workshop we discussed the method, assumptions and scenarios that that would be used. Method, assumptions and scenarios were then confirmed following post-workshop consultation with BERG.

Beca mapped each scenario to understand the processes involved and where costs and barriers would fall. These maps were used to compile a list of quantities that needed to be estimated.

Quantities that need to be estimated relate to both a list of costs that are relevant for at least one scenario, for example, the cost per hour of a farm consultant, and a series of throughputs, for example, the total consultant hours per farm assessment and the total farms assessed each year.

This approach allowed us to define a manageable list of throughputs that would need to be estimated for one or more scenarios, and unit costs that would need to be estimated to drive costs in each throughput. These costs and quantities are listed in this Appendix.

This approach resulted in simplifying assumptions being made across each scenario.

After this initial mapping exercise we engaged key experts and stakeholders to further identify potential barriers, and gain an initial estimate of costs and throughput quantities (i.e. hours needed per farm assessment).

Overall, stakeholder engagement was successful. On occasion stakeholders were either unable to identify costs or unable to disclose costs.

A simple excel model was to estimate costs across five years of the introduction of a scenario and long-term annual costs.

Figure A1 outlines the steps described.

Step 1: Confirm method, assumptions and scenarios with BERG	Step 2: Map the interactions and processes involved in each scenario	Step 3: Compile an inventory of costs and quantities that need to be estimated	Step 4: Interview key stakeholders / experts in order to confirm scenario maps, understand barriers and estimate quantities	Step 5: Model costs based on quantities identified and overlay own expert view of barriers

Figure A1: Key steps in analysis

1.2 Analysis Boundaries

We have included administration costs from the conclusion of the legislative process or similar (policy development and consultation are excluded) up to the point at which enforcement options would need to be engaged (costs of audit are included, court costs and other enforcement costs are excluded).

Only those costs which participants (government, sector organisations or farmers) are required to take are included. For example, where sector organisations are likely to undertake farmer extension but not required to do this by the scenario in question, this cost is not included. For example, if an On-farm point of obligation scenario was implemented agricultural organisations may undertake programmes to support farmer participation.

This assumption impacts for which scenarios the cost of farmers undertaking a farm environment plan / emissions reduction plan are included:

- We have assumed that under the Regulated biological emissions levels scenario, farmers who do not meet biological emissions limits are required to undertake an emissions reduction plan. The cost of engaging a rural professional is therefore included as an administration cost.
- Within the Government-industry agreement scenario we have assumed agricultural processors will estimate farm biological emissions and provide high-emissions farmers with emissions reduction advice. We have therefore assumed this is an administration cost for agricultural processors (it is an essential part of this scenario).
- It is *possible* that under an On-farm point of obligation scenario farmers who have high emissions liabilities may choose to engage the advice of a rural professional to support minimising their farm ETS liability. However, as this is something farmers may choose to do as a result of the incentives the ETS places on farmers, this is not included as an administration cost.

1.3 Assumptions Applied

The aim of our assessment is to understand the costs and barriers of a range of scenarios to mitigate biological emissions. We are not seeking to undertake detailed policy development.

In the event that any of the mitigation scenarios identified were implemented, there are policy decisions that would need to be made. Many of these decisions will impact the administration costs of that scenario.

We have therefore needed to apply a number of assumption to our analysis. For example, the criteria for farming enterprises to be excluded from policies on the basis of small size of operation. These assumptions are applied and defined for the purposes of providing clarity to our analysis. We have not made any judgements as to what the optimal policy settings within each scenario may be.

1.3.1 Present Mitigation Options available to Farmers

Administration costs and barriers under different scenarios will at times be driven by the need to verify farm information. For example, where a farmer is able to receive recognition of mitigation from the use of 'low-emissions' breeding, this will have different verification costs and barriers to mitigation through, for example, reduced stock numbers.

The New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC) has recently completed a report for BERG on 'On-farm options to reduce agricultural GHG emissions in New Zealand'.[4] This report noted the following options available to farmers in New Zealand to reduce **absolute**[5] emissions:

1. "Improving the productivity/efficiency of farm systems, by increasing the proportion of feed consumed by animals that contributes towards the production of milk and meat, and adjusting stocking rates downwards to deliver absolute emissions reductions."

2. "Reducing the GHG emissions for a given amount of feed, e.g. by replacing high-protein feeds with feeds that have a lower protein (nitrogen) content and hence reduce the amount of nitrous oxide emitted (and nitrogen leached) per unit of feed eaten."

3. "Reducing the amount of feed eaten by reducing the total livestock production on a farm, accompanied by less feed grown per hectare and/or purchased, and/or turning parts of the farm area towards alternative land uses."

These could be summarised as:

1. Improving the efficiency of converting feed into product,

2. Reducing the emissions per unit of feed, and

3. Reducing production.

1.3.2 Expanded list of tools and technologies

We have established an additional list of tools and technologies that may be available in the future. This allows Beca to test scenarios against both existing mitigation options and potential mitigation options in the future. We consulted with the New Zealand Agricultural Greenhouse Gas Research Centre. This consultation identified as a full list of tools and technologies:

1. Reducing animal numbers or production;

2. Improving farm efficiency and production per unit of greenhouse gas emissions;

3. Reducing nitrogen inputs such as fertiliser and the nitrogen content of supplementary feed;

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[4] Reisinger, A., Clark, H., Journeaux, P., Clark, D. & Lambert, G. (2017). *On-farm options to reduce agricultural GHG emissions in New Zealand*. New Zealand Agricultural Greenhouse Gas Research Centre

[5] Mitigation measures can reduce 'absolute emissions' or 'emissions intensity'. Absolute emissions refers to reduction in total greenhouse gas emissions from the farm system. Emissions intensity refers to the level of emissions per unit of product, for example, greenhouse gas emissions per kilogram of milk solids, kilogram of beef live weight

4. Improved effluent management, either standing animals off pasture or systems that mitigate manure management methane (bio-digester);

5. Pastures or feeds that reduce methane or nitrous oxide emissions (brassicas have already been shown to do this, potential for GMO ryegrass in future);

6. Selective breeding for low-emissions stock;

7. Methanogen vaccine, methanogen inhibitor or similar;

8. Nitrification inhibitor or similar, applied to pasture or coated on fertiliser;

9. Purchase of New Zealand ETS units (NZUs).

We have assumed a potential methanogen vaccine would be dosed annually and that a potential methanogen inhibitor is supplied through a slow release 'bolus', also applied once a year.

Purchase of emissions trading units will be an important option available to farmers under emissions trading scheme options. Strictly speaking, this option would not be considered a 'mitigation'.[6] For the purposes of our analysis however it is a further farmer action that could be undertaken under mitigation scenarios.

We assume that each of these technologies will be able to be captured in the New Zealand greenhouse gas inventory in the event they are verified under a mitigation scenario. Analysis of each mitigation scenario will assess potential barriers to verification.

1.3.3 Exclusion of Forestry or Soil Carbon Emissions and Removals

Note we have not included forestry or soil carbon emissions or removals in our analysis. We have defined our analysis as scenarios to mitigate **biological** emissions.

Converting pastoral land to forestry will result in two processes that reduce greenhouse gas emissions: firstly, there will be a reduction in biological emissions as ruminant production decreases; secondly, there will be an increase in forestry removals as new forest planting removes carbon from the atmosphere. We have included verification of the reduction in biological emissions but not the increase in forestry removals.

Note that policy frameworks for forestry removals are already well established, specifically the inclusion of afforestation removals and deforestation emissions in the emissions trading scheme.

1.3.4 Liable Entity

With regards to our assessment of a scenario where biological emissions face surrender obligations under the ETS at the farm level, we are assuming the liable entity is the **business owner**. This assumption is

[6] Emissions trading results in the shifting of a right to emit from one enterprise to another, rather than an actual emissions reduction. This is different to emissions offsetting, which results in an emissions reduction outside the boundary of the emitting activity.

based on the conclusions of the MPI Technical Paper “Reporting Agricultural Emissions at the Farm Level”, produced by KPMG (the KPMG Report).[7]

The KPMG Report also suggests that obligations for agricultural greenhouse gas emissions be limited to ‘economically significant enterprises’, as per the Statistics New Zealand definition.

Under the Statistics New Zealand definition of economically significant enterprise, an enterprise must meet at least one of the following criteria:

- Annual expenses or sales subject to GST of more than $30,000;
- 12-month rolling mean employee count of greater than three;
- Part of a group of enterprises;
- Registered for GST and involved in agriculture or forestry; or,
- Over $40,000 of income recorded in the IR10 annual tax return (this includes some units in residential property leasing and rental).

1.3.5 Farm Participants

Some scenarios will require farmers to undertake an assessment of farm emissions. For such scenarios we have assumed that an exemption will apply to farms under a certain threshold.

In practice, as per the recommendations of the KPMG Report, obligations may be limited to economically significant enterprises.

For the purposes of this report, we require an assumption of the number of farmer participants under each of the scenarios that requires farmer actions. We have made the following assumptions:

- We have defined dairy farms of less than 10 hectares as non-commercial. This is based on milk solids per hectare and farm working expenses and revenue per kilogram of milk solids contained in the DairyNZ
- Beef+LambNZ have communicated to Beca that they report approximately 12,000 sheep and beef farms in New Zealand as commercial. This roughly corresponds to sheep and beef farms greater than 80 hectares.
- For simplicity, we have assumed a further 500 deer farms in New Zealand are economically significant. This corresponds to a threshold of 80 hectares also for a deer farm.

The key aspect for this report is an assumption that any action within a scenario that relates to farms will apply to 24,000 enterprises. In places we have also applied different assumptions to dairy farms and sheep, beef and deer farms, and in these occasions simply assumed a 50:50 split between dairy and non-dairy farms.

Table A1 displays the number of farms reported in the 2012 Agricultural Census above alternative threshold hectare levels. Assumed threshold levels for dairy, sheep and beef and deer farmers are shown in bold. Overall, this leads to an assumption of 24,000 farmer participants in scenarios that require farmer compliance action.

[7] KPMG. (2013). *Reporting Agricultural Emissions at the Farm Level.* Ministry for Primary Industries

Table A1: Number of participant farms under different exemption assumptions

Farm type	Number of farms above threshold No exemptions	10 ha	20 ha	40 ha	60 ha	80 ha	100 ha	200 ha
Dairy	12,147	**11,580**	11,433	11,145	10,503	9,459	8,232	4,134
Sheep and beef	25,116	20,391	17,721	14,868	13,209	**12,234**	11,325	8,490
Deer	1,125	1,032	915	699	597	**522**	459	270
Assumed farms included in reporting schemes								**24,000**
Total farms in New Zealand								38,388

Source: 2012 Agricultural Census tables, Statistics New Zealand

Note this approach leads to a disproportionate amount of sheep and beef farm exemptions (over 50% of sheep and beef farms are exempt). In many cases however such farms are likely to be what is known as a ‘lifestyle block’ rather than a commercially orientated farming enterprise. For example, 7,400 sheep and beef farms are under 20 hectares in size. It is likely appropriate to assume this high level of exemption for sheep and beef enterprises compared to dairy enterprises.

1.3.6 Calculation of Farm Emissions

Two scenarios require an estimate of farm enterprise biological emissions for regulatory purposes. A third scenario includes voluntary reporting of biological emissions. We have considered two alternatives in relation to an assumption for how farm biological emissions would be calculated under such a situation.

Firstly, farmers may be asked to submit a list of key parameters to government. This could include, for example, stock numbers, milk production, effluent management system, time stock spend off pasture, fertiliser use, etc. The government would then calculate farm greenhouse gas emissions based on these parameters.

A second scenario involves this calculation being performed by farmers and farmers then submitting an estimate of biological emissions to government.

This issue was discussed at the workshop held with a BERG sub-group on July 20th 2017. The view was that Beca should assume that the OVERSEER nutrient budget software is used to estimate biological emissions. An existing programme exists under which rural professionals can become ‘Certified Nutrient Management Advisors’ and this equips rural professionals with the knowledge required to produce an OVERSEER report for regulatory purposes. Either this OVERSEER report or an output from this report (a farm biological emissions report could be developed for OVERSEER), would then be submitted to the government.

Further detail on OVERSEER is provided in Appendix 1.

1.3.7 Emissions Trading Scheme

We have based our assessment on the assumption that New Zealand continues to have an emissions trading scheme for all other sectors. As a result, we assume the government is already running an emissions registry and private sector organisations are offering brokering services for NZUs.

In the event that the New Zealand emissions trading scheme was repealed, the costs presented and barriers identified for scenarios that include biological emissions entering the emissions trading scheme would need to be revised. Likely, costs and barriers would be significantly greater.

1.3.8 Dairy Sector Nitrogen Reporting

The dairy sector is already asking farmers to supply information required to model nitrogen loss from farms. The same information can be used to estimate biological emissions. Where scenarios required farmers to submit information to agricultural processors for the calculation of biological emissions, we assumed there was no additional cost for dairy farmers to do this.

Stakeholders estimated that approximately 4000 dairy farmers are already reporting nitrogen loss to regional councils using a certified nutrient management advisors. We assumed that 4000 dairy farmers had an existing obligation to undertake an initial OVERSEER report and this was therefore a ‘sunk cost’. We also assumed these dairy farms undertook this assessment on average once every two years, and discounted our cost estimate accordingly.

2 Identification of Mitigation Scenarios

A workshop was held between Beca and a sub-committee of BERG on the 20th July 2017. Amongst other things, this workshop undertook a process to develop a long-list and short-list of scenarios to mitigate biological emissions. Beca undertook some further analysis immediately following this workshop, further refining the long-list and short-list of options considered, in consultation with the BERG sub-committee.

2.1 Long List of Mitigation Scenarios

In undertaking a long-listing exercise scenarios were identified that used either different regulatory mechanisms and / or included a different focus of regulation.

The regulatory mechanism identified were:

1. Emissions trading: the government places emissions trading obligations on biological emissions.
2. Direct regulation: the government regulates biological emissions mitigation.
3. Incentives for action: the government provides financial incentives for biological emissions reduction.
4. Voluntary industry action: the agricultural industry adopts voluntary standards that encourage or require farmers to reduce biological emissions.

The different possible focuses of scenarios identified were:

a. Farm inputs: scenarios focus on reducing stock numbers and / or fertiliser use.

b. Farm practices: scenarios focus on increasing use of mitigation technologies and practices.

c. Farm outputs: scenarios include an estimation of farm biological emissions and then directly focus on reducing the specific level of farm biological emissions.

Table A2 maps out a long-list of options that are identified by considering the two variables of regulatory mechanism and focus of regulation.

Table A2: Long-list of mitigation scenarios

	A. Farm Inputs (stock, fertiliser use)	B. Farm practices (use of technology)	C. Outputs (estimate of farm biological emissions)
1. Emissions Trading	Option 1A. Emissions trading scheme with a processor point of obligation. Emissions factors are based on stock numbers slaughtered, milk production and fertiliser use.	Option 1B. Emissions trading scheme with a processor point of obligation. Emissions factors are based on stock numbers, milk production and fertiliser use. Rebates are available where technologies or practices are used (eg. Use of low-emissions breeding).	Option 1C. Emissions trading scheme with on-farm point of obligation. Farmers annually assess farm biological emissions and face an emissions obligation.

	A. Farm Inputs (stock, fertiliser use)	B. Farm practices (use of technology)	C. Outputs (estimate of farm biological emissions)
2. Direct regulation	Option 2A. Regulation of farm inputs. For example, regulated maximum stock per hectare.	Option 2B. Regulated farm practices. Government considers mitigation options individually and regulates use of specific practices, for example, low-emissions breeding may become mandatory within artificial breeding programmes.	Option 2C. Regulated biological emissions. Farmers periodically assess farm biological emissions and must, within a specified timeframe, operate within mandated biological emissions limits.
3. Incentives for action	Option 3A. Payments (or carbon credits) for reduced stock numbers, fertiliser use, etc. Government provides incentive payments for farmers who voluntarily reduce stock numbers or fertiliser use.	Option 3B. Payments (or carbon credits) for use of mitigation technologies. Government subsidises mitigation technologies and practices and / or provides a payment to farmers who use mitigation technologies and practices.	Option 3C. Payments (or carbon credits) for achievement of farm greenhouse gas emissions levels. Where farmers can demonstrate low-emissions production they may apply for and receive payment from the government.
4. Voluntary industry action	Option 4A. Agricultural processors encourage reductions in stock intensity and fertiliser use (would include industry extension services).	Option 4B. Industry agrees voluntary use of new mitigation technologies (would include industry extension services).	Option 4C. Industry develops voluntary programme to benchmark and reduce farm biological emissions (would include industry extension services). Achievement of emissions reduction plans are voluntary.

2.2 Short Listing of Mitigation Scenarios

Mitigation scenarios were short listed within the workshop based on if they were considered realistic in a New Zealand context and also if inclusion of the option supported analysis across a spectrum of mitigation scenarios. Table A3 displays a high-level consideration of different options under this approach. Note that by including scenarios that represent a broad spectrum of possibilities it is possible that approximate administration costs and barriers to implementation can be inferred for scenarios not included in the short-list, based on similar scenarios that have been assessed.

Table A3: Multi-criteria analysis of long-list of options

	Option											
	1A	1B	1C	2A	2B	2C	3A	3B	3C	4A	4B	4C
Feasible in a New Zealand context	√√	√	√√		√	~				√	√	√
Support spectrum of analysis	√		√		√	√		√			√	
Total	**3**	**1**	**3**		**2**	**1.5**		**1**		**1**	**2**	**1**
Scenarios taken forward	√	~	√		√	√		√			√	~

2.2.1 Further Discussion on Shortlisting of Options

Options that provided farmers payments for greenhouse gas emissions have been employed in overseas jurisdictions. For example, the Australian Carbon Farming Initiative allows farmers and land managers to earn carbon credits by storing carbon or reducing greenhouse gas emissions on the land (these credits represent an incentive).

These options were however not considered feasible in a New Zealand context. The agricultural sector in New Zealand is generally opposed to policies that subsidise agricultural production both in New Zealand and abroad. Likewise, the New Zealand government's approach to greenhouse gas regulation thus far has been to transfer responsibility for emissions reductions from the Crown to emitters. Over the course of multiple iterations of public consultation on greenhouse gas mitigation there has been little request for policies that operate in this nature.

One option was taken forward to support analysis across a spectrum of options. Taking option 3B forward, that provides incentives for the use of mitigation technologies, allowed an approximate understanding of Option 1B, which provided rebates to farmers who used mitigation technologies while also introducing biological emissions into the emissions trading scheme. Option 1b could be considered to be a combination of Option 1a and 3b.

Options 3a, 3b and 3c are considered not mutually exclusive. For example, the Dairy Action for Climate Change (2017) already includes elements of both option 3b and 3c.

All short-listed options have parallels in either: greenhouse gas policies implemented in New Zealand for other sectors (ETS options), policies implemented in New Zealand for other environmental externalities (regulatory options), options implemented for biological emissions in other countries (Option 3B) and options used in the agricultural sector for water quality issues (voluntary industry action).

Note not all options are mutually exclusive. Specifically, voluntary industry action in water quality issues has been supported also by regulation at a later date. For example, fencing of waterways on dairy farms was initially conducted across a large majority of dairy farms under voluntary industry action prior to becoming a regulated requirement.

2.3 Final List of Mitigation Scenarios Considered

The final short list agreed at the workshop were:

Scenario 1) Emissions Trading Scheme - Processor Point of Obligation (Option 1a in long-list)

Scenario 2) Emissions Trading Scheme – On-farm Point of Obligation (Option 1c in long-list)

Scenario 3) Regulated Biological Emissions Levels (Option 2C in long-list)

Scenario 4) Regulated Farmer Interventions (Option 2B in long-list)

Scenario 5) Voluntary industry adoption of best practice (Option 4a, 4b and 4c in long-list)

Scenario 6) Government incentives for farm practices (Option 3b in long-list).

We have reordered and renamed some of these scenarios in our final report.

2.3.1 Potential Scenario Combinations

The scenarios identified are not necessarily mutually exclusive. A number of scenarios lend themselves to being combined.

As an example of combined measures, dairy farmers in New Zealand have fenced a large volume of waterways as a result of the Dairying and Clean Streams Accord (2003) and the Sustainable Dairying: Water Accord (2013), mitigation options for water quality similar to Scenario 5.

Recently the government has moved to make fencing of waterways on dairy farms mandatory, an option similar to Scenario 4. In introducing a discussion document on this policy Minister Nick Smith said the following:

> *"Farmers have made great progress in fencing nearly 24,000 kilometres of waterways, but it is now time for regulation to bring the stragglers in line." (Media release, February 20 2016)*

We have not completed an additional cost estimate for these scenarios, rather, simply discussed in our final report how our estimates of cost could be applied to these scenarios and potential barriers to bundling scenarios in this way.

3 Detailed assumptions and estimate of costs

3.1 Estimate of costs

In total, we were able to limit our assessment to 17 individual cost estimates. Table A4 lists these cost estimates and the source utilised.

Table A4: List of cost estimates

List of costs	Cost estimate	UOM	Notes	Source / notes
Government policy analyst / sector policy analyst	$180,000	FTE	Includes salary and overheads	Public information, confirmed with stakeholders
Government regulatory analyst	$160,000	FTE	Includes salary and overheads	Public information, confirmed with stakeholders
Government auditor (FTEs) / processor accountant / processor administration	$500	per hour	Hourly cost. Includes overheads.	Public information.
Farm advisor (provided to farmers by processors to support participation) (FTEs)	$180,000	FTE	Includes salary and overheads.	Based on rural consultant fees. Note overheads are expected to be higher due to travel and training requirements.
Additional 0800 CLIMATE FTEs	$95,000	FTE	Includes salary and overheads. This is the ETS support phone.	Stakeholder consultation. Public information.
Farm advisor (rural consultant / sector organisation)	$175	per hour	Hourly cost. Includes overheads.	Stakeholder information.
Farm manager compliance time (hours)	$36	per hour	Does not include overheads (considered minimal)	Public information (average salary of $65,000)
Vet technician	$100	per hour	Hourly cost. Includes overheads. *Only used for additional information on cost of verification of methanogen vaccine and inhibitor.*	Stakeholder consultation.
Brokerage fee (minimum)	$500	Minimum transaction fee	This is a minimum fee, applies only to transactions less than 10,000 NZUs	Consultation with NZU broker
Account establishment fee	$0	One off fee	One-off account establishment fee. Alternative scenarios assume account establishment fees are used	Consultation with NZU broker

List of costs	Cost estimate	UOM	Notes	Source / notes
			to reduce on-going brokerage costs.	
Brokerage fee (large purchase / in house NZU trader)	$0.05	per NZU (for transactions greater than 10,000 NZU)	This is the effective price for all transactions greater than 10,000 NZUs, where prices exceed the minimum fee.	Consultation with NZU broker
Annual OVERSEER fee / contribution	$0	per annum fee	OVEERSEER Limited is required to be a not-for-profit. Users may face a charge as a result of emissions trading, but this would not be additional on the sector (reduce costs faced elsewhere OVERSEER use).	Stakeholder consultation.
Information System (annual)	$200,000	per annum	Upgrade required for on-farm biological emissions reporting.	Information has been poor from stakeholders on IT costs. This is an estimate.
Information System (set-up)	$1,000,000	Set up	Upgrade required for on-farm biological emissions reporting.	Information has been poor from stakeholders on IT costs. This is an estimate. Impacts transition costs only.
Upgrade to ETS Registry	$1,000,000	Set up	Required to handle a greater number of transaction and transactions, improve protection from hacking, etc.	Information has been poor from stakeholders on IT costs. This is a rough estimate. Only impacts transition costs.
Government change management programme.	$170,000	per annum	Impacts transition costs only. Doubled for On-farm point obligation scenario.	Consultation with MPI, own analysis.
Government communication	$40,000	per year	E-newsletters to farmers	Stakeholder consultation.

We have considered also including costs associated with training new certified nutrient management advisors. Stakeholder informed us that this is a two stage course. Stage one is a short course and costs includes a $1500 course fee plus time for undertaking the course, travel and accommodation. Stage two is a six month course which includes two two-day courses 3 case studies, which each take 2-3 days to complete, plus general course work. Certifying circa 50 new nutrient management advisors would be a significant cost.

We judge that this cost of training is already included in the price farmers pay for a rural consultant ($175 per hour). We have used this price to also estimate the cost per full time equivalent (FTE) for farm advisors. Including this as a separate cost would amount to 'double counting'.

3.2 Scenario quantities

A number of quantities were estimated to drive costs through the model.

3.2.1 Time required for farm emissions estimates

Table A5 displays the hours assumed for each farm to undertake an estimate of farm biological emissions. Stakeholders noted that each subsequent report would require less time to undertake. This was due to some information being replicated and also farmers building an understanding of what information is needed and taking measures to maintain easy to access records for this information.

For Scenario 5 we assumed farmers would self-report key information. We assumed no additional time for dairy farmers to undertake this, as the sector has an existing nitrogen self-reporting programme which can be utilised to also report biological emissions.

Hours for standard OVERSEER assessments required both farm managers and certified nutrient management advisors. Hours for ‘OVERSEER Lite’ and self-reporting only required farm manager time.

Table A5: Assumed time requirement for farm emissions estimate (hours)

	Average	Dairy	Other
Hours per OVERSEER assessment year 1	4.0	3.0	5.0
Hours per OVERSEER assessment year 2	3.0	2.5	3.5
Hours per OVERSEER assessment (ongoing) and hours to	2.5	2.0	3.0
Hours per ‘OVERSEER Lite’ assessment	2.5	2.0	3.0
Hours voluntary self-reporting of key information (dairy is already doing this)	1.5	-	3.0
Hours farm reduction plan and review	40 (plan)	20 (review)	

3.2.2 Compliance rates

We assumed a 95% compliance rate for On-farm point of obligation and Regulated biological emissions, and a 80% compliance rate for Government-industry agreement. The compliance rate for the Government-industry agreement represents the percentage of farmers who self-report key parameters required for biological emissions.

Table A5: Compliance rate assumptions

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5 and out-years
On-farm point of obligation	5%	35%	65%	95%	95%	95%
Regulated biological emissions limits	5%	35%	65%	95%	95%	95%
Government-industry agreement	5%	35%	65%	80%	80%	80%

3.2.3 Audit

Table A6 displays the assumptions applied to the audit regime. Estimates of the time per audit and the number of audits needed are highly uncertain. Audit levels in the ETS are generally quite high, with an aim to frequently audit every participant. Such an aim is not possible for farmer participants.

We assumed emissions reduction plans were not audited. This was a surplus requirement as the level of biological emissions the farm reported was already subject to audit.

Table A6: Assumptions applied to audit regime

	Processor and mitigation technology suppliers	Farm reporting	Reduction plans	Nutrient advisors	Farm reports (use of methanogen vaccine)
Time per audit (hours) (includes potential mileage)	40	20	20	40	2
% audit	10%	1.0%	0.0%	10%	1.0%

3.2.4 Other parameters

Other parameters defined in the cost estimate model are listed in Table A6.

Table A6: Estimates of other parameters

Parameter	Estimate	Notes
Farmer time to establish account with NZU broker	2 hours	

Parameter	Estimate	Notes
Annual hours subsequent years	1 hour	
Number of processors	70	Based on ETS Annual Report
Number of mitigation technology suppliers	30	Estimate
ETS compliance time - Processor	40 hours	This includes any time engaging with broker, estimating emissions, engaging with EPA, submitting emissions return.
ETS compliance time – Farmer	2 hours	This is time depositing NZUs to EPA.
Time to set up registry account (EPA)	1 hour	
Time to set up registry account (farmer)	1 hour	

3.3 Scenario assumptions

Table A2 displays the assumptions used within each scenario. Numbers in red indicate areas of high uncertainty. This table is used in the model to drive scenario costs. For example, a '2' in IT System for On-farm point of obligation indicates a doubling of this cost.

Table A7: Scenario assumptions

	Processor point of obligation	On-farm point of obligation	NZU allocations for low-emissions technologies	Regulated biological emissions limits	Regulated use of mitigation technologies or practices	Government-industry agreement
Government Policy Analysts	2	2	2	2	2	1
Use of OVERSEER	0	1	0	1	0	1
Upgrade to ETS Registry	0	1	0	0	0	0
IT System (receive farmer information)	0	2	0	1	0	0
Regulatory Analysts	0.2	18	4	2	2	1
0800 Number Staff	0.2	8	2	2	2	1
Frequency of Certified Nutrient Report	0	1	0	0.33	0	0
Emissions reduction plan frequency	0	0	0	0.33	0	0.33
Frequency self-reporting	0	0	0	0	0	1
Processor administration (emissions returns)	1	0	2	0	0	0
Processor administration of self-reporting (FTEs)	0	0	0	0	0	1.25

	Processor point of obligation	On-farm point of obligation	NZU allocations for low-emissions technologies	Regulated biological emissions limits	Regulated use of mitigation technologies or practices	Government-industry agreement
Number of Audits (processors)	7	0	2	0	2	0
Number of Audits (farm reporting)	0	228	0	228	0	0
Number of Audits (farm records)	0	0	120	0	120	0
Number of Audits (reduction plans)	0	0	0	0	0	0
Number of nutrient advisors (total)	0	58	0	47	0	19
Number of Audits (nutrient advisors)	0	1	0	0	0	0
Communication	0	1	1	1	1	1

3.3.1 Detailed scenario costs

Detailed cost estimates are presented in Table A8. The scenario assumptions in Table A7 drive the costs presented in Table A8. All input parameters and input costs are estimated to two significant figures. In the main assessment all costs are rounded to two significant figures also. The costs contained in Table A8 are raw outputs.

Table A8: Detailed breakdown of scenario cost estimates

	Processor point of obligation	On-farm point of obligation	NZU allocations for low-emissions technologies	Regulated biological emissions limits	Regulated use of mitigation technologies or practices	Government-industry agreement
Total operating costs	**$2,739,718**	**$39,356,297**	**$3,581,836**	**$15,347,491**	**$1,296,800**	**$6,908,039**
Government direction	$360,000	$360,000	$360,000	$360,000	$360,000	$180,000
Use of OVERSEER	$0	$0	$0	$0	$0	$0
Upgrade to ETS Registry	$0	$1,000,000	$0	$0	$0	$0
Regulatory Analysts	$32,000	$2,880,000	$640,000	$320,000	$320,000	$160,000
IT System (receive farmer information)	$0	$400,000	$0	$200,000	$0	$0
0800 Number Staff	$19,000	$760,000	$190,000	$190,000	$190,000	$95,000
Certified Nutrient Manager Report (rural professional)	$0	$9,143,750	$0	$3,657,500	$0	$0
Certified Nutrient Manager Report (farmer)	$0	$1,886,806	$0	$754,722	$0	$0
Biological emissions self-reporting	$0	$0	$0	$0	$0	$1,040,000

	Processor point of obligation	On-farm point of obligation	NZU allocations for low-emissions technologies	Regulated biological emissions limits	Regulated use of mitigation technologies or practices	Government-industry agreement
Processor administration of self-reporting	$0	$0	$0	$0	$0	$225,000
Emissions Reduction Plans (rural professional)	$0	$0	$0	$3,990,000	$0	$3,326,400
Emissions Reduction Plans (farmer)	$0	$0	$0	$823,333	$0	$686,400
Audit (auditor)	$140,000	$2,291,692	$102,000	$2,289,354	$102,000	$3,899
Audit (farmer / processor time)	$140,000	$164,667	$68,667	$164,667	$68,667	$0
Brokerage	$192,098	$11,400,000	$384,196	$0	$0	$0
Compliance time - ETS	$1,400,000	$1,646,667	$800,000	$0	$0	$0
Compliance time - brokerage	$0	$823,333	$0	$0	$0	$0
Communication to farmers	$0	$40,000	$40,000	$40,000	$40,000	$40,000

3.3.2 Transition costs

Transition costs were also estimated for core scenarios. Table A9 displays the raw estimate of transition costs associated with core scenarios.

Table A9: Estimate of transition costs of core scenarios

	Processor point of obligation	On-farm point of obligation	NZU allocations for low-emissions technologies	Regulated biological emissions limits	Regulated use of mitigation technologies or practices	Government-industry agreement
Total cost over first five years	**$14,130,589**	**$166,461,358**	**$19,361,178**	**$107,904,710**	**$7,528,000**	**$58,100,409**
Year 0	$432,000	$4,102,248	$636,000	$4,728,021	$636,000	$912,795
Year 1	$2,739,718	$15,548,775	$3,785,836	$20,266,523	$1,500,800	$5,656,244
Year 2	$2,739,718	$21,357,011	$3,785,836	$21,192,923	$1,500,800	$9,837,014
Year 3	$2,739,718	$45,087,842	$3,785,836	$24,477,686	$1,296,800	$12,228,359
Year 4	$2,739,718	$40,601,184	$3,785,836	$18,619,778	$1,296,800	$13,830,119
Year 5 and out-years	$2,739,718	$39,764,297	$3,581,836	$18,619,778	$1,296,800	$15,635,879